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SPECIFICATIONS BOOK

WASTEWATER TREATMENT PLANT EXPANSION

FOR

CITY OF PEMBROKE, GEORGIA



June 5, 2025

MES No. 2020-48

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A. GENERAL SPECIFICATIONS

SECTION 01001
GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 COMMENCEMENTS AND PROSECUTION OF WORK

- A. Contract time shall begin at which time the Owner will issue a written Notice to Proceed. The Contractor must commence construction within ten (10) days of issuance of a written Notice to Proceed. The Contractor shall maintain sufficient labor and supervision on the job until all items have been completed and the Engineer's Final Certification has been issued.

1.02 COOPERATION

- A. The General Contractor and Sub-Contractors shall cooperate with one another and with other Contractors doing related work and shall coordinate their work with the work of other trades and other Contractors so as to facilitate the general progress of the work. Each trade shall afford all other trades and all other Contractors every reasonable opportunity for the installation of their work and for the storage of their materials.

1.03 SANITARY FACILITIES, TEMPORARY

- A. Do not allow any sanitary nuisances to be committed in or about work; enforce sanitary regulations of Local and State Health authorities.

1.04 SITE EXAMINATION OF EXISTING CONDITIONS

- A. The Contractor, in undertaking the work under this Contract, is assumed to have visited the premises and to have taken into consideration all conditions which might affect his work. No consideration will be given to any claim based on a lack of knowledge of existing conditions, except where the Contract Documents make definite provisions for adjustment of cost or extension of time due to existing conditions that cannot be readily ascertained.

1.05 SPECIFICATIONS EXPLANATION

- A. Attention is directed to the fact that the detailed specifications and separate sections may be written in short or abridged form. In regard to every section of the specifications and all parts thereof, mentioned therein or indications on the

drawings or articles, materials, operations, or methods required that the Contractor:

1. Provide each item mentioned and indicated (of quality or subject to qualifications notes).
 2. Perform (according to the conditions stated) each operation prescribed.
 3. Provide therefore all necessary labor, equipment, and incidentals.
- B. Wherever in these specifications or on the drawings the words "directed", "required", "ordered", or words of like import are used, it shall be understood that the directions, requirements, permission, or order of the Engineer is intended; and similar words "approved", "accepted", "satisfactory", or words of like import shall mean approved, acceptable to, or satisfactory to the Engineer.
- C. For the convenience of reference and to facilitate the letting of Contracts or Sub-Contracts, these specifications are separated into titled sections. Such separation shall not, however, operate to make the Engineer an arbiter to establish limits to the Contracts between the Contractor and Sub-Contractors, nor shall such operation be interpreted as superseding normal union functions.
- D. Notwithstanding the appearance of such language in the various divisions of the specifications as "The Electrical Contractor", "The Roofing Contractor", etc., the Contractor is responsible to the Owner for the entire Contract and the execution of all work referred to in the Contract Documents.

1.06 STANDARD

- A. Wherever reference is made to the standard specifications of nationally known organizations and specific articles, sections, divisions, or headings are not given, such specifications shall apply in full. Standard specifications were included herein by abbreviation or otherwise shall form a part of this specification the same as if quoted in full.
- B. The Engineer may require, and the Contractor shall furnish if required to do so, certificates from manufacturers to the effect that the products or materials furnished by them for use in the work comply with the applicable specified requirements for the materials or products being furnished.

1.07 TELEPHONE, TEMPORARY

- A. Contractor shall provide mobile telephone numbers for the Project Superintendent and Project Foreman either prior to or during the Preconstruction Meeting.

1.08 TEMPORARY UTILITIES

- A. Contractor shall furnish water, electricity, and heating fuel necessary for construction. The contractor shall provide necessary temporary piping, faucets, valves, wiring, switches, outlets, etc., to carry services to the work. The Contractor shall make all temporary utility connections for his own use and remove temporary services on completion of the Contract.

1.09 WORK OUTSIDE OF THE PROPERTY LINE

- A. All work outside of the property line called for by the Contract Documents shall be performed by the Contractor and all costs for same shall be included in the Contract.

1.10 AS-BUILT DRAWINGS

- A. The Contractor shall, upon completion of the work, furnish a marked set of drawings showing field changes affecting the various mechanical trades, utilities, and electrical, as actually installed and as specified under those sections of the specifications, and deliver them to the Engineer. The engineer will furnish prints to the Contractor for marking.

1.11 LIQUIDATED DAMAGES

- A. Substantial Completion - If the Contractor neglects, fails, or refuses to achieve Substantial Completion of the work by not later than 12 A.M. (Midnight), the Contractor shall pay to the Owner, Liquidated Damages in the amount of three hundred dollars (\$300.00) per calendar day for each and every day that the Contractor is in default after the date indicated on the Notice to Proceed.
- B. Final Completion - If the Contractor neglects, fails, or refuses to complete the work by not later than 12 A.M. (Midnight), the Contractor shall pay to the Owner, Liquidated damages, in the amount of three hundred dollars (\$300.00) per calendar day for each and every day that the Contractor is in default after the date indicated on the Notice to Proceed. Liquidated Damages for Substantial Completion and Final Completion are cumulative.
 - 1. The said amount is fixed and agreed upon by and between the Contractor and the Owner because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the Owner would in such an event sustain, and said amount is agreed to be the amount of damages which the Owner would sustain and said amount shall be retained from time to time by

the Owner from current Progress Payment should the construction progress fall behind schedule.

2. Time is of the essence of each and every portion of this Contract and of the specification wherein a definite and certain length of time is fixed for the performance of any act whatsoever; and where under the Contract an additional time is allowed for the completion of any work, the new time limit fixed by such extension shall be of the essence of this Contract.
3. Extensions of time apply to Liquidated Damages only and shall be allowed only for conditions over which the Contractor has no control, such as acts of God, transportation strikes affecting the delivery of materials or equipment which are used in the project, manufacturing strikes affecting the production of materials or equipment which are used in the project, and weather above and beyond the normally expected loss of time-based on historical climatological conditions over the last 10 years. For any time requested over what should be expected based on historical climatological conditions the amount of rain or temperature must meet the following conditions. To get credit for delays due to temperature the temperature must be at a level that would prevent construction in accordance with the other sections in these specifications. In order to get credit for a rain delay, the rain event must be persistent for more than four hours during that day and rainfall must be in excess of 0.5" for that 4-hour period or more than 1" during the day.

1.12 MATERIALS PRIOR APPROVAL AND SUBSTITUTIONS

- A. Where items of equipment and/or materials are specifically identified herein by a manufacturer's name, model, or catalog number, only such specific item may be used in the base bid, except as hereinafter provided.
- B. If Contractors wish to use items of equipment and/or materials other than those specifically identified in the Specifications, Contractor shall apply in writing to the Engineer for approval of substitution at least seven (7) days prior to the opening of bids, submitting with his request for approval complete descriptive and technical data on the item(s) he proposes to furnish.
- C. Approved substitutions will be listed in an addendum issued to all General Contractors prior to the opening of bids.
- D. Unless requests for changes in the Specifications are approved prior to the opening of bids, as defined above, the successful Contractor will be held to furnish

specified items. After the contract is awarded, changes in specifications will be made only as defined under "Substitution of Equipment".

1.13 SUBSTITUTION OF EQUIPMENT AND MATERIALS

- A. After execution of the contract, substitution of equipment and/or materials other than those specifically named in the Contract Documents will be approved by the Engineer for the following reasons only:
 - 1. That the equipment or material is no longer available.
 - 2. That the equipment or material does not perform the function for which it was intended.
 - 3. That the equipment or material cannot be delivered due to conditions beyond the Contractor's control.
- B. To receive consideration, requests for substitutions must be in writing accompanied by documentary proof of equality, and difference in price and delivery, if any.
- C. In case of a difference in price, the Owner shall receive all benefits of the difference in the cost involved in any substitutions, and the contract altered by change order to credit the Owner with any savings so obtained.

1.14 INSPECTING AND TESTING OF MATERIALS

- A. Wherever in these Contract Documents inspecting and testing of material is called for, the selection of bureaus, laboratories, and/or agencies for such inspecting and testing shall be made by the Engineer, and the character of the test shall be stipulated by the Engineer. Documentary evidence satisfactory to the Engineer that the materials have passed the required inspection and tests must be furnished in quadruplicate to the Engineer by the bureau, agency or laboratory selected. Materials satisfactorily meeting the requirements of the inspection or tests shall be approved by the Engineer and the Contractor notified of the results. The cost of such inspecting and testing shall be paid for by the Contractor.

1.15 ON-SITE TESTING AND INSPECTING

- A. Wherever in these Contract Documents testing or inspecting is called for, the selection of bureaus, laboratories, and/or agencies for such testing or inspecting shall be made by the Engineer. Documentary evidence satisfactory to the Engineer that the materials have passed the required tests or inspections shall be furnished

in quadruplicate to the Engineer. The cost of such tests and inspections shall be paid for by the Contractor.

1.16 MEASUREMENTS AND DIMENSIONS

- A. Before ordering materials or doing work which is dependent on the proper size of installation upon coordination with site conditions, the Contractor shall verify all dimensions by taking measurements at the site and shall be responsible for the correctness of same. No consideration will be given to any claim based on differences between the actual dimensions and those indicated on the drawings. Any discrepancies between the drawings and/or specifications and the existing conditions shall be referred to the Engineer for adjustment before any work affected thereby is begun.

1.17 SHOP DRAWINGS

- A. Shop drawings shall be dated and contain: Name of the project; description and names of equipment, materials, and items; and complete identification of locations at which material or equipment is to be installed, reference to the section of the specifications where it is specified and drawings number, where shown. In addition to the above, the Shop drawings shall: (1) show complete information for checking and for fabrication, installation, and erection, without reference to other drawings or notes; (2) shall be of drafting line work and lettering that is easily readable under field conditions; (3) have plane oriented the same as plans on the Contract Drawings; (4) list grade, class, or strength of materials; (5) be checked and initialed by the suppliers drafting room checker; (6) be checked and coordinated with other phases of the work, by a person in the Contractor's employ who is experienced and qualified in the checking and coordination of shop drawings.
 - 1. No exceptions taken. (If checked here, fabrication may be undertaken. Approval does not authorize a change to contract sums unless stated in a separate letter or by change order.)
 - 2. Note markings. (If checked here, fabrication may be undertaken. The contractor is to coordinate markings noted.)
 - 3. Revise and resubmit.
 - 4. Rejected.
 - 5. Engineer review is for conformance with the design concept of the project and compliance with the information given within the Contract Documents only. The Contractor is responsible for dimensions being confirmed and correlated at the site; for information that pertains solely to the fabrication

processes or to means, method, techniques, sequence, and procedures of construction; and for coordination of the work of all trades.

6. Failure to note a noncompliance will not prevent later rejection when the noncompliance is disclosed.
- B. Shop drawings shall not, after having been submitted, be later issued with revised or additional materials, except for items corrected during the checking by the Contractor or reviewed by the Engineer.
- C. The following notation will be used by the Engineer in his review.
- D. Submission of Shop drawings shall be accompanied by a transmittal letter in duplicate, containing the project name, Owner's project number, Contractor's name, and a number of drawings, title, and other pertinent data.
- E. The Contractor shall promptly submit to the Engineer, five copies of Architectural items and six copies of Engineering items, required by the Contract Documents in accordance with the aforesaid schedule so as to cause no delay in his work or in the work of any other Contractor.
- F. For standard items not requiring special shop drawings for manufacture, submit six copies of the manufacturer's product data showing illustrated cuts of the items to be furnished, scaled details, size dimensions, performance characteristics, capabilities, wiring diagrams, control, and all other pertinent information.
- G. The Contractor shall: (1) check, coordinate, correct, stamp, date, and sign all copies of each drawing, and deliver them to the Engineer for his review; (2) identify the set of drawings he has checked; this set shall be shown by checked marks or correction that every item has been verified and with the requirements of the Contract Documents.

1.18 MAINTENANCE MANUAL

- A. Contractor shall, prior to completion of the contract, deliver to the Engineer, three copies of the manual, assembled and bound with a hardcover, for the Owner's guidance, full details for care and maintenance of visible surfaces and of equipment included in the contract.
- B. Contractor shall, for this manual, obtain from subcontractor, literature of manufacturers relating to equipment, including motors; also furnish cuts, wiring diagrams, control diagrams, instruction sheets, and other information pertaining to same that will be useful to Owner in overall operation and maintenance.

- C. Where the above-described manuals and data are called for under separate sections of the specifications, they are to be included in the manual description in this article.

1.19 ELECTRONIC MEDIA

- A. Contractor may request an electronic file of construction plans in its native AutoCAD format for convenience during construction. The initial cost for preparation of the file shall be \$1,000.00, due prior to receipt of the file. The contractor must subscribe to obtain all updates to the file when and if plans are modified. The cost for each update provided to the Contractor shall be \$200.00. Prior to receipt of the file, the Contractor must execute an Indemnification Agreement with P.C. Simonton and Associates, Inc. dba M.E. Sack Engineering. Transmission of the file to, or use by, any third party is prohibited.

END OF SECTION

SECTION 01150
MEASUREMENT AND PAYMENT

PART 1- GENERAL

1.01 QUANTITIES

- A. Quantities: Quantities listed in the Proposal are approximate only and are intended to serve as a guide in comparing bids and may be increased or decreased without invalidating the unit price bid.
- B. Payment: The contractor shall be paid for actual in-place quantities as determined by the Engineer's field measurements.
- C. Discrepancies: In case of discrepancies between the figures shown in the unit prices and totals, the unit prices shall apply, and the totals shall be corrected to agree with the unit price.

1.02 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall bear the responsibility for delivery of equipment, spare parts, special tools, and materials to the site and shall comply with the requirements specified herein and shall provide required information concerning the shipment and delivery of the materials specified. Manufacturer shall supply detailed storage instructions, as necessary, at the time of shipment. These requirements also apply to any sub suppliers making direct shipments to the Site.
- B. Equipment shall be delivered on site. All exposed openings shall be protected to prevent entrance of debris, moisture or water during transportation and storage. Contractor shall unload material and sensitive equipment/material must be store out of the weather.
- C. All items shall be checked against packing lists immediately on delivery to the site for damage and for shortages. Damage and shortages shall be remedied with the minimum of delay.
- D. Delivery of portions of the equipment in several individual shipments shall be subject to review of Engineer before shipment. When permitted, all such partial shipments shall be plainly marked to identify, to permit easy storage, and to facilitate eventual installation.

- E. Contractor shall guarantee all equipment against faulty assembly, defective workmanship, breakage, or other failure. Materials shall be suitable for service connections. Connections shall be manufactured at standard sizes so that unit can be installed in the field

PART 2 - MEASUREMENT AND PAYMENT

2.01 GRADING

- A. Measurement: Measurement will be made on the basis of the percent completion of the item of work. All cut and fill quantities are based on the difference between initial topographic data and proposed contours shown on the plans.
- B. Payment: Payment will be made at the price bid for each item. Work shall include all equipment, labor, and material to complete each task. This item will include but is not limited to excavation, material transportation and placement, grading to the lines and grades shown on the plans, compaction, and stabilization.

2.02 DEMOLITION

- A. Measurement: Measurement shall be made on the basis of the percentage of completed items in accordance with the plans, specifications, and bid documents.
- B. Payment: Payment will be made on the basis of the completed item of work. The lump sum price shall include furnishing all labor, materials, and equipment necessary to complete this item of work. Work shall include, but is not limited to, removal of any storm pipe, drainage structures, carport and storage building including the water and sewer line associated, headworks, forcemain, water lines, fire hydrants or other material that exist and will not be used as part of this project, plug and seal of the existing water well, excavation, disposal at an approved site, backfill, compaction and surface restoration.

2.03 GRANITE ROADWAY BASE

- A. Measurement: Measurement shall be made on the basis of the number of square yards of graded aggregate base applied to the parking lot and roadway at the specified thickness, as shown on the construction plans. Irregular areas such as turnouts, filler strips, and intersections will be measured to the closest

square yard. Prior to the installation of the asphalt, all areas will be checked for proper thickness.

- B. Payment: Payment will be made on the basis of the number of square yards of granite crusher run (graded aggregated) base at the specified thickness applied to the roadway at the unit price stated in the bid. The price shall include all labor, equipment, and material to complete the task. Work shall include, but not be limited to, the furnishing, hauling, placing, and compaction of the crusher run base in order to bring the base to the lines, grades, and cross sections shown on the construction plans or established by the Engineer.

2.04 ROCK DRIVE

- A. Measurement: Measurement will be made on the basis of the number of square yards of granulated rock drive in place, in accordance with the construction plans and accepted by the Engineer.
- B. Payment: Payment will be made on the basis of the number of square yards of granulated rock drive in place in accordance with the unit price bid as stated in the contract. Work shall include, but is not limited to, the furnishing, hauling, placing and compaction of the granulated rock in order to bring the drive to the grades and cross sections as designated on the construction plans and as determined by the Engineer.

2.05 ASPHALT PAVING

- A. Measurement: Measurement will be made on the basis of the number of square yards of asphalt in place, in accordance with the construction plans and accepted by the Engineer.
- B. Payment: Payment will be made on the basis of the number of square yards of asphalt in place in accordance with the unit price bid as stated in the contract. Work shall include, but is not limited to, the furnishing, hauling, placing and compaction of the asphalt in order to bring the pavement to the lines, grades and cross sections as designated on the construction plans and as determined by the Engineer. The unit price bid shall also include surface cleaning, prime, and tack.

2.06 DISCHARGE, GRAVITY SEWER, AND STORM DRAINAGE PIPE AND STRUCTURES

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.

- B. Payment: Payment will be made at the lump sum stated in the bid. The price bid shall include furnishing all labor, materials, and equipment necessary to complete this item. Work shall include, but is not limited to, excavation, trenching, necessary shoring and sheeting, dewatering, forming, form wrecking, foundations as required, furnishing and installing the storm drainage structures, manholes, raiser sections, castings, inverts, stub outs, plugs, pipe connections, concrete manhole markers (if applicable), ram-nek, placement of grates, manhole rings and covers as applicable, grouting around pipe, all pipe bedding, furnishing and installing pipe backfill, compaction, grading, complete surface restoration and cleanup.

2.07 ELECTRICAL COMPLETE

- A. Measurement: Measurement shall be made on the basis of the percent complete of the task in accordance with approved plans and specifications.
- B. Payment: Payment will be based on the percent of this task completion at the time of the request based on the price bid. The work shall include equipment, labor, and materials required to complete the task. The task shall include, but is not limited to supplying and installing all electrical materials, sensors (including discharge sensors), site lighting, conduit, wire, control panels, breakers, fiber, handholes, manholes; testing, operational start-up, trenching, excavation, backfill, clean up and surface restoration.

2.08 CONTROL AND SCADA SYSTEM COMPLETE

- A. Measurement: Measurement shall be made on the basis of the percent complete of the task in accordance with approved plans and specifications.
- B. Payment: Payment will be based on the percent of this task completion at the time of the request based on the price bid. The work shall include equipment, labor, and materials required to complete the task. The task shall include, but is not limited to supplying and installing SCADA equipment, SCADA panels, RTUs, SCADA software and License, integration and commissioning, conduit, wire, communication with existing sewage pumps stations, existing Land Application Pump Station, and discharge sensors; testing, and operational start-up.

2.09 EROSION CONTROL AND GRASSING

- A. Measurement: Measurement will be made on the basis of the completed item of work. All silt fence will be measured by the linear foot of the silt fence properly installed and trenched in.
- B. Payment: Payment will be made on the basis of the price bid for each item. Work shall include all equipment, material, and labor to complete the installation. This item will include but is not limited to trenching, grading, inlet and outlet protection, furnishing, and installing silt fence; temporary and final stabilization; check dams, straw bale, sediment traps, compost socks, emergency spillways and concrete washout, maintaining erosion and sediment control structures and facilities, and establishing a final stand of cover in accordance with the plans and specifications. Retainage on final grassing will be based on the engineer's estimate of the cost to complete the task, which may not be reflected in the contractor's bid price.

2.10 COMPLETE HEADWORKS AND TRUCK DUMP STATION

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made at the lump sum stated in the bid. The price bid shall include furnishing all labor, materials, and equipment necessary to complete this item. Work shall include, but is not limited to, excavation, trenching, backfill, shoving, sheeting, dewatering, receiving, and installing automated screen filter equipment, screw conveyor, compactor, screen mountings, discharge piping, manual cleaning screen filter equipment, manual rake, biotrickling filter vessel (odor control system), media, irrigation system, dampers, blower, parshall flume, ultrasonic flow meter, spiral separation units, grit airlift units, discharge piping, truck dump station, refrigerated autosampler equipment, miscellaneous hardware, spare parts, instrumentation and process control equipment, operations and maintenance manual, and other auxiliaries as required for proper installation and operation, water and air piping, valves, gates, fittings, conduit, miscellaneous hardware construction of concrete structure to include all concrete, rebar, framing, modification and finishing, concrete pads, testing, operational setup, general cleanup, and surface restoration.

2.11 COMPLETE INFLUENT PUMP STATION

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made at the lump sum stated in the bid. The price bid shall include furnishing all labor, materials, and equipment necessary to complete this item. Work shall include, but is not limited to, excavation, trenching, backfill, shoving, sheeting, dewatering, receiving and installing pumps, miscellaneous hardware, spare parts, aluminum cover, supports, instrumentation and process control equipment, operations and maintenance manual, and other auxiliaries as required for proper installation and operation, piping, valves, gates fittings, conduit, miscellaneous hardware, construction of concrete structure and concrete pads to include all concrete, rebar, framing and finishing, testing, operational setup, general cleanup, and surface restoration.

2.12 COMPLETE SBR SYSTEM-BASED TREATMENT PLANT

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made on the basis of the percentage completion of the lump sum price stated in the bid. The price bid shall include furnishing all labor, materials, tools, and equipment necessary to complete the task. The task shall include, but is not limited to, excavation, trenching, backfill, shoving, sheeting, dewatering, receiving, and installing SBR system, digester, and post equalization equipment such as, mixers, transfer and sludge pumps, decanter assembly, floating weir, retrievable fine bubble diffuser system, lifting system, fixed coarse bubble diffuser system; SBR, digester, and post equalization positive displacement blowers; structures, air and water piping (including drinking and NPRL), yard piping (including influent and LAS forcemain relocation), water and sewer connection to existing maintenance shop, appurtenances, chemical metering pump skids, chemical storage tanks, chemical piping, pipe insulation, pipe supports, miscellaneous hardware, spare parts, davit crane, instrumentation and process control equipment, electrical equipment, walkways, railing, stairs, operations and maintenance manual, and other auxiliaries as required for proper installation and operation, construction of concrete structures and basins to include all concrete, foundation, rebar, framing, modification and finishing, concrete pads for SBR system and auxiliary equipment such as the emergency power supply, the transformer, the UV system and Filtration system. Piping, valves, fittings,

conduit, miscellaneous hardware, liner, coating, buildings (dewatering building, chemical storage building, blower building, electrical building, and operations building), site development, testing, operational setup, general cleanup, and surface restoration.

2.13 COMPLETE DISK FILTRATION SYSTEM

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made at the lump sum stated in the bid. The price bid shall include furnishing all labor, materials, and equipment necessary to complete this item. Work shall include, but is not limited to, receiving, and installing disk cloth filters, metal tanks, drive assembly, pumps, piping and appurtenances, miscellaneous hardware, spare parts, instrumentation and process control equipment, walkways, stairs, operations and maintenance manual, and other auxiliaries as required for proper installation and operation.

2.14 COMPLETE UV DISINFECTION SYSTEM

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made at the lump sum stated in the bid. The price bid shall include furnishing all labor, materials, and equipment necessary to complete this item. Work shall include, but is not limited to, receiving and installing UV lamp modules, electronic ballast, metal tank, miscellaneous hardware, spare parts, instrumentation and process control equipment, automatic mechanical cleaning system, operations and maintenance manual, and other auxiliaries as required for proper installation and operation, construction of concrete structure to include all concrete, rebar, framing.

2.15 COMPLETE REJECT PUMP STATION

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made at the lump sum stated in the bid. The price bid shall include furnishing all labor, materials, and equipment necessary to complete this item. Work shall include, but is not limited to, excavation, trenching, backfill, shoving, sheeting, dewatering, receiving and installing

pumps, miscellaneous hardware, spare parts, aluminum cover, supports, instrumentation and process control equipment, operations and maintenance manual, and other auxiliaries as required for proper installation and operation, piping, valves, fittings, conduit, miscellaneous hardware, construction of concrete structure to include all concrete, rebar, framing and finishing, testing, operational setup, general cleanup, and surface restoration.

2.16 COMPLETE UNDERDRAIN PUMP STATION

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made at the lump sum stated in the bid. The price bid shall include furnishing all labor, materials, and equipment necessary to complete this item. Work shall include, but is not limited to, excavation, trenching, backfill, shoving, sheeting, dewatering, receiving and installing pumps, miscellaneous hardware, spare parts, aluminum cover, supports, instrumentation and process control equipment, outfall sensors, communication to control room, power generator, operations and maintenance manual, and other auxiliaries as required for proper installation and operation, piping, valves, fittings, conduit, miscellaneous hardware, construction of concrete structure to include all concrete, rebar, framing and finishing, testing, operational setup, general cleanup, and surface restoration.

2.17 COMPLETE RECLAIMED WATER PUMP STATION

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made at the lump sum stated in the bid. The price bid shall include furnishing all labor, materials, and equipment necessary to complete this item. Work shall include, but is not limited to, pumps, hydropneumatic tank, piping and appurtenances, miscellaneous hardware, spare parts, aluminum cover, supports, instrumentation and process control equipment, operations and maintenance manual, and other auxiliaries as required for proper installation and operation, piping, valves, fittings, conduit, miscellaneous hardware, construction of concrete structure to include all concrete, rebar, framing and finishing, testing, operational setup, general cleanup, and surface restoration.

2.18 COMPLETE SLUDGE DEWATERING SYSTEM

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made at the lump sum stated in the bid. The price bid shall include furnishing all labor, materials, and equipment necessary to complete this item. Work shall include, but is not limited to, receiving and installing belt filter press equipment, pumps, shaftless screw conveyor equipment, piping and appurtenances, miscellaneous hardware, spare parts, instrumentation and process control equipment, operations and maintenance manual, and other auxiliaries as required for proper installation and operation.

2.19 EMERGENCY POWER SUPPLY

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made at the lump sum stated in the bid. The price bid shall include furnishing all labor, materials, and equipment necessary to complete this item. Work shall include, but is not limited to, receiving and installing the emergency power supply, air supply/exhaust system, transfer switch, wiring, conduit, miscellaneous hardware, spare parts, instrumentation and control equipment, walkways, stairs, operations and maintenance manual, fuel supply tank, and other auxiliaries as required for proper installation and operation.

2.20 TRANSFORMER

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made at the lump sum stated in the bid. The price bid shall include furnishing all labor, materials, and equipment necessary to complete this item. Work shall include, but is not limited to, receiving and installing electrical transformer, wiring, conduit, overcurrent protection, miscellaneous hardware, spare parts, and other auxiliaries as required for proper installation and operation.

2.21 LABORATORY CASEWORK AND LABORATORY EQUIPMENT

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made at the lump sum stated in the bid. The price bid shall include furnishing all labor, materials, and equipment necessary to complete this item. Work shall include, but is not limited to, wood cabinets, filler and closure panels, countertops, shelves, sinks, water, gas, and electrical fittings and accessories, miscellaneous hardware, fume hood, sterilizer, incubator, furnace, refrigerator, spare parts, instrumentation, operations and maintenance manual, laboratory supplies, and other auxiliaries as required for proper installation and operation.

2.22 MOBILIZATION

- A. Payment: Payment will be made for the price as stated in the Contract once the Contractor has established his construction yard and met the requirements established in the Contract Documents. Mobilization will be recognized as complete once the Contractor has provided a construction schedule and moved his equipment and a substantial amount of material to the job site. Construction must be underway and progressing. Payment for mobilization will be limited to a maximum amount not to exceed 5.0% of the bid price.

2.23 SBR EXPANSION TANK

- A. Measurement: Measurement shall be made on the basis of the percentage completed of the task in accordance with the plans and specifications.
- B. Payment: Payment will be made on the basis of the percentage completion of the lump sum price stated in the bid. The price bid shall include furnishing all labor, materials, tools, and equipment necessary to complete the task. The task shall include, but is not limited to, excavation, trenching, backfill, shoving, sheeting, dewatering, construction of concrete structures and basins of the SBR expansion tank to include all concrete, foundation, rebar, framing, modification and finishing, general cleanup, and surface restoration.

END OF SECTION

**SECTION 02210
SITE GRADING**

PART 1 – GENERAL

1.01 QUALITY ASSURANCE

A. Reference Standards:

1. Standards of American Society for Testing and Materials:

ASTM-D-698 Moisture-Density Relations of Soils Using 5.5 lb. (2.5 KG) Hammer and 12 inch (304.8 mm) Drop

2. Methods of Sampling and Testing of American Association of State Highway and Transportation Officials (AASHTO), latest edition.

1.02 TESTING

A. All soil testing shall be performed by an Independent Testing Laboratory selected by the Engineer and paid for by the Contractor.

1.03 EXCESS EXCAVATED MATERIALS

A. Excess excavated materials shall be wasted off site by the Contractor at no expense to Owner, or as directed by the Engineer.

1.04 BORROW MATERIAL

A. Any borrow material required to accomplish all levels, lines and grades indicated shall be furnished by the Contractor at no expense to the Owner.

B. Borrow material shall be obtained from borrow pits off site.

C. The Contractor shall pay for all soil analysis for borrow material.

1.05 EXCAVATED MATERIAL

A. All material to be excavated shall be classified as earth.

1.06 UNSUITABLE BEARING MATERIALS

A. Should unsuitable bearing materials be encountered at levels indicated and found to have insufficient bearing values the Engineer may order the excavation carried to lower depths.

B. Compensation for the removal and/or replacement of unsuitable materials shall be in accordance with the General Conditions, Article 10.01.

- C. Excavation of unsuitable bearing materials shall not proceed until the conditions have been observed by the Engineer and written approval has been given by the Owner.

PART 2 – EXECUTION

2.01 TOP SOIL

- A. Areas to be stripped shall first be scraped clean of all brush, weeds, grass, roots and other material.
- B. Remove topsoil from areas to be graded and stockpile in locations where it will not interfere with structures, roads or utility operations.
- C. Topsoil shall be free from subsoil, debris and stones larger than 2 inches in diameter. The stored topsoil shall be left in piles to be used for finished grading. Contractor shall install a minimum of 4" thick topsoil across pervious areas of the site prior to planting. If topsoil from site is unsuitable or insufficient to achieve 4" thickness, additional material is to be provided by the Contractor at no additional cost to owner and from a source approved by Engineer.
- D. Stockpiles shall be protected from contamination by undesirable foreign matter and shall be graded to shed water.

2.02 EXCAVATION

- A. Excavations shall be accomplished to bring surface to the levels, lines and grades as indicated.
- B. Excavated material to be used for fill or backfill material shall be stockpiled on the site as directed by the Engineer. Stockpiles shall be graded to shed water.

2.03 FILLING

- A. All fill material required to bring areas to the levels, lines and grades indicated shall be selected and approved materials from approved borrow areas.
- B. Sub-grades on which fill material is to be placed shall be scarified to a depth of not less than 4 inches by plowing or discing. A layer of suitable fill material, approximately 3 inches in depth, shall be spread over the scarified surface and compacted.
- C. Fill material shall be spread and compacted in successive uniform layers not exceeding 8 inches in depth (loose measure) until the total thickness of fill is completed.

2.04 COMPACTION

- A. Compaction required for material fill shall be 95% of Standard Proctor, maximum dry density as determined by the procedures of ASTM D-698. Fill areas shall be crowned and sloped to drainage ditches or as required to prevent ponding of surface water.

- B. Compaction by flooding of any material is not acceptable. In the event that any flooding takes place, the material and all adjacent softened material shall be removed and replaced with compacted fill at no cost to the Owner.

2.05 FINISH GRADE

- A. Distribute topsoil evenly to levels, lines and grades shown.
- B. Finish grade to be trimmed and raked true to line and grade to avoid surface ponding.
- C. Remove stone two inches or greater in diameter and debris from soil.
- D. Finish grade tolerance to +/- 0.05 foot for roadways and +/- 0.10 foot for other areas.

END OF SECTION

SECTION 02221
TRENCH EXCAVATION, BACKFILL, AND COMPACTION

PART 1 – GENERAL

1.01 SCOPE, STANDARDS & DEFINITIONS

- A. Work under this section shall consist of furnishing all materials, equipment and labor for excavation, trenching and backfilling for utility systems. "Utility systems" shall include underground piping and appurtenances for water distribution systems, storm water drains, sewage collection systems, force mains, spray irrigation system and all other pipes and appurtenances shown on the drawings.
- B. Applicable Standards and Reference
 - I. ASTM D2321 Soil Classification and Restrictions
 - a. Class IA = Manufactured crushed stone, shell, crushed slag or rock, open graded, clean, large voids, contains no fines, can allow sand migration to create excessive settling. Suitable as drainage blanket.
 - b. Class IB = Manufactured aggregate dense graded, clean, crushed stone with sand and gradation present. Closer void so little migration of sand, little fines. Minimal migration of sand. Suitable as drainage blanket.
 - c. Class II = Coarse grained soils and sand, graded gravel and sandy mix, minimal migration of silt or sand, Use as drainage blanket and drains limited.
 - d. Class III = Coarse grain sand with fines, silty gravel, gravel-sand-silt mixture, clayey gravels, silty sand mixture. Not to be used in the presence of water.
 - e. Class IVA = Fine grain soils, inorganic, Inorganic silts and very fine sand, silty clayey fine sands, inorganic clay with minor plasticity, lean clay. Use only where no water exists and shallow fills.
 - f. Class IVB = Fine Grained soils inorganic, micaceous fine sand, silty soil, fat clay, clay with high plasticity. Use requires geotechnical evaluation.
 - g. Class V = Organic soils, clay and silt with organics. No permitted use other than top 6" outside roadways for soil amendment for grassing.

1.02 EXISTING UTILITIES

- A. Before opening trenches, the Contractor shall examine all available records and explore for the location of all sub-surface pipes, valves or other structures and reference such locations on the surface.

- B. In opening trenches, every effort shall be made not to interfere with these utilities structures. Expose existing piping by hand before excavating by machine. Excavate existing utilities sufficiently in advance of pipe laying to determine crossing arrangement. Slight deviations may be permitted in order to clear such structures. The Contractor shall be entirely responsible for the preservation of all underground or overhead utility lines and structures, such as gas, water, sewer lines, telephone conduit, power lines, etc., and shall replace, adjust or repair, without additional compensation, any such lines damaged or interfered with as a result of this construction.
- C. Schedule work to keep roads and utilities in usable condition; coordinating all operation with the Owner to avoid inconvenience insofar as practicable.

1.03 EXCAVATED MATERIAL

- A. All material to be excavated shall be classified as earth.

1.04 BORROW MATERIAL

- A. Any borrow material required to accomplish all levels, lines and grades indicated shall be furnished by the Contractor at no expense to the Owner.
- B. Borrow material shall be obtained from borrow pits off site.
- C. The Contractor shall pay for all soils analysis for borrow material.

1.05 TESTING

- A. All soil testing shall be performed by an Independent Testing Laboratory selected by the Engineer and paid for by the Contractor.

1.06 QUALITY ASSURANCE

- A. All excavation within the rights of way of city streets and county, State or Federal roadways, shall be backfilled in accordance with the then prevailing requirements of the Georgia Department of Transportation, Highway Division.
- B. Reference Standards: Methods of Sampling and Testing of American Association of State Highway and Transportation Officials (AASHTO).

PART 2 – EXECUTION

2.01 GENERAL EXCAVATION

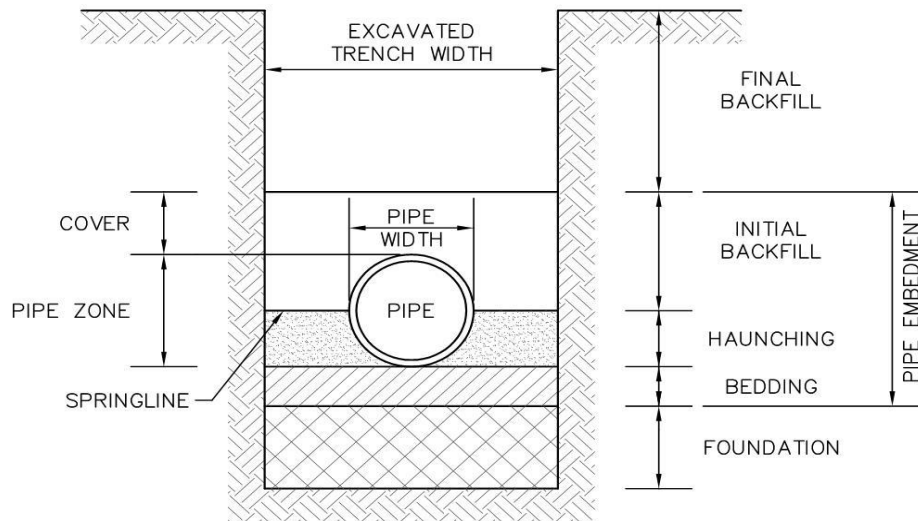
- A. The Contractor shall do all excavation of whatever substances encountered to depth shown on plans. Excavated materials not required for fill or backfill shall be removed from site as directed by the Engineer.
- B. Contractor is to excavate to provide 3 foot minimum cover over utility.
- C. Excavation for manholes and other accessories to have 12 inches minimum and 24 inch maximum clearance on all sides.
- D. Excavation shall not be carried below the required level.
- E. Where excavation is carried below grades indicated, the Contractor shall refill same to the proper grade with compacted earth or stone, or as directed by the Engineer.
- F. Banks of trenches shall be vertical.
- G. Width of trench shall be as shown on the plans. The bottom of trench for sewers and culverts shall be rounded so that an arc of the circumference equal to 0.6 of the outside diameter of the pipe rests on undisturbed soil.
- H. Bell holes shall be excavated accurately to size by hand.

2.02 UNSUITABLE BEARING MATERIALS

- A. Should unsuitable bearing materials be encountered at levels indicated and found to have insufficient bearing values the Engineer may order the excavation carried to lower depth.
- B. Compensation for the removal and/or replacement of unsuitable bearing materials shall be in accordance ASTM D2321 requirements.
- C. Excavation of unsuitable bearing materials shall not proceed until the conditions have been observed by the Engineer and written approval is given by the Owner.

2.03 PIPE BEDDING

A. The following detail provides trench & pipe zone terminology.



PIPE BEDDING DETAIL
N.T.S.

- B. The trench floor should be constructed to provide firm, stable, and uniform support for the full length of the pipe. This can be accomplished by bringing the entire trench floor level grade and then creating bell holes at each joint to permit proper joint assembly, alignment and support. Portions of the trench that are excavated below grade should be returned to grade and compacted as required to provide proper support. If native trench soil is not suitable for pipe bedding, the trench should be over excavated and refilled with suitable foundation material either local sandy material compacted to 90% Std. Proctor or #57 stone depending on the presence of water and, as approved by the engineer. Bedding material shall be Class IB or II as defined in ASTM D2321. Large rocks or hard material should not be contained in the bedding area (minimum of 6") below the pipe.
- C. The most important factor in assuring proper pipe-soil interaction is the haunching material and its density. This material provides the majority of the support that the pipe requires to function properly in regards to deflection and performance. The

haunching material shall be placed and compacted under the pipe haunches as shown in the detail above. Proper control should be exercised to avoid deflecting the pipe from proper alignment. The same material that is used for bedding should be used for haunching and compacted to the same standards. Haunching material shall be Class IB or II as defined in ASTM D2321.

- D. Initial backfill, as shown in the detail above, shall be accomplished with suitable, compactable material and compacted in 6" layers. Material shall meet the requirements of Class Ib, II or III as restricted in ASTM D2321.
- E. Final Backfill will be accomplished by placing material in 12" lifts and compacting to a level determined by the final use of the area above the pipe. Final backfill in roadways shall require placement of suitable Class IA, IB, II and III backfill material, placed in 12" lifts and compacted to 100% standard proctor (ASTM Test D-698). Final Backfill outside of roadways shall be Class II, III or IVA and lightly compacted to avoid settling in the future. The top 6" of the final backfill, outside of roadways, shall be suitable for establishing a final grassed surface.
- F. Material used in the "trench & pipe zone" shall be restricted as per the limitations and restrictions as outlined in ASTM D2321

2.04 BRACING AND SHORING

- A. The Contractor shall do all bracing, sheeting and shoring necessary to perform and protect all excavations as required for safety.
- B. Sheeting driven alongside the pipe should be cut off and left in place to an elevation 1.5 feet above the top of the pipe.
- C. All other sheeting shall be removed as directed by the Engineer.

2.05 DEWATERING FOR EXCAVATION

- A. The Contractor shall pump or remove any water accumulated in any excavated area and shall perform all work necessary to keep excavations clear of water while foundations, structures or any masonry are being constructed or while pipe is being laid.
- B. No structure or pipe shall be laid in water, and water shall not be allowed to flow over or rise upon any concrete or masonry or piping until same has been inspected and the mortar or joint material has cured.

- C. No extra compensation will be allowed for removal of water.
- D. All water pumped or bailed from the trenches or other excavation shall be conveyed to a point of discharge where it will neither cause a hazard to the public health, nor damage to the public or private property, or to work completed or in progress.

2.06 BACKFILL

- A. The soil at the sides of a pipe and above it is the backfill.
- B. Prior to backfilling any excavation, all piping and structures shall be observed by the Engineer.
- C. After pipes have been tested and approved, backfilling shall be done with approved material free from large clods or stones.
- D. Backfill shall be placed in uniform layers, four inches thick, on both sides of the pipe and thoroughly compacted with pneumatic or hand tampers. The backfill shall be brought up uniformly on both sides of the pipe and compacted to an elevation of one foot above the top of the pipe, after which the fill shall be placed in eight inch lifts. No rock will be allowed in the backfill within a distance of one foot from the pipe, and rock larger than six inches in the greatest dimension will not be permitted in any part of the trench or backfill.
 - 1. Backfill shall be compacted to not less than 95% of the maximum dry weight per cubic foot as determined by AASHTO Method T-99 (Standard Proctor Test).
 - 2. The top 18 inches of backfill under any paved area shall be compacted to 100% Standard Proctor.
 - 3. Water settling will not be permitted in clay soils. It may be required at the option of the Engineer in sandy soils.

2.07 REPLACING PAVEMENTS

- A. Subgrades shall be compacted with a mechanical tamper.
- B. The minimum width of replaced concrete pavements shall be 4 feet at interiors and 6 feet at joints and constructed as shown on Standard Details. Avoid cutting pavements at joints; if unavoidable, reconstruct same as original joint. Depth shall be equal to the original thickness. Existing pavements edges shall be cut vertical.
- C. Use high-early-strength cement if road is to be opened in less than 3 days.
- D. The minimum width of replaced bituminous pavements shall be 3 feet with 8 inch concrete patch. The existing pavement shall be cut vertically and horizontally to a straight line. The 8 inch concrete patch shall be minimum 3,000 psi concrete containing black dye and shall be flush with the existing pavement.

END OF SECTION

SECTION 02415 SITE DEMOLITION

PART 1 GENERAL

1.01 DESCRIPTION

This section specifies demolition and removal of buildings, portions of buildings, utilities, other structures, and debris from trash dumps shown.

1.02 RELATED WORK

- A. Demolition and removal of roads, walks, curbs, and on grade slabs outside buildings to be demolished.
- B. Safety Requirements: GENERAL CONDITIONS Article, ACCIDENT PREVENTION.
- C. Disconnecting utility services prior to demolition: Section 01 00 00, GENERAL REQUIREMENTS.
- D. Reserved items that are to remain the property of the Owner.
- E. Asbestos Removal: See Hazardous Material Sections of General Conditions.
- F. Lead Paint: See Hazardous Material Sections of General Conditions.
- G. Environmental Protection: See Erosion and Sedimentation Control Specification.
- H. Construction Waste Management: See General Requirements Specification.

1.03 PROTECTION

- A. Perform demolition in such manner as to eliminate hazards to persons and property; to minimize interference with use of adjacent areas, utilities and structures or interruption of use of such utilities; and to provide free passage to and from such adjacent areas of structures. Comply with requirements of GENERAL CONDITIONS Article, ACCIDENT PREVENTION.
- B. Provide safeguards, including warning signs, barricades, temporary fences, warning lights, and other similar items that are required for protection of all personnel during demolition and removal operations.
- C. Maintain fences, barricades, lights, and other similar items around exposed excavations until such excavations have been completely filled.
- D. Provide enclosed dust chutes with control gates from each floor to carry debris to truck beds and govern flow of material into truck. Provide overhead bridges of tight board or prefabricated metal construction at dust chutes to protect persons and property from falling debris.

- E. Prevent spread of flying particles and dust. Sprinkle rubbish and debris with water to keep dust to a minimum. Do not use water if it results in hazardous or objectionable condition such as, but not limited to; ice, flooding, or pollution. Vacuum and dust the work area daily.
- F. In addition to previously listed fire and safety rules to be observed in performance of work, include following:
 - 1. No wall or part of wall shall be permitted to fall outwardly from structures.
 - 2. Maintain at least one stairway in each structure in usable condition to highest remaining floor. Keep stairway free of obstructions and debris until that level of structure has been removed.
 - 3. Wherever a cutting torch or other equipment that might cause a fire is used, provide, and maintain fire extinguishers nearby ready for immediate use. Instruct all possible users in use of fire extinguishers.
 - 4. Keep hydrants clear and accessible at all times. Prohibit debris from accumulating within a radius of 4500 mm (15 feet) of fire hydrants.
- G. Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The contractor shall take necessary precautions to avoid damages to existing items to remain in place, to be reused, or to remain the property of the Owner; any damaged items shall be repaired or replaced as approved by the Resident Engineer.

The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition or removal works. Repairs, reinforcement, or structural replacement must have Resident Engineer's approval.

- H. The work shall comply with the requirements of the Erosion and Sediment Control Specification and other sections of this specification.
- I. The work shall comply with the requirements of GENERAL REQUIREMENTS.

1.04 UTILITY SERVICES

- A. Demolish and remove outside utility service lines shown to be removed.
- B. Remove abandoned outside utility lines that would interfere with installation of new utility lines and new construction.

PART 2 - EXECUTION

2.01 DEMOLITION

- A. Completely demolish and remove buildings and structures, including all appurtenances related or connected thereto, as noted below:
 - 1. In accordance with Building Demolition Specification.
 - 2. As required for installation of new utility service lines.
 - 3. To full depth within an area defined by hypothetical lines located 1500 mm (5 feet) outside building lines of new structures.
- B. Debris, including brick, concrete, stone, metals, and similar materials shall become property of Contractor and shall be disposed of by him daily, off the project site to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Resident Engineer. Break up concrete slabs below grade that do not require removal from present location into pieces not exceeding 600 mm (24 inches) square to permit drainage. Contractor shall dispose debris in compliance with applicable federal, state, or local permits, rules and/or regulations.
- C. Remove and legally dispose of all materials, other than earth to remain as part of project work, from any trash dumps shown. Materials removed shall become property of contractor and shall be disposed of in compliance with applicable federal, state or local permits, rules and/or regulations to a permitted site. All materials in the indicated trash dump areas, including above surrounding grade and extending to a depth of 1500mm (5feet) below surrounding grade, shall be included as part of the lump sum compensation for the work of this section. Materials that are located beneath the surface of the surrounding ground more than 1500 mm (5 feet), or materials that are discovered to be hazardous, shall be handled as unforeseen. The removal of hazardous material shall be referred to Hazardous Materials specifications.
- E. Remove existing utilities as indicated or uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Resident Engineer. When Utility lines are encountered that are not indicated on the drawings, the Resident Engineer shall be notified prior to further work in that area.

2.02 CLEAN UP

On completion of work of this section and after removal of all debris, leave site in clean condition satisfactory to Resident Engineer. Clean up shall include off the off-site disposal of all items and materials not required to remain property of the Owner as well as all debris and rubbish resulting from demolition operations.

END OF SECTION

SECTION 02520
STORM DRAINAGE AND APPURTENANCES

PART 1 – GENERAL

1.01 APPLICABLE STANDARDS

- A. Appurtenances shall be constructed in accordance with the referenced Georgia Department of Transportation Standard Drawings.
- B. American Society for Testing and Materials (ASTM):
 - C- 32 Specification for Sewer and Manhole Brick.
 - C- 76 Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.
 - C-144 Aggregate for Masonry Mortar.
 - C-270 Mortar for Unit Masonry
 - C-443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
 - C-913 Specification for Precast Concrete Water and Wastewater Structures
 - C-536 Test for Continuity of Coatings in Glassed Steel Equipment by Electrical Testing.
- C. Only reinforced concrete pipe will be allowed under roadways or frequently traveled areas.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Roadway Storm Drainage Pipe: Pipe shall be reinforced Concrete Pipe which conforms to ASTM Specification C-76 and shall be of sizes shown. Pipe shall be Class III minimum and as indicated on GA. D.O.T. Standard 1030 D.

B. Non Roadway Storm Drainage Pipe: Pipe shall be one of the following:

1. Corrugated metal pipe shall conform to AASHTO designation M-36, AREA Manual 1-4 requirements for corrugated metal culverts, or Federal Specification QQ-C- 806, with the following applicable requirements:
 - a. The outside and inside surfaces of the corrugated metal pipe shall be completely coated with bituminous material with a minimum thickness of 0.05 inch at the crest of the corrugations. Immediately prior to the application of the bituminous coating, the corrugated metal pipe shall be cleaned of all dirt, grease, mill scale, or loose rust and shall be dry.
 - b. The outside and inside surfaces of the corrugated metal pipe shall be completely coated with a pure aluminum coating metallurgically bonded by an alloy layer between the steel and the aluminum. The coating shall be applied at a minimum of 1 oz./sq.ft., 2 mils. each side. The weight of aluminum (total both sides) shall be as follows: Minimum check limit triple-spot test=1.00 oz/sq feet, minimum check limit single-spot test=0.90 oz/sq feet. The aluminized steel pipe shall be Armco Aluminized Steel Type 2 or equal.
 - c. All rivets shall be placed in the inside valley of the corrugations. The interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs, where used, shall be so placed as to facilitate moving the pipe without damage to the exterior or interior coating. All lateral pipe shall be sixteen (16) gauge. All pipe under possible traffic areas will be twelve (12) or fourteen (14) gauge as indicated.
 - d. To facilitate field jointing, the ends of pipes with helical corrugations shall be rerolled to form circumferential corrugations from the end. The diameter of the reformed ends shall not exceed that of the pipe barrel by more than the depth of the corrugation.
2. Polyvinyl chloride (PVC) pipe shall be manufactured and tested in accordance with specification for "Poly (Vinyl Chloride) PVC Large Diameter Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter." The pipe and fittings shall be made of PVC plastic and shall have a smooth (not ribbed or corrugated) inside surface.
 - a. All pipe shall be bell and spigot. The bell shall consist of an integral wall section or an internal plastic sleeve. The solid cross section rubber ring shall be factory assembled on the spigot. Size and dimensions shall be as shown on the plans. Standard laying length shall be 13 feet $\pm$ 1 inch.

- b. All fittings and accessories shall be as manufactured and furnished by the pipe supplier or approved equal and have bell and/or spigot configurations compatible with that of the pipe.
 - c. Pipes shall be designed to pass all tests described herein at 73° F ($\pm$ 3° F).
 - d. The pipe stiffness shall equal or exceed 10 psi when tested in accordance with ASTM D 2412.
3. High density Polyethylene (HDPE) pipe shall be manufactured for use in nonpressure storm sewer. The pipe shall be manufactured to meet AASHTO M294, Type 'S' for 12" through 36" and AASHTO MP6-96, Type 'S' OR 'D' for 42" and 48" pipe. The pipe and fittings shall be made from HDPE material and shall have a smooth (not ribbed or corrugated) inside surface.
- a. All pipe shall be bell and spigot. The bell shall be an integral part of the pipe. The joint shall use a gasket to form a water tight connection meeting ASTM D3212. Gaskets shall be installed in the bell or in the spigot by the manufacturer. The use of Silt tight fittings may be requested in lieu of water tight connection if approved by the engineer.
 - b. All fittings shall conform to AASHTO M294 or MP6-95. Fabricated fittings shall be welded on the interior and exterior at all junctions.
 - c. Pipe and fittings material shall be high-density polyethylene meeting ASTM D3350.
 - d. Installation shall be in accordance with ASTM D2321.
 - e. Pipe may be Advanced Drainage System, Inc., N-12 or N-12 HC or Hancor Sure Lok 10-8 pipe.
 - f. HDPE end sections are NOT allowed.

C. Pipe Joints:

- 1. Joints for concrete pipe shall be one of the following types:
 - a. Bell and spigot with rubber gaskets.
 - b. Tongue and groove with rubber gaskets.
 - c. Tongue and groove with preformed plastic gaskets.

2. Rubber Gaskets shall conform to ASTM Specification C443. Only a neutral agent shall be used as a lubricant. Preformed Plastic Gaskets shall conform to Federal Specification SS-S210, Type I-rope form.
3. Field joints of corrugated steel pipe shall maintain pipe alignment during construction and prevent infiltration of side material during the life of the installation. Circumferential and longitudinal strength shall be provided in accordance with the structural joint performance criteria of Division 2, Section 23 of the AASHTO standard specification for Highway Bridges. The bands shall be constructed in such a manner that will effectively engage the pipe ends. Coupling bands shall not be more than 3 nominal sheet thicknesses lighter than the thickness of the pipe to be connected and in no case lighter than 0.052 inches. Bolts and nuts for coupling bands shall conform to the requirements of ASTM Designation: A307.

Bands shall be furnished to lock with the circumferential corrugations, including rerolled end helical pipe. The corrugated bands shall be not less than 7 inches wide for diameter 4 to 36 inches, inclusive, and not less than 10 1/2 inches wide for all other pipe diameters.

NO DIMPLE BANDS WILL BE ALLOWED.

4. Joints for PVC pipe must be an integral bell gasketed joint which forms a silt tight joint.

D. Precast Concrete Manhole Sections:

ASTM C913, except that spacing of manhole steps or ladder rungs shall not exceed 12 inches.

E. Masonry Manholes: Shall be constructed of the following materials:

1. Brick: ASTM C32, Grade MS
2. Mortar of Masonry: ASTM C279, Type M.
3. Aggregate for Masonry Mortar: ASTM C144.
4. Water for Masonry Mortar shall be fresh, clean and potable.

F. METALS

1. Frames, Covers, and Grating: Frames, covers, and grating shall conform to AASHTO M-306-07 and shall be of grey iron castings.
2. Manhole Steps: Manhole steps shall be constructed of a number of 3 reinforcing bar encapsulated in polypropylene plastic with a non-skid tread. Finished dimensions of the steps shall be identical to that of malleable iron manhole steps. Steps to have a minimum tread width of 12 inches.

2.02 DELIVERY AND STORAGE

- A. Storm Drainage Pipe: Care shall be exercised in loading and unloading pipe, fittings, specials and castings at all times in order to avoid shock and damage to the materials. Lifting shall be by hoist or by rolling on skids. Dropping will not be permitted. The Contractor shall be responsible for the safe handling of all materials and no damaged materials shall be used in the work. Materials shall be inspected upon arrival at the site, and any damaged or defective materials shall be immediately removed from the site. All materials shall be stored above grade.
- B. Cementitious Materials: Cementitious materials in bags shall be stored in enclosed structures; floors shall be elevated above the ground a distance sufficient to prevent the absorption of moisture.
- C. Metal Items: Metal items, including reinforcing steel, shall be stored above grade in a manner which will not cause excessive rusting or coating with grease or other objectionable materials.
- D. PVC Pipe: PVC pipe shall be stored protected from sun light by means of covering the pipe or storing inside a building or under a covered shed. Any pipe showing signs of prolonged outside storage (i.e. faded exterior color or signs of drying) shall be rejected.
- E. Aggregates: Aggregates shall be stored on areas to prevent the inclusion of foreign material. Aggregates of different sizes shall be stored in separate piles. Stockpiles of coarse aggregate shall be built in horizontal layers not exceeding 4 feet in depth to minimize segregation. Should the coarse aggregate become segregated, it shall be remixed to conform to the grading requirements.
- F. Brick, Concrete Masonry Units and Precast Concrete Manholes: Brick, concrete masonry units and precast concrete manholes shall be handled with care to avoid chipping and breakage, and shall be stored to protect them from contact with the earth and exposure

to the weather, and shall be kept dry until used. Masonry units or precast concrete containing frost or ice shall not be used.

PART 3 – EXECUTION

3.01 DRAINAGE PIPE

- A. Each section of pipe shall be carefully examined before being laid, and defective or damaged pipe shall not be used.
- B. Under no circumstances shall pipe be laid in water, and no pipe shall be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Pipe shall be laid true to line and grades indicated and shall rest upon the pipe bed for the full length of each section. Runs of pipe shall be laid with outside bells or grooved ends up-grade beginning at the lower end of the pipe line. Pipe having its grade and/or joint disturbed after laying shall be removed, cleaned, and relayed.
- C. When pipes are protected by head walls or connect with drainage structures, the exposed ends of the pipe shall be placed or cut flush with the inside face of the structure. After the pipe is cut the rough edges shall be smoothed up in an approved manner. All pipe shall be laid so that markings are on top and the inner surfaces abut neatly, tightly and smoothly.
- D. All pipe in place shall be observed by the Engineer before being covered and concealed unless this requirement is waived by the City Inspector and the Design Engineer. Contractor shall clear all pipe of silt debris prior to final acceptance.

3.02 CORRUGATED METAL PIPE JOINTS

- A. Corrugated metal pipe shall be butted to form a smooth joint; the space between the pipe and coupling bands shall be kept free from dirt and grit so that the corrugations fit snugly. The coupling band while being tightened shall be tapped with a soft head mallet of wood, rubber or plastic to take up slack and insure a tight joint. Coupling band bolts and damaged areas of the coupling bands and pipe shall be given a coating of bituminous cement. Pipe on which the asphalt coating has been damaged to such extent that satisfactory field repairs cannot be made will be replaced.

3.03 CONCRETE PIPE JOINT

- A. Joint installation shall be in accordance with the recommendations of the manufacturer of the joint material. Surfaces to receive lubricants, cements or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installation of the pipe, and any loose or improperly affixed gaskets and jointing materials shall be removed and replaced.
- B. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint, the gasket or jointing material becomes loose and can be seen through the exterior joint recess when the joint is pulled up to within one inch of closure, the pipe shall be removed and the joint remade.

3.04 MASONRY WORK

- A. Mortar for Masonry: Mortar for brick masonry, rubble stone masonry, and for bedding cast iron frames in masonry shall be Type M, conforming to ASTM C270.
- B. Mortar for pargetting Masonry Walls: Mortar for pargetting masonry walls below grade shall be Type M, conforming to ASTM C270.
- C. Brickwork: Brick in circular walls shall be laid in all header courses to form full and close mortar joints, ends and sides in one operation. Vertical joints shall be radial from the center. Brickwork around pipe inlets and outlets shall not be allowed. Gaps shall be poured with concrete.
- D. Masonry Structures: Masonry structure walls shall be constructed of brick, concrete masonry units or precast concrete structural sections.

3.05 PRECAST CONCRETE

- A. Walls shall be constructed on a footing of cast-in-place concrete, except that precast concrete base sections may be used for precast concrete structure risers. Precast base sections shall conform to the applicable requirements for precast risers and tops in ASTM C913. Mortar that has hardened to the extent that it cannot be made workable without the addition of water shall not be used. Thickness of parget shall be not less than 1/2 inch. No pargetting will be permitted on the inside of structures. Pargetting will not be required for precast concrete structures. Joint work inside masonry structures shall be smooth.

- B. One course of brick work is allowed for leveling and adjustment. All other adjustments must be poured in place concrete with a maximum height of 24 inches.
- C. For single and double wing catch basins a concrete pad shall be poured 4 inches thick with a minimum slope of 1" per foot away from the curb and gutter and towards the box.

3.06 METAL WORK

- A. Iron and steel shall be formed to shape and size with sharp lines and angles. Shearing and punching shall produce clean true lines and surfaces. Casting shall be sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Exposed surfaces shall have a smooth finish and sharp well defined lines and arises. The necessary rivets, lugs, and brackets shall be provided.

3.07 FIELD TEST

- A. A light held in a drainage structure shall show a practically full circle of light through the pipe when viewed from the adjoining end of the line.
- B. Lines under pavements shall be tested for infiltration by means of a suitable weir or other measurement device as directed by the Owner. When determination of infiltration is not practicable because of dry trench conditions, an exfiltration test shall be applied by filling with water so that the hydraulic head will be at least 6 inches above the crown of the upper end and of the section being tested. The amount of leakage (infiltration or exfiltration) shall not exceed 100 gallons per inch of diameter per day per mile of pipe.

END OF SECTION

SECTION 02540 EROSION CONTROL

PART 1 – GENERAL

1.01 The work specified in this Section consists of furnishing, installing and maintaining temporary erosion controls and temporary sedimentation controls.

1.02 DEFINITIONS

- A. Temporary erosion controls shall include grassing, mulching, watering and reseeding on-site sloped surfaces, providing berms at the top of the slopes and providing interceptor ditches at the ends of berms and at those locations which will ensure that erosion during construction will be either eliminated or minimized.
- B. Temporary sedimentation controls shall include silt dams, traps, barriers and appurtenances at the toe slopes.

PART 2 – MATERIALS

2.01 Hay bales shall be clean, seed free cereal hay type, securely bound.

2.02 Netting shall be 1/2 inch, galvanized steel chicken wire mesh.

2.03 Filter stone shall be crushed stone conforming to the Department of Transportation - State of Georgia-Standard Specifications – Construction of Transportation Systems - 2013 - Table 800.01, Size Number 3.

2.04 Rolled Erosion Control Products:

- A. Mulch Control Netting. A planar woven natural fiber or extruded geosynthetic mesh used as a temporary degradable rolled erosion product anchor loose fiber mulches
Max. Gradient = 5:1 (H:V) in slope application
C Factor = ≤ 0.10 @ 5:1 in slope application
Max Shear stress 0.25 lb/sf in channel application
Min. Tensile Strength ultra short (3 mo) and short (12 mo) term = 5 lbs/ft
Min Tensile Strength extended term ((24 mo) = 25 lbs/ft
- B. Open Weave textile. A temporary degradable rolled erosion control product composed of processed natural or polymer yarns woven into a matrix, used to provide erosion control and facilitate vegetation establishment.

Max. Gradient = 3:1 (H:V) in slope application

C Factor = ≤ 0.15 @ 3:1 in slope application

Max Shear stress = 1.5 lb/sf in channel application

Min. Tensile Strength ultra short (3 mo) and short (12 mo) term = 50 lbs/ft

Min Tensile Strength extended term ((24 mo) = 100lbs/ft

- C. Erosion Control Blanket. A temporary degradable rolled erosion control product composed of processed natural or polymer fibers mechanically, structurally or chemically bound together to form a continuous matrix to provide erosion control and facilitate vegetation establishment.

Netless Rolled Erosion Control Blankets:

Max. Gradient = 4:1 (H:V) in slope application

C Factor = ≤ 0.10 @ 4:1 in slope application

Max Shear stress = 0.5 lb/sf in channel application

Min. Tensile Strength ultra short (3 mo) and short (12 mo) term = 5 lbs/ft

Single-net Erosion Control Blankets:

Max. Gradient = 3:1 (H:V) in slope application

C Factor = ≤ 0.15 @ 3:1 in slope application

Max Shear stress = 1.5 lb/sf in channel application

Min. Tensile Strength ultra short (3 mo) and short (12 mo) term = 50 lbs/ft

Min Tensile Strength extended term ((24 mo) = 100lbs/ft

Double-net Erosion Control Blankets:

Max. Gradient = 2:1 (H:V) in slope application

C Factor = ≤ 0.2 @ 2:1 in slope application

Max Shear stress = 1.75 lb/sf in channel application

Min. Tensile Strength ultra short (3 mo) and short (12 mo) term = 75 lbs/ft

- D. Turf Reinforcement Mat. A rolled erosion control product composed of non-degradable synthetic fibers, filaments, nets, wire mesh, and/or other elements, processed into a permanent, three dimensional matrix of sufficient thickness. TRMs, which may be supplemented with degradable components, are designed to impart immediate erosion protection, enhance vegetation establishment and provide long term functionality by permanently reinforcing vegetation during and after maturation. These products are typically used in hydraulic applications such as high flow ditches, channels, steep slopes, stream banks, and shorelines, where erosive forces may exceed the limits of natural, unreinforced vegetation.

Slope Application max gradient = 0.5:1 (H:V)

Channel Application Max Shear Stress: 5A, B,C as defined in FHWA guidelines

5A = 6.0 lb/sf, 5B = 8.0 lb/sf, 5C = 10.0 lbs/sf

Min. Tensile Strength: 5A, B,C as defined in FHWA guidelines
5A = 125.0 lb/ft, 5B = 150.0 lb/ft, 5C = 175.0 lbs/ft
5A, B,C as defined in FHWA guidelines

PART 3 – EXECUTION

3.01 SEDIMENTATION CONTROL

- A. Silt dams, traps, barriers, and appurtenances shall be installed and shall be maintained in-place for duration of construction.
- B. Hay bales shall be staked with two (2) 1 x 4 wood stakes per bale driven eighteen (18) inches into the ground and finishing flush with the top of the bale.
 - 1. Install two (2) stakes per bale with the long dimension of the stakes parallel to the long dimension of the bale.
 - 2. Where bales are installed in multiple layers the bales shall be installed with vertical joints staggered and two (2) 1 x 4 wood stakes per bale driven through all layers, full from top of bale to eighteen inches into the ground.
- C. Hay bales which have deteriorated shall be replaced with new materials.
- D. Erosion and sedimentation controls shall be maintained in a condition which will retain unfiltered water.
- E. The Contractor shall construct the sedimentation ponds and control devices prior to clearing and grubbing the site to insure complete silt control. When the silt or the debris level is greater than 1 foot above the bottom of the pond, the Contractor shall remove the silt or debris to restore the proper elevation for the bottom of the pond.
- F. The Contractor shall have all erosion and sedimentation control devices in service and operating properly prior to completion and final acceptance of the contract.
- G. Two widths of silt fence are available, Type A or C (36" height) and Type B (22" height). In order to determine which to use, the project duration, slope gradient, and slope length must be known (See Table 6-13.1 below). Approved silt fence fabrics are listed in the Georgia Department of Transportation list #36. The manufacturer shall have either an approved color mark yarn in the fabric or label the fabricated silt fence with both the manufacturer and fabric name every 100 feet.

TABLE 6-13.1

Land Slope	Maximum Slope Length Behind Fence
<u>Percent</u>	<u>feet</u>
<2	100
2 to 5	75
5 to 10	50
10 to 20	25
>20	15

All silt fence must meet the minimum standards set forth in Section 171- temporary Silt Fence, of the Department of Transportation, State of Georgia, Standard specification, current edition. See Table 6-13.5 for current Georgia DOT silt fence specifications.

3.02 EROSION CONTROL BALNKET INSTALLATION

- A. Prepare a stable and firm soil surface free of rocks and debris. Apply soil amendments as necessary to prepare seedbed. Place fertilizer, water, seed in accordance with manufacture and specification recommendations. Unroll parallel to the primary direction of flow. Ensure that the product maintains intimate contact with the soil over the entire installation. Do not stretch or allow material to bridge over the surface. Staple/stake blanket to soil such that each staple/stake is flush with the underlying soil. Install anchor trenches, seams and terminal ends as specified.
- B. The Upslope Trench, Seams and Terminal Ends may be secure by anchor trench, checks, slots or staples as outlined in Erosion Control technology Council (ECTC) standards for upslope security.
- C. Staple installation shall be at a rate of 1.7 staples per square yard minimum. Sandy or silty soils may require more. Wet installations may require a more density securing.
- D. If seaming method is used seams shall overlap at least 4" and staples must be placed at sufficient spacing to avoid separation.
- E. Staples must be placed at 4"x 4" spacing on check slots and check seams.
- F. Consecutive rolls shall have overlaps of at least 6" and secured with staples every 1 foot.

3.03 RESPONSIBILITY

- A. The Contractor shall be solely responsible for insuring that no silt or debris leaves the immediate construction site. Any silt or debris that does leave the immediate site shall be cleaned up and the area disturbed shall be returned to its natural state as directed by the Engineer at the Contractor's expense.
- B. The Contractor has the option to submit additional control measures in the form of shop drawings.

END OF SECTION

SECTION 02555
WATER DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.01 GENERAL

Water distribution systems shall be designed to sustain EPD's standards for safe drinking water quality. Special consideration should be given to distribution main sizing, providing for design of multidirectional flow, adequate valving for distribution system control, and provisions for adequate flushing. Distribution systems should be designed to maximize turnover and to minimize residence times while delivering acceptable pressures and flows.

1.02 REFERENCE STANDARDS

A. American Water Works Association (AWWA):

- C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
- C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
- C151 Ductile-Iron Pipe, Centrifugally Cast
- C300 Reinforced Concrete Pressure Pipe, Steel-Cylinder Type
- C500 Gate Valves 3" - 48" for Water and Other Liquids
- C502 Dry Barrel Fire Hydrants
- C600 Installation of Cast Iron Water Mains
- C651 Disinfecting Water Mains
- C800 Threads for Underground Service Line Fittings
- C900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. - 60 In.

B. American National Standards Institute (ANSI):

- A 21.10 Gray Iron and Ductile Iron Fittings, 2" - 48" for Water and Other liquids
- A 21.11 Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe Fittings
- A 21.4 Cement Mortar Lining for Cast Iron and Ductile Iron Pipe and Fittings for Water
- A 21.51 Ductile Iron Pipe, Centrifugally Cast in Metal or Sand Lined Molds, for Water or Other Liquids
- B 18.2 Square and Hex Head Bolts and Screws

C. American Society of Testing and Materials (ASTM):

A 47	Malleable Iron Castings
A 48	Gray Iron Casting
A 88	Seamless Copper Water Tube
A 240	Chromium and Chromium Nickel Stainless Steel Plate Sheet and Strip for Fusion Welded Uni fired Pressure Vessels
A 307	Low Carbon Steel Externally and Internally Threaded Standard Fasteners
D 1784	Rigid Poly (Vinyl chloride) Compounds, and Chlorinated Poly (Vinyl Chloride) Compounds
D 2239	Polyethylene (PE) Plastic Pipe (SDR PR)
D 2241	Poly Vinyl Chloride (PVC) Plastic Pipe (SDR PR and Class T)
D 3139	Joints for Plastic Pressure Pipe Using Flexible Elastomeric Seals

D. Rule for Safe Drinking Water, Georgia State EPD: Chapter 391-3-5.10

1.03 DESCRIPTION

- A. All valves of the same type shall be from a single manufacturer. Parts for valves of the same type and size shall be interchangeable. Spare parts shall be furnished where required in the payment items. Special tools required for repacking or disassembling valves shall be provided.
- B. All valves shall open left (counterclockwise).

1.04 SUBMITTALS

- A. Six copies of the manufacturer's drawings and catalog cuts of the following items shall be submitted for approval of the Design Engineer:
 - 1. Pipe
 - 2. Fittings
 - 3. Joints and Couplings
 - 4. Hydrants
 - 5. Valves

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Materials delivered to the site shall be inspected for damage, unloaded, and stored with the minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and rubber gaskets under cover and protect from exposure to direct sunlight. Store materials above ground. Interior of pipe and fittings shall be kept free of dirt and debris.

- B. Pipe, fittings, valves, hydrants, and other accessories shall be handled to insure delivery to the point of installation in sound undamaged condition. If coatings or linings of pipe or fittings are damaged, such pipe or fittings shall be removed from the site and new materials furnished. Pipe shall not be dragged. Rubber gaskets that are not installed immediately shall not be left in the sunlight but shall be stored under cover and protected from exposure to direct sunlight.

PART 2 – PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE (PVC)

- A. IPS Size PVC Pipe: Class 200 SDR 21 - Polyvinyl chloride water main pipe shall conform to Designation ASTM D2241 and shall consist of Type I, Grade 1 PVC compound conforming to ASTM D1784. All pipe shall be Class 200, SDR 21. The standard laying length shall be 20 ft. ± 1 inch.
- B. DIP Size PVC Pipe: AWWA C-900
 - 1. C-900 polyvinyl chloride water main pipe 4" TO 12" shall conform to Designation ASTM D2241 and shall consist of Type I, Grade 1 PVC compound conforming to ASTM D1784. All pipe larger than 4" to 12" shall meet the requirements of AWWA C900, "Poly Vinyl Chloride (PVC) pressure pipe." All pipe shall be class 200 pipe and shall meet the requirements of DR14. The standard laying length shall be 20 ft. ± 1 inch. The FM approved pressure class will be used to determine pressure class.
 - 2. C-905 polyvinyl chloride water main pipe 14" to 30" shall be manufactured from compounds conforming to PVC cell classification of 12454B as defined in ASTM D-1784. The integral bell joint system meets the requirements of ASTM D-3139 and utilizes an elastomeric gasket materials conforming to ASTM F-477. All pipe shall be class 200 pipe and shall meet the requirements of DR18. The standard laying length shall be 20 ft. ± 1 inch.
- C. When DIP size PVC pipe is used two 2" PVC pipe shall be SDR 21, minimum pressure class of 200psi.
- D. Pipe shall have integral bell and spigot joints. Provisions shall be made for contraction and expansion at each joint with an elastomeric ring. Threaded or solvent welded type joints shall not be used. Bell end pipe and couplings with elastomeric gaskets shall meet the requirements of ASTM 3139.
- E. All fittings such as tees, ells, etc. using welded joints shall be factory welded and shall meet the same specifications as the welded bell section. Lubricants shall be non-toxic,

shall not promote biological growth. Solvent cemented joints are not allowed for buried pipes.

- F. The Contractor shall install a continuous run of 14 gauge copper tracer wire with underground coating above the top of the PVC pipe 12 inches above the pipe but no deeper than 48 inches below finished grade. The tracer wire shall be suitable for detection with metal pipe location equipment.
- G. All water pipe shall be blue in color and labeled "water" every three feet as a minimum.
- H. Pipe shall carry National Sanitation Foundation (NSF) seal and be factory marked with manufacturer's identification, pipe size, material and pressure rating. Detection tape shall be placed along all PVC water mains.

2.02 DUCTILE IRON PIPE

- A. Ductile iron pipe shall conform to the requirements of ANSI Standard A21.51 and AWWA C151. All pipe shall class 350. Class designations for the various classes of pipe shall be painted on the outside of each joint of pipe. Weights shall be conspicuously painted in white on each joint of pipe after the bituminous coating has hardened.
- B. All joints shall have the same pressure rating as the pipe with which it is used. Joints shall be rubber gasketed push on or mechanical joint. Joints shall meet the requirements of ANSI A21.11 and AWWA C111.
- A. Pipes shall be cement lined in accordance with the latest edition of AWWA Standard C104.

2.03 GALVANIZED STEEL PIPE

- A. This pipe and fittings shall conform to the requirements of ASTM A120. The pipe shall be "standard weight", unless otherwise specified.

2.04 PLASTIC TUBING

- A. Plastic pipe shall conform to all the requirements of the "Specifications for Polyethylene (PE) Plastic Pipe (ADR PR)", as they apply to PE 3306 of ASTM D2239.
- B. The hydrostatic design stress shall be 630 psi for water at 23° centigrade (73.4° F) and 500 psi for water at 37.8° C (100° F).

- C. The polyethylene extrusion compound from which the pipe is extruded shall meet the requirements of Type III, Grade 3, Class C material as described in "Specification for Polyethylene Molding and Extrusion Materials", ASTM D1248, except that melt index shall be determined under a higher temperature than any of the conditions as listed in Section 6(b) of "Method of Test for Measuring Flow Rates of Thermoplastics by Extrusion Plastometer", ASTM D1238. The test condition shall be the same as for condition J, except that the temperature shall be 310° C (590° F), with a load of 12.5 kilograms. Under these conditions the resin shall extrude at a maximum rate of 0.25 grams per ten (10) minutes. The pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions or other defects. The pipe shall be uniform in color, capacity, density, and other physical properties.
- D. The size, the type of plastic pipe material, dimension ratio, commercial standards with which the pipe complies, the manufacturer's name and the National Sanitation Foundation (NSF) seal of approval, shall be conspicuously marked on the outside of the pipe at intervals of not more than five (5) feet.

2.05 FITTINGS

- B. Fittings shall be ductile iron and shall conform to the latest edition of AWWA Standard C110 or C153. The fittings shall be of the lightest class conforming to the pressure rating of the pipelines in which they are installed. In no case shall the fittings be lighter than class 200.
- C. Fittings for galvanized steel pipe shall be malleable iron conforming to ANSI B16.3 except the nipples and couplings shall be the same material as the pipe. All fittings shall be hot dip galvanized in accordance with ASTM A120.
- D. Pipe having mechanical joints or slip-on joints with rubber gaskets shall be used. Lead-tip gaskets shall not be used.
- E. The mechanical joint shall meet the requirements of AWWA C111 and shall have the same pressure rating as the fitting of which it is a part.
- F. Fittings shall be cement lined in accordance with the latest edition of AWWA Standard C104.

2.06 HYDRANTS

- A. All fire hydrants shall conform to AWWA C502.

- B. All fire hydrants shall have a 6" mechanical joint inlet connection and be equipped with a 5 1/4 inch valve, two 2 1/2 inch hose nozzles, and one 4 1/2 inch pumper connection, all with ANSI (National) standard threads. Operating nuts shall be 1 1/2 inch, pentagon type.
- C. All fire hydrants shall be equipped with "O" ring-type stem seals.
- D. All fire hydrants shall be designed for 150 psi working pressure and 300 psi test pressure.
- E. All fire hydrants shall be equipped with a 6" gate valve, complying with other sections of the specifications, installed on the fire hydrant lead between the hydrant and the main.
- F. The Contractor shall paint the hydrant with XO 14 Tractor Red (Federal Safety Color) paint.
- G. All fire hydrants shall be designed such that clockwise rotation of the stem closes the valve and counterclockwise rotation opens the valve. Hydrant covers shall have the word "Open" and an arrow showing the proper rotation of the operating nut cast in or permanently attached.
- H. An independent drain shall be provided, completely draining the hydrant after use. The drain shall be activated to the open position by the closing of the hydrant valve. The drain rod shall be easily cleaned. The drain shall have a protective shield integral with the hydrant base to minimize clogging and prevent undermining.
- I. All working parts of the hydrant shall be easily removed for inspection or servicing without digging or the use of hoists or derricks or special tools. The hydrant cover and stand pipe shall be removable without requiring the water to be shut off.
- J. Each fire hydrant shall be equipped with a ground line mounted breakaway flange and cast iron safety stem coupling specially designed so that upon sustaining severe impact the hydrant will shear off at the ground line without loss of water in the main.
- K. All fire hydrants shall be Mueller standard or equal as approved by the Engineer.

2.07 METERS

- A. All meters shall be approved first-line products of recognized manufacturers and shall be compatible with the meter reading system currently being used by the water system owner and operator.

- B. Meters, meter materials, and meter test shall conform to applicable AWWA Specifications and shall meet or exceed current AWWA Specifications.
- C. Each meter shall have manufacturer's serial number on the lid.
- D. All body parts as cases, boxes, and lids shall be of bronze composition.
- E. Meters shall be split case, positive displacement type.
- F. The register shall read in U.S. Gallons and shall be hermetically sealed and driven by permanent magnets.

2.08 METER BOXES

- A. The meter box shall be the approved standard product used by the water system owner and operator.
- B. They shall be rectangular and of adequate dimension to accommodate the specified meters.
- C. Boxes shall have cast iron or polyethylene covers labeled "WATER METER".
- D. Boxes for 5/8" by 3/4" meters shall have inside width not less than 10 inches, inside length not less than 15 inches and overall height not less than 12 inches.
- E. Boxes shall be designed and built to withstand traffic loads typical of yard installations.

2.09 VALVES

- A. All valves 2" in diameter and smaller shall be constructed of brass or bronze except that the hand wheel which shall be of malleable iron construction with screwed ends. All valves 2 1/2" in diameter and larger shall have flanged ends for interior service and mechanical joints for buried service unless otherwise approved. They shall be iron body, bronze mounted, except that in the smaller sizes the valves may be all bronze.
- B. Gate Valves:
 - 1. Gate valves smaller than three inches shall meet the requirements of Fed. Spec. WW V 54, Class A, 125 pounds.

2. Gate valves three inches and larger shall have nonrising stems and shall meet the requirements of AWWA Standard C 500. Valves for lighter pressures than the AWWA Standard shall meet the requirements of the above specifications except that the requirements for metal thickness and strengths and structural designs shall be adjusted as required to meet hydrostatic test pressures not less than 150 psi.
3. All gate valves shall have standard stuffing box seals. Bonnet bolts, studs and nuts shall be cadmium plated. Seating devices shall be bronze to iron or bronze to bronze. The glands shall be bronze or bronze bushed. Gland bolts and nuts shall be bronze.
4. All gate valves shall be of the double disc or wedge type. The wedge or disc shall be totally encapsulated in rubber. The sealing rubber shall be permanently bonded to the wedge or disc to meet ASTM tests for rubber metal bond ASTM D249.
5. Valves to have two inches square operating nut, with the exception that gate valves in altitude valves pits shall have hand wheels.
6. Valves buried in ground or located in vaults or structures shall have suitable extensions for socket operation with top of operating nut located two feet below finished grade maximum.
7. Any valve installed in a vault readily accessible for entry shall be equipped with handle wheels in lieu of operating nuts. No hand wheels are allowed in buried valves.

C. Check Valves:

1. Check valves 2" through 24" shall be iron body, bronze mounted swing check valves meeting the requirements of AWWA Standard C508 76.
2. The check valve shall be metal to metal or composite to metal seat construction with flange ends or screw and coupled ends.

D. Altitude Valves:

1. All altitude valves furnished for use in the systems shall be equipped for showing at all times the position of the valve. Said altitude valves shall be of the size specified on the drawings and suitable for the use intended.

2. The Contractor shall supply the services of a qualified manufacturer's representative to check and calibrate each altitude valve installation for proper working pressure and sequence.

E. Air Release Valves

1. Air release valve shall have all bronze body and bonnet. They shall be the direct acting type.
2. Valves shall be hydrostatically tested to at least 150 psi.
3. The valve shall have stainless steel floats and an internal coating with rust inhibitors.

2.10 BACKFLOW PREVENTERS

- A. The backflow preventers used shall be those specifically designed for use in connections when the danger from backflow presents a health hazard.
- B. All domestic backflow preventers shall be of the reduced pressure type or double check type as shown on plans. All fire protection system backflow preventers shall be of the double check detector type.
- C. Backflow preventers 3/4" to 2" shall be Ames LF 2000 B, LF 4000 B, or equal meeting or exceeding the following specifications:

Mainline Case – Bronze or Copper Alloy
Working Parts Bronze & Stainless Steel
Springs Stainless Steel
Diaphragms Buna N and Mylar
Valve disc Silicone Rubber
Check Valve Enclosure Glass Reinforced Plastic
Maximum Rated Working Pressure 175 psi
Temp. Range 33° 180°F

- D. Backflow Preventers 2½" to 10" shall be Ames M200, M400, or LFM300 Lead Free or equal meeting or exceeding the following specifications:

Body 8" 10" Stainless Steel
Body 2½" 6" Stainless Steel
Working Parts Stainless Steel
Springs 2½" 6" Stainless Steel

Springs 8" 10" Stainless Steel
Valve Disc Silicone Rubber
Maximum Rated Working Pressure 175 psi
Temp. Range 33° 140°F

- E. Backflow preventers larger than 10" shall be designed for conditions that do present a health hazard. It shall be the reduced pressure type and depending on the application, may require detection of leaks or unauthorized use. Detectors above 10" shall be submitted for approval. The submittal shall include complete shop drawings. The submittal will be reviewed based on the product's ability to meet the needs of the project and the Owner.

PART 3 – EXECUTION

- A. All valves shall be carefully mounted in their respective positions free from distortion and strain. All valves shall be properly packed and left in satisfactory operating condition at the completion of the project.
- B. Valve box, cover, and the concrete pad shall be installed with each valve as shown in miscellaneous details.

3.01 PIPE INSTALLATION

- A. PVC pipe shall be installed in accordance with the Uni Bell Plastic Pipe Association guide for installation of polyvinyl chloride plastic pressure pipe for municipal water main distribution system and the printed recommendations of the manufacturer.
- B. Ductile iron pipe shall be installed in accordance with AWWA C600. Concrete pipe shall meet the latest edition of AWWA Standard C300.
- C. Pipeline alignment and gradient shall be straight or shall follow true curves as near as practicable. Curvature in pipelines, where required, shall be well within the allowable laying radius, horizontal and vertical.
- D. Excavation, cleaning, laying, jointing and backfilling shall follow as closely as is possible so as to progress the work. In no case shall pipe be left in the trench overnight without completing the jointing. The completed pipeline shall not be left exposed in the trench unnecessarily, and the Contractor shall backfill and compact the trench as soon as is possible after laying and jointing is completed. Each day at the close of work, and at all times when laying is not in progress, the exposed end of the pipeline in the trench shall be closed with a head or barrier of wood or metal. If at any time it becomes necessary

to cover the end of any uncompleted pipe line with backfill, the end of that pipe shall be closed with a mechanical joint plug.

- E. The Contractor shall keep exposed ends of pipe properly plugged during laying to prevent dirt and other materials from entering the line, and shall also, before the system is accepted, thoroughly clean all lines.
- F. Thrust Blocks (Reaction Blocking) shall be provided as specified AWWA C600. All exposed pipes, valves, hydrants, etc., shall be securely strapped and all ends and bends braced.
- G. Other means of pipe restraining in addition to thrust blocking shall include "mega lug" utilization and all threads bolted through fittings in accordance with AWWA C600. Thrust blocking may not be eliminated with the use of joint restraint.
- H. Mechanical joints shall be made only by experienced mechanics. Sockets and spigots shall be washed with soapy water before slipping gland and gasket over spigot. The spigot shall be inserted in the socket full depth. The gasket shall be brushed with soapy water, and pushed into position making sure the gasket is evenly seated in the socket. The gland shall then be properly positioned for compressing the gasket. All bolts and nuts shall be tightened with a torque wrench to a uniform, permanent tightness. Bolts shall be tightened alternately 180 degrees apart. Sockets, spigots, glands and bolts shall be kept clean and wet with soapy water until each joint is completed.
- I. All water distribution mains shall have a minimum 36" of cover.

3.02 INSTALLATION OF MAINS

- A. Water lines must not be installed in contaminated areas such as sanitary landfill or dump areas.
- B. No water main or pipe shall pass through or come into contact with any part of a sewer or sewer manhole.
- C. A continuous and uniform bedding shall be provided in the trench for all buried pipe.
- D. Backfill material shall be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect pipe.
- E. Thrust restraint shall be provided at all points where hydraulic thrust may develop. This will include providing reaction blocking, tie rods or joints designed to prevent movement to all bends, tees, valves, plugs, hydrants and other points where thrust may

develop. Additional restraints may be necessary on fusible pipe at the connection to appurtenances or transitions to different pipe materials to prevent separation of joints. The restraint may be provided in the form of an anchor ring encased in concrete or other methods as approved by the Division.

- F. Whenever a state route or heavily traveled off-system road or a railroad is crossed, the agency that has jurisdiction over the road or the railroad must be notified, prior to the installation of the mains. At the crossing, a steel casing with sufficient diameter must be jacked and bored to accommodate the carrier pipe. Any free boring at low traffic city streets and county roads must conform to the applicable local and/or state requirements.
- G. Installation of water lines and appurtenances along highways, streets and roadways must comply with the applicable regulations of, and permits issued by, the Georgia Department of Transportation, local County and Municipality with reference to construction operations, safety, traffic control, road maintenance and repair.
- H. When non-metallic pipe is installed, detection tape shall be installed.
- I. Any pipe, pipe fittings, plumbing fittings or fixtures, solder, or flux used in the installation or repair of a public water system must meet the new definition of lead free meaning: (a) not containing more than 0.2 percent lead when used with respect to solder; and (b) not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures.
- J. If soils are found to be aggressive, the water main shall be protected by encasement in polyethylene, the provision of cathodic protection (in very severe instances), or the use of corrosion resistant water main materials.
- K. Stones found in the trench shall be removed for a depth of at least six (6) inches below the bottom of the pipe.
- L. All distribution mains shall be provided with sufficient earth and other suitable cover to prevent freezing. This shall be not less than 24 inches measured above the top of pipe.

3.03 FIRE HYDRANT INSTALLATION

- A. Fire Hydrants shall meet the current AWWA Standard C502.
- B. All fire hydrants shall have 36" minimum pipe cover provided for the branch supply line.

- C. Each fire hydrant shall be set on a stable foundation at least 18 inches square and 6 inches thick and shall be blocked against the end of the trench with concrete and anchored.
- D. Hydrant drainage shall be provided by installing around the hydrant at least 7 cubic feet of gravel or crushed stone below the top of the hydrant supply pipe.
- E. The barrel of the fire hydrant shall be set plumb (perpendicular to the ground) with the lowest discharge outlet at least fifteen (15) inches high but no higher than 24 inches above finished grade. No fire hydrant shall be installed within 10 feet of any private driveway. Hydrants shall be located no closer than 5 feet of a curbing and no further than 12 feet of the curbing.
- F. Immediately before installation of a hydrant, the following operations shall be performed:
 - 1. The hydrant shall be thoroughly inspected.
 - 2. The hydrant interior shall be thoroughly cleaned.
 - 3. The hydrant shall be opened and closed to determine that all parts are in proper working order, with valves seating properly and the drain valve operating freely.

3.03 HYDROSTATIC TEST

- A. Upon completion of backfilling operations and not less than seven (7) days after the last concrete blocking anchor has been poured, the pipe system shall be subject to hydrostatic test.
- B. Pressure and leakage tests shall be performed in accordance with the latest edition of AWWA Standard C600.
 - a. For PVC: Allowable leakage shall be no greater than as calculated in $L = ND(P)^{1/2} / 7,400$ where L is allowable leakage in gallons/hour, N is the number of joints in the length of pipe tested, D is the nominal diameter of the pipe in inches and P is average test pressure during the leakage test in pounds per square inch (psi-gauge).
 - b. For DIP: Allowable leakage shall be no greater than as calculated in $L = SD(P)^{1/2} / 133,200$ where L is allowable leakage in gallons/hour, S is the length of pipe tested in feet, D is the nominal diameter of the pipe in inches and P is

average test pressure during the leakage test in pounds per square inch (psi gauge).

- C. The system shall be filled with water and all air expelled.
- D. The Contractor shall pressurize the system to 1.5 times the working pressure or 150psi, whichever is greater, at the highest point in the system.
- E. The test pressure shall be maintained for two hours.
- F. If the pressure cannot be maintained, the cause shall be determined, corrected and test repeated until successful.

3.04 LEAKAGE TEST

- A. Following the pressure test, the system shall be subject to a leakage test.
- B. Leakage shall be defined as the quantity of water that must be supplied into the pipe to maintain the design working pressure after all air in the pipe line has been expelled and the pipe has been filled with water.
- C. Leakage shall not exceed the quantity determined by the formula given below:

$$L = ND(\text{Square Root of } P)/7400$$

WHERE	L	=	allowable leakage in gallon/hr.
	N	=	number of joints in pipe line
	D	=	nominal diameter of the pipe inches
	P	=	average test pressure during leakage test in psig

- D. If leakage exceeds the allowable rate, leaks shall be found and repaired and the test repeated until successful.

3.05 CORROSION CONTROL

- A. General:
 - a. All treated water shall be evaluated to ensure that water quality parameters and characteristics are optimized to obtain the desired water stability throughout the distribution systems of a water supply.
 - b. The primary approaches to internal corrosion control in drinking water systems are to modify the water chemistry to make it less corrosive and to encourage

formation of passivating films on the contacting surface. This is typically accomplished through pH and/or alkalinity adjustment or through the addition of a corrosion inhibitor. Most corrosion control treatment will be beneficial for reducing corrosion of lead, copper, iron, steel and galvanized pipe.

- c. Where adjustments to water quality parameters such as chlorine residual, pH, alkalinity or carbonate buffer strength prove insufficient to control corrosion rates, the use of corrosion inhibitors should be considered. Orthophosphate is particularly effective for this purpose in most situations.
- d. To control corrosion, certain basic approaches can be utilized:
 - i. Using pipe materials and designing the system so it is not corroded by a given water;
 - ii. Modifying the water quality so it is not corrosive to the pipe material; and
 - iii. Placing a protective barrier or lining between the water and the pipe.

B. Corrosion Control Study:

- a. Monitoring/testing equipment shall be provided for determining the effectiveness of stabilization treatment and the chemical residuals at the entry point and in the distribution system, including an acceptable pH probe that utilizes three standards for calibration.
- b. A sample site location plan for water quality parameter monitoring. Entry point and distribution system samples shall be collected for water quality data and other system information pertinent to achieving optimum corrosion control. The frequency of sampling and number of sites shall be determined by the Division. The water quality parameters include:

pH	Conductivity
Temperature	Hardness
Alkalinity	Iron
Calcium Manganese	Sulfate Aluminum
Ammonia	Dissolved Oxygen
Total Phosphorus	Natural Organic Matter
Chloride	Total and Free Chlorine
	Corrosion Control Inhibitors
	Total & Free Chlorine (Orthophosphate, Silica)

- c. A summary of all water quality parameter monitoring results. These results should be evaluated considering the location of sample sites within the

distribution system and used as the basis for considering corrosion control treatment options.

- d. A desktop evaluation utilizing corrosion control computer modeling or regulatory guidance. The evaluation shall recommend optimal corrosion control treatment and water quality parameter performance requirements for the selected treatment.
- e. Identification of possible limitations and secondary impacts for treatment options.

C. Adjustments to water quality

- a. pH adjustment by the addition of lime, caustic soda or soda ash in order to stabilize the water with regard to calcium carbonate. Advantages of aeration for iron, H₂S or CO₂ removal should be balanced against the fact that dissolved oxygen is a corrosive agent.
- b. pH/Alkalinity adjustment includes adding a base or similar chemical to the water to increase pH to a level where the practical lead or copper solubility lowers, acids are neutralized, and less soluble metal compounds are formed on the pipes. Treatment shall be designed to operate within the optimum pH range and alkalinity concentration.
 - i. Caustic Soda- Caustic soda (sodium or potassium hydroxide) will increase the pH with minimal effect on alkalinity and dissolved inorganic carbon (DIC). A stable pH is very difficult to provide when using caustic soda on water having low alkalinity. Caustic soda can cause severe burns and damage the eyes.
 - ii. Soda Ash- Soda ash (sodium or potassium carbonate) will increase the alkalinity, DIC, and moderately increase the pH. Soda ash is relatively safe to handle compared to caustic soda.
- c. Aeration
 - i. Aeration can increase the pH and reduce excess DIC by removing carbon dioxide. Aeration is most effective when there is an adequate carbon dioxide concentration in the water.
 - ii. The carbon dioxide content of aggressive water may be reduced by aeration.

- A. Water mains and accessories shall be disinfected in accordance with "Rules for Safe Drinking Water" as published by the Georgia Environmental Protection Division.
- B. The mains shall be flushed into the storm drainage system before disinfecting by maintaining a velocity of at least 2.5 feet per second for a period of ten minutes.
- C. The continuous feed method may be used for any size main or system where satisfactory quantity and quality water is available. The tablet method shall not be acceptable.
- D. Following disinfection of the water system, the system shall be flushed until chlorine concentration is less than 1 milligram per liter. Flushing shall not allow chlorinated water to be discharged into the storm sewer system without first allowing the chlorine in the system to dissipate. The contractor shall use a Pollard Water LPD-250 or equal equipment along with LPD-Chlor tablets (Sodium Sulfate or Ascorbic Acid) to de-chlorinate the water using 1 tablet per 2000 gallons of water minimum prior to flushing, then after adequate testing, discharge the de-chlorinated water to the storm sewer system or onto the land surface. During the de-chlorination flushing the flow through the LPD 250 will be maintained at between 200 and 1200 GPM. No flows for de-chlorination or flushing will not be allowed outside this flow specification. The contractor may apply to the owner of the sanitary sewer system to obtain permission to discharge the chlorinated water into the sanitary sewer system for a fee. The contractor shall be charged at the going rate per gallon for treating the water discharged to the sanitary sewer system.
- E. When new water mains are placed in or returned to service, they shall be disinfected in accordance with the latest addition of AWWA Standard C651.
 - a. Before the main is chlorinated, it shall be filled to eliminate air pockets and shall be flushed to remove particulates. A flushing velocity of not less than 2.5 feet/second is usually maintained in pipe sizes less than 24 inches in diameter. For larger diameter mains, an alternative to flushing, such as broom-sweeping of the main, is acceptable prior to chlorinating the main.
 - b. During disinfection of the water mains, an appropriate cross-connection control device, consistent with the degree of hazard, shall be provided for backflow protection of the active distribution system.
 - c. The quality of the water used during the disinfection procedures shall meet the required drinking water standards.

- d. The chlorine solution used for the “continuous feed” method of disinfection of water mains shall have a free chlorine residual concentration not less than 25 mg/L. This heavily chlorinated water shall be retained in the main for at least 24 hours, during which time all valves and hydrants shall be operated to ensure disinfection of the appurtenances. At the end of the 24-hour period, the treated water in all portions of the main shall have a residual of not less than 10 mg/L free chlorine. Re- chlorinate if required results are not obtained on all samples.
 - e. After the applicable retention period, the heavily chlorinated water must not be disposed in a manner that will harm the environment. Neutralizing chemicals, such as Sulfur Dioxide, Sodium Bisulfite, Sodium Sulfite or Sodium Thiosulfate can be used to neutralize the chlorine residual remaining in the water to be wasted.
 - f. Flush all lines until residual is equal to existing system. After final flushing and before the water main is placed into service, water samples shall be collected from the main and tested for microbiological quality in accordance with the Georgia Rules for Safe Drinking Water, Chapter 391- 3-5. The laboratory results must show the absence of coliform organisms in the water. Reflush and re-disinfect the lines, as necessary, until satisfactory bacteriological results are obtained.
- F. When cutting into existing mains, for abandonment or reuse, the pipes must be disinfected.
- a. All water mains that are depressurized and/or wholly or partially dewatered shall be disinfected in accordance with the current AWWA C651 Standards, including swabbing with hypochlorite solution, flushing, and/or slug chlorination as appropriate. Leaks or breaks that are repaired with clamping devices while the mains remain full of water under pressure may require no disinfection.
 - a. Chlorine required to produce 25 mg/L concentration in 100 feet of pipe by diameter:

Pipe Diameter (inches)	100% Chlorine		1% Chlorine Solution	
	(lbs.)	(g)	(gal)	(L)
4	0.013	5.9	0.16	0.6
6	0.030	13.6	0.36	1.4
8	0.054	24.5	0.65	2.5
10	0.085	38.6	1.02	3.9

12	0.120	54.4	1.44	5.4
16	0.217	98.4	2.60	9.8

Note: 1% chlorine solution may be prepared with sodium hypochlorite (contains 5% to 15% available chlorine) or calcium hypochlorite (contains approximately 65% available chlorine by weight). To prepare 1% chlorine solution using calcium hypochlorite, add one (1) pound (454 grams) of calcium hypochlorite in approximately 8 gallons of water.

- b. Amounts and types of chemicals advised to be used for neutralizing various residual chlorine concentration in 100,000 gallons of water

Residual Chlorine Concentration Mg/L	Chemicals							
	Sulfur Dioxide (SO ₂)		Sodium Bisulfate (NaHSO ₃)		Sodium Sulfite (Na ₂ SO ₃)		Sodium Thiosulfate (Na ₂ S ₂ O ₃ ·5H ₂ O)	
	Lb.	Kg	Lb.	Kg	Lb.	Kg	Lb.	Kg
1	0.8	0.36	1.2	0.54	1.4	0.64	1.2	0.54
2	1.7	0.77	2.5	1.13	2.9	1.32	2.4	1.09
10	8.3	3.76	12.5	5.67	14.6	6.62	12.0	5.44
50	41.7	18.91	62.6	28.39	73.0	33.11	60.0	27.22

- G. Surface water crossings, both over and under water, may present special concerns and should be discussed with the Division before the final plans are prepared.

- At above water crossings, the pipe shall be adequately supported and anchored, protected from vandalism, damage and freezing, and accessible for repairs or replacement. At underwater crossings, a minimum of 3 feet of cover shall be provided over the pipe.
- The installation of ductile iron pipe with restrained push-on joints and encased in concrete, may be considered with the prior approval of the Division. Otherwise, when crossing water courses which are greater than 15 feet in width, only pipes of special construction, having flexible, watertight joints shall be installed.
- Valves shall be provided at both ends of water crossings so that the section can be isolated for testing or repair; valves shall be easily accessible and not subject to flooding. Sampling taps shall be installed at each end of the crossing, and permanent taps shall be made for testing and determining leaks.

- H. There shall be no physical connection between the distribution system and any pipes, pumps, hydrants, or tanks whereby unsafe water and other contaminating materials may be discharged or drawn into the system.
 - a. The approval of the Division shall be obtained for interconnections between potable water supplies.
 - b. Neither steam condensate nor cooling water from engine jackets or other heat exchange devices shall be returned to the potable water supply
- I. Water services and plumbing should conform to relevant local and/or state plumbing codes, or to the Standard Plumbing Code, as applicable within the jurisdiction in which the system is located. The product that is used for the service line must be listed as being certified for conformance with the NSF Standard 61.
 - a. All new and existing services connected to community and non-transient noncommunity water systems shall be individually metered.
 - b. Individual booster pump(s) shall not be allowed for any individual residential service from the public water supply mains. Where permitted for other types of services, booster pumps shall be designed in accordance with AWWA standards.
- J. Water loading stations present special problems since the fill line may be used for filling both potable water vessels and other tanks or contaminated vessels. To prevent contamination of both the public supply and potable water vessels being filled, the following principles shall be met in the design of water loading stations:
 - a. there shall be no backflow to the public water supply;
 - b. the piping arrangement shall prevent contaminant being transferred from a hauling vessel to others subsequently using the station; and
 - c. hoses shall not be contaminated by contact with the ground.
- A. Bacteriologic Tests:
 - 1. Bacteriological testing shall be performed after the repairs are complete. However, depending upon the circumstances, the water main may be returned to service prior to completion of testing to minimize the time the customers are out of service.

2. Tests shall be performed to detect the presence of coliform organisms on samples taken from the end farthest from the point at which chlorine was introduced into the system and at 1000 ft. intervals.
3. The bacteriological sample shall meet the requirements established by EPD for suitable disinfection for human consumption.
4. If unsatisfactory samples are produced, disinfection shall be repeated until samples are satisfactory.

END OF SECTION

**SECTION 02611
BASE AND PAVING**

PART 1 – GENERAL

1.01 APPLICABLE STANDARDS

- A. When used in this section, the term "Standard Specifications" shall mean the DEPARTMENT OF TRANSPORTATION, STATE OF GEORGIA STANDARD SPECIFICATIONS – CONSTRUCTION OF TRANSPORTATION SYSTEMS 2013 or later edition.
- B. American Society for Testing and Materials (ASTM):
 - D 698 Test for, Moisture Density Relations for soils
 - D 1557 Test for, Moisture Density Relations for soils

PART 2 – PRODUCTS

2.01 MATERIALS

- A. Base: The base shall conform to Section 310, Graded Aggregate Construction, of the Standard Specifications.
- B. Prime: The prime coat shall be RC 70 and shall conform with Section 412, Bituminous Prime, of the Standard Specifications.
- C. Tack Coat: The tack coat shall be RC 70 and shall conform with Section 413, Bituminous Tack Coat of the Standard Specifications.
- D. Intermediate Course (Binder): The intermediate course shall be Superpave 12.5 mm or 19 mm Asphaltic Concrete and shall conform with Section 402, Hot Mix Asphaltic Concrete Construction of the Standard Specifications.
- E. Crack Relief Interlayer: The crack relief interlayer shall be OGI Asphaltic Concrete and shall conform with Section 415, Asphaltic Concrete Open Graded Crack Relief Interlayer of the GDOT Standard Specifications and Special Provisions.
- F. Surface Course Asphalt Plant Mix: The surface course shall be either Superpave 9.5 mm or 12.5 mm Asphaltic Concrete and shall conform with Section 402, Hot Mix Asphaltic Concrete Construction, of the Standard Specifications.

- G. Paint: Paint for pavement marking shall be in conformance with MUTCD publication and shall conform with Section 870, Paint, of the Standard Specifications.
- H. Concrete Curb and Gutter: Shall conform to Section 441 Concrete Curb, Gutter, Combination Curb and Gutter, Header, and Median of the Standard Specification.

PART 3 – EXECUTION

3.01 COMPACTION

- A. Sub-grade: The upper 24 inches of sub-grade soils in all cut areas and all fill areas that are to receive new pavements shall be scarified and re-compacted until a density equivalent to 95% standard Proctor maximum dry density in accordance with ASTM D698 has been obtained.
- B. Base: All base shall have minimum compaction of 100% of the maximum density obtained by the test procedure present in ASTM D1557, Method D (Modified Proctor). The maximum permissible lift thickness shall be 6 inches (compacted). The contractor shall be required to perform all work necessary to meet the minimum compaction requirements.
- C. Moisture Content: Compaction shall be performed only when the moisture content of the soil is within 4% of the optimum moisture content at the time of compaction as determined by ASTM D698. Soils are to be dried prior to compaction by discing and aeration. An Independent Testing Laboratory shall determine if soils are within the optimum moisture content. The contractor shall be required to perform all work necessary to meet the minimum compaction requirements.

3.02 CONSTRUCTION

- A. Preparation of Sub-grade: Prior to placing of base and pavements, the construction of all utility lines (water, sewer, power, gas, etc.) which are to be placed under the pavements shall have been completed.
- B. Base: The base course shall be constructed in accordance with Section 310 of the Georgia Department of Transportation Standard Specifications to the compacted thickness specified.
- C. Prime: The prime coat shall be applied at a rate of 0.25 gallons per square yard and in accordance with Section 413 of the Georgia Department of Transportation Standard Specifications.

- D. Tack Coat: The tack coat shall be applied at a rate of 0.10 gallons per square yard and in accordance with Section 413 of the Georgia Department of Transportation Standard Specifications.
- E. Crack Relief Interlayer: The crack relief interlayer shall be constructed in accordance with GDOT Section 415 of the Georgia Department of Transportation Standard Specifications and Special Provisions.
- F. Intermediate and Surface Course Asphalt Plant Mix: The intermediate and surface courses shall be constructed in accordance with Section 402 of the Georgia Department of Transportation Standard Specifications to the thickness indicated. All thicknesses are compacted.
- G. Painting Stripe: Pavement striping is required and shall be in accordance with Georgia Department of Transportation MUTCD publication.
- H. Existing pavement which has pavement markings damaged by this construction shall be repainted.
- I. Concrete Curb and Gutter: Shall be constructed in accordance with Section 441 of the Georgia Department of Transportation Standard Specification.

3.03 TESTING

- A. Compaction testing shall be performed by an approved testing laboratory. Sub-grade and base compaction testing shall be performed at a spacing not to exceed 500' staggered for the entire length of the street. On streets shorter than 1,000' the testing spacing shall reduce to 300' and in no case will be less than three tests per street, equally spaced. The Design Engineer and Construction Inspector shall be provided copies of the test information prior to placement of base material or final pavement.
- B. Prior to the installation of any base material a test roll must be performed along the entire roadway length, both sides of the road. The test roll shall be performed utilizing an 18 C.Y. tandem axle dump truck loaded with at least 12 C.Y. of soil or gravel. The same test roll will be required on the base material prior to beginning pavement installation. The Design Engineer and Construction Inspector shall be present during the test roll.
- C. Prior to beginning the installation of any asphalt pavement, the base material shall be tested to determine thickness and graded cross section of the base material. The contractor shall provide labor and equipment to auger through the base material to

check to insure the thickness specified in the plans and specifications has been achieved. In addition, the cross slope of the base and the depth below the gutter face shall be checked, utilizing a string line, to insure proper crown and asphalt depth at the edge has been achieved with the base grading. If the depth of base material is insufficient the base present will be removed, the subgrade lowered and adequate base material will be replaced to achieve the required thickness. If the cross slope or edge depth is determined to be less than the specified thickness, the area will be rejected until the area is re-graded to the slope and the thickness specified on the approved plan.

- D. The Owner at his option may check the thickness of the asphalt pavement and base material after the installation is complete. If the Owner finds the materials to be less than specified the contractor/developer shall take necessary measures to meet the requirements of the approved plans and specifications.
- E. Prior to any striping being performed, the contractor shall prepare a striping plan for approval by the Construction Inspector.

3.04 EXISTING PAVEMENT RESTORATION

- A. Pavement damaged due to construction shall be patched or replaced in accordance Section 400 of the Georgia Department of Transportation Standards and Specifications.
- B. Pavement damaged by new utility trenches shall be restored in accordance with the pavement removal and replacement details. Any pavement removed must be disposed of by the contractor at a permitted site.
- C. Existing inlets, manholes, or valve boxes shall be adjusted by the Contractor to the new grade lines and elevations. All adjustments to structures in areas proposed for pavement shall be accomplished prior to construction of the surface course.
- D. Adjustment to grade of existing frames shall include raising or lowering the upper portion of the structure, including any necessary sleeve extensions, adjustable manhole rings, gaskets, mortar, masonry or other approved material, to bring the frame to the required grade.

3.05 STRIPING OF PAVEMENT MARKINGS

- A. Striping shall consist of furnishing and applying traffic markings with paint or thermoplastic in accordance with the contract drawings and specifications, and the requirements of the current Federal and State "Manual On Uniform Traffic Control Devices."

- B. Thermoplastic Plastic Stripe shall consist of solid or broken (skip) lines, words and/or symbols of the type, color and the location shown on the plans. It is the intent of these specifications that short lines which are defined to be crosswalks, stop bars, arrow symbols and crosshatching shall be extruded. All other lines, unless otherwise specified, shall be sprayed.
- C. Cleaning: All pavement areas to be striped shall be thoroughly cleaned. Cleaning may be accomplished by the use of hand brooms, rotary brooms, air blasts, scrapers or other approved methods which leave the paving surface thoroughly clean and undamaged. Particular care shall be taken to remove all vegetation and road film from the area to be striped.
- D. Warranty: The Contractor shall transfer to the Governing Authority the warranty on Thermoplastic materials issued by the Manufacturer.

END OF SECTION

**SECTION 02650
SANITARY SEWERS**

PART 1 – GENERAL

1.01 APPLICABLE STANDARDS

A. American National Standards Institute (ANSI):

A21.4	Cement Mortar Lining for Cast Iron and Ductile Iron Pipe and Fittings for Water
A21.6	Cast Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids
A21.11	Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings
A21.51	Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds, for Water or Other Liquids

B. American Society of Testing and Materials (ASTM):

A48	Gray Iron Castings
C12	Installing Vitrified Clay Sewer Pipe
C425	Compression Joints for Vitrified Clay Bell and Spigot Pipe
C478	Precast Reinforced Concrete Manhole Sections
C594	Compression Couplings for Vitrified Clay Plain End Pipe
C700	Extra Strength and Standard Strength Clay and Perforated Clay Pipe
D1784	Rigid Poly (Vinyl Chloride) Compounds and Chlorinated Poly (Vinyl Chloride) Compounds
D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR PR and Class T)
D2321	Underground Installation of Flexible Thermoplastic Sewer Pipe
D2774	Underground Installation of Thermo plastic Pressure Piping
D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D3139	Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals
D3212	Sewer Pipe Joints using Elastomeric Seals

C. American Water Works Association (AWWA):

C 600	Installation of Cast Iron Mains

1.02 SUBMITTALS

- A. Materials used in the sanitary sewer system shall be submitted for approval to the Design Engineer. The Design Engineer shall review the drawings, provide a list of materials and certify compliance to the Owner.
- B. Six copies of shop drawings or manufacturer's standard drawings or catalog cuts shall be submitted for the following:
 - 1. Precast concrete manholes
 - 2. Manholes and Frames
 - 3. Gaskets One of each type
 - 4. Pipe One of each type
 - 5. Valves One of each type

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall be responsible for handling and storage of all materials and damaged materials shall not be used in the work. Materials delivered to the site shall be promptly inspected for damage upon arrival. Damaged or defective materials to be immediately removed from the site.
- B. All materials to be stored at least 12 inches above grade. Inside of pipes and fittings shall be kept free of dirt and debris. Rubber gaskets and plastic pipe not used immediately shall be protected from direct sunlight. Manhole units shall be handled with care to avoid chippage or breakage.

PART 2 – PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE AND FITTINGS

- A. Polyvinyl chloride pipe and fittings for gravity sewers shall be SDR 35 for less than 12' bury and SDR – 26 for 12' bury and over, meeting ASTM D3034 for type PSM Polyvinyl Chloride (PVC) sewer pipe. The joints shall be Push On "O" ring gasket type with integral bell and spigot meeting ASTM 3212. Threaded or solvent welded type joints shall not be used.
- B. Polyvinyl chloride pressure pipe shall meet one of the following specifications:
 - 1. IPS Size PVC Pipe: Class 200 SDR 21 - Polyvinyl chloride water main pipe shall conform to Designation ASTM D2241 and shall consist of Type I, Grade 1 PVC

compound conforming to ASTM D1784. All pipe shall be Class 200, SDR 21. The standard laying length shall be 20 ft. ± 1 inch.

2. DIP Size PVC Pipe: AWWA C-900-07

- a. C-900 polyvinyl chloride water main pipe 4" TO 12" shall conform to Designation ASTM D2241 and shall consist of Type I, Grade 1 PVC compound conforming to ASTM D1784. All pipe larger than 4" to 12" shall meet the requirements of AWWA C900, "Poly Vinyl Chloride (PVC) pressure pipe." All pipe shall be class 200 pipe and shall meet the requirements of DR14. The standard laying length shall be 20 ft. ± 1 inch. The FM approved pressure class will be used to determine pressure class.
- b. C-905 polyvinyl chloride water main pipe 14" to 30" shall be manufactured from compounds conforming to PVC cell classification of 12454B as defined in ASTM D-1784. The integral bell joint system meets the requirements of ASTM D-3139 and utilizes an elastomeric seal conforming to ASTM F-477. All pipe shall be class 200 pipe and shall meet the requirements of DR18. The standard laying length shall be 20 ft. ± 1 inch.
- c. When DIP size PVC pipe is used two 2" PVC pipe shall be SDR 21, 200 PSI pressure class, iron pipe

C. Marking: Pipe shall be clearly marked with:

1. Manufacturer's Identification
2. Nominal Pipe Size
3. Material, Type and Grade
4. SDR or Pressure Rating
5. All gravity sewer pipe shall be green. Force main pipe shall be white or brown.
6. All pipe regardless of color shall be clearly marked "SEWAGE FORCE MAIN" or "GRAVITY SEWER" as appropriate, marked every three feet.

2.02 DUCTILE IRON PIPE AND FITTING

A. Type: Coated Ductile

B. Joints:

1. Push on type in accordance with ANSI A21.11.

- 2. Mechanical joint in accordance with ANSI A21.11 and fittings may be in accordance with A21.53..
- C. Ductile iron pipe shall conform to ANSI A21.51.
- D. Pipe shall have a Protecto 401 lining or equal. The lining should have a high resistance to fatty oils, detergents and sewage generated hydrogen sulfide.
- E. Pipe shall be coated outside with one mil. thick bituminous coating conforming to ANSI A21.4 and AWWA C110, C115OR C151.

2.03 REINFORCED CONCRETE PIPE AND MANHOLES (WET WELLS OR VALVE PITS)

- A. Precast concrete sections to be manufactured in accordance with provisions of ASTM C478. As a minimum, the interior of all sections shall be coated with two coats of bituminous coating. The first coat shall be spray applied and the second coat should be roller applied. In addition, in extremely corrosive environments, to include force main receiving manholes, wetwells, and the first two manhole from the force main connection shall be lined with sealed HDPE sheet liner. The HDPE liner shall have a watertight seal at all joints and penetrations. The liner shall be Agru Sure Grip Liner or equivalent.
- B. Precast concrete riser sections to be 48 inches in diameter with minimum wall thickness of 4 inches.
- C. Precast concrete base units to have minimum wall thickness of 5 inches.
- D. Jointing material shall be rubber gasket type conforming to ASTM C443 or vulcanized butyl rubber base flexible joint sealer in rope form conforming to Federal Specification SS S 00210, Kent Seal No. 2 or approved equal. The inside and outside of the joint shall be finished with mortar. Mortar shall be one part Port-land cement and two parts sand.
- E. Manhole base sections shall provide for a flexible watertight union between pipe and manhole base. Manhole sleeves shall be of high quality synthetic rubber with tensile strength of 1,500 psi, resistant to raw sewage, ozone, acids, and weathering, flexible at temperatures below 0°F and resistant to heat as high as 250°F. A substantial, serrated flange of the sleeve material shall be integrally cast into the wall of the manhole base forming a tight waterseal. The sleeve shall protrude through the wall of the base. A watertight union shall be secured with the end of the pipe with stainless steel strap

clamps. Manhole sleeves shall be Interpace Corp. Lock Joint Manhole Sleeves or approved equal.

- F. Pick up holes shall not penetrate the interior walls or the riser.

2.04 MANHOLE FRAMES AND COVERS

- A. Frames and covers to have machined bearing surfaces.
- B. Covers to have checkered top design and marked "Sanitary Sewer" and include the name of the utility owner.
- C. Combined weight of frame and cover shall be approximately 450 pounds.
- D. Frame shall have a depth of approximately 9 inches and an access opening of not less than 20 inches.
- E. Covers shall have two pick holes located at edges.
- F. Materials shall conform to ASTM A48 for Class 30 gray iron castings.

2.05 MANHOLE STEPS

- A. Manhole steps shall be constructed of a number 3 reinforcing bar encapsulated in polypropylene plastic with a non skid tread.
- B. Finished dimensions of the steps shall be identical to that of malleable iron manhole steps.
- C. Steps to have a minimum tread width of 12 inches.

2.06 NUTS AND BOLTS

- A. Stainless Steel Flanged: Square head MB/SF, hexagon nuts; ASTM 307B; ANSI B18.2, zinc plated.

2.07 GASKETS

- A. Flanged pipe gaskets shall conform to requirements of ASA A21.10 and shall be suitable for the indicated services.

2.08 VALVES

- A. All valves two inches in diameter and smaller shall be constructed of brass or bronze except the hand wheel, which shall be of malleable iron construction. Valves two inches in diameter and smaller shall have screwed ends unless approved otherwise. All valves 2½ inches in diameter and larger shall have flanged ends unless otherwise approved. They shall be iron body, bronze mounted, except that in the smaller sizes the valves may be all bronze at the contractors option and expense.
- B. The contractor shall prepare and submit for approval complete detailed drawings of all valves in accordance with the requirements of the appropriate section of these specifications. All valves of the same type shall be from a single manufacturer. Parts of valves of the same type and size shall be interchangeable. Spare parts shall be furnished as specified under the proposal items. Special tools required for repacking or disassembling valves shall be provided.
- C. All valves shall be carefully mounted in their respective positions free from all distortion and strain. All valves shall be properly packed and left in satis-factory operating condition at the completion of the project. All valves shall open left.
- D. Gate Valves
 - 1. Gate valves should not be used in raw sewage applications. Gate valves should only be used where primary and partial secondary treatment has already occurred.
 - 2. Unless otherwise specified or directed, gate valves three inches and larger shall have non rising stems and shall meet the requirements of AWWA Standard C 500. Valves for lighter pressures than the AWWA Standard shall meet the requirements of the above specifications except that the requirements for metal thicknesses and strengths and structural designs shall be adjusted as required to meet hydrostatic test pressures not less than 125 psi.
 - 3. Unless otherwise specified or directed, gate valves smaller than three inches shall meet the requirements of Federal Specification WW V 54, Class A, 125 pounds.
 - 4. All gate valves shall have standard stuffing box seals. Bonnet bolts, studs and nuts shall be cadmium plated. Seating devices shall be bronze to iron or bronze to bronze as specified or required. The glands shall be bronze or bronze bushed. Gland bolts and nuts shall be bronze.

5. All gate valves 2½ inches in diameter and larger shall be of the double disk type. All gate valves two inches in diameter and smaller may be of the double disk or the solid wedge type.

E. Plug Valves

1. All plug valves shall be the two way type.
2. Nonlubricated, eccentric with resilient faced plugs.
3. Port area of 4 to 20 inch valves shall be at least 70 percent of full pipe area.
4. Valves to be designed for 125 psi working pressure.
5. Bodies to be semisteel with raised seats.
6. Seats to have either a welded in overlay of approximately 90 percent pure nickel on surfaces contacting the plug face or shall be bronze conforming to ASTM B 62 and attached to the body by stainless steel set screws.
7. Upper and lower plug stem bushings to be stainless steel and shall be permanently lubricated.
8. Exposed nuts, bolts and washers to be zinc plated.
9. Flanges to be faced and drilled to ASA 125 pound standard.

F. Check Valves

1. Type: Ball Check
 - a. Static head must exceed 10 feet to use ball check valves.
 - b. No ball check valve will be mounted vertically to compensate for low static head.
 - c. Ball check ends must be flanged.
 - d. The body shall be cast iron, ASTM A159 72, Class 35.
 - e. The ball shall be hollow steel with vulcanized nitrile rubber covering.
 - f. Pressure rating shall be 150 psi.
 - g. Valve to be Flygt HDL or equal.

2. Lever Actuate Spring Check Valve

- a. Where static head is less than 10 feet lever action swing check valves shall be used.
- b. Lever action swing checks may be spring and lever type or weight on lever type as approved by the design engineer and the Owner.
- c. Valves shall be installed in the horizontal position.
- d. The valve body, disc, cover and lever shall be cast iron, ASTM A159 72, Class 35.
- e. The disc arm shall be cast steel
- f. The seat ring shall be bronze or stainless steel.
- g. All studs, bolts or nuts shall be commercial grade steel.
- h. The gate shall be rubber faced.
- i. The hinge shaft shall be stainless steel.
- j. The chamber shall be bronze.
- k. The valve shall be Clow F5340 (outside spring and lever) or Clow F5345 (outside weight and lever) or an approved equal.

G. Automatic Sewage Air Release Valve

1. The automatic sewage air release valve shall be designed to allow entrapped air to escape from the sewage force main line. After the air escapes out of the air release valve, the valve shall shut off until more air accumulates in it and the opening cycle will repeat automatically.
2. The sewage release valve must have a compound internal linkage of precision molded delfin or stainless steel. All other internals must be stainless steel to positively prevent galvanic action. The float rod shall be 20" long to provide an air gap between the linkage and waste level inside the valve to retard the waste solids from clogging the linkage. The stainless steel float must withstand a minimum 1000 psi pressure. Each valve shall be complete with hose and blow off valves to permit back flush-ing without dismantling valve.

Body and cover	cast iron	ASTM A48 Class 30
Internal Delfin linkage		ASTMD2133 (or Stainless Steel)
Stainless Float		ASTM A240
Buna N		ASTM SB800
3. Typical installation will utilize standard body valve. Valve height 28" with back flushing attachments 33 1/2". If depth of trench is not deep enough, furnish short valve. Valve height 17 1/2" with back flushing attachments 23 1/2".
4. Automatic sewage air release valve to be as manufactured by Crispin, Val matic, or APCO equal to APCO Series 400 with accessories.

2.09 ACCESSORIES, PLUG, AND GATE VALVES

- A. Valves to have two inch square operating nut unless otherwise indicated.
- B. Valves buried in ground or located in vaults or structures to have suitable extensions for socket operation with top of operating nut located two feet below finished grades maximum.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Plastic piping installation shall be in accordance with ASTM D2321 Recommended Practice for non pressure pipe and ASTM D2774 Recommended Practice for pressure pipe.
- B. Ductile iron pressure piping shall be installed in accordance with AWWA Standard C600.
- C. Material selection for piping material shall be as indicated. If piping materials are not indicated the Contractor has the option of selecting materials in accordance with this section.
- D. Service sewer lines shall be constructed of same material as the mains.
- E. Sewer lines shall not be laid closer than 10 feet horizontally to a water main. Pressure sewer lines shall pass beneath water lines, with the top of the sewer being at least 18 inches below the bottom of the water line. Where sanitary sewer lines pass beneath water lines, no joints in the sewer line shall be closer than 10 feet, horizontal the water line. When the vertical or horizontal separation cannot be accomplished, then concrete encasement shall extend a minimum of 10 feet on both sides of crossing.
- F. Pipe laying to proceed up grade with pipe bells or groove on the upper end. Pipe to be laid with joints close and even, butting all around. Sagging joints will not be tolerated.
- G. Pipe shall be straight and of uniform grade between manholes, laid to line and grade.
- H. All sewer shall be designed and constructed to give velocities of not less than 2.0 FPS. Since the Owner has adopted a low flow plumbing device ordinance, the following slopes will be used.

Minimum Slope in Feet

<u>Sewer Size</u>	<u>Per 100 Feet</u>
8"	0.44
10"	0.30
12"	0.24
15"	0.15
18"	0.12
21"	0.10
24"	0.08
30"	0.058
36"	0.046

- I. An allowable deviation from the design grades will be allowed up to 5% of the grade shown on the plan. If the grade is steeper than allowed 5% deviation the engineer must verify that the project was installed to all minimum requirements and determine the impact of the additional grade. If the grade is flatter than the 5% deviation, then it exceeds the allowable tolerance and the installation of that line is not acceptable and must be replaced. All sewer mains installed will be field checked for grades during preparation of "Record drawings".
- J. Bell holes shall be dug so the pipe barrel will carry the load of the pipe. Pipe shall be bedded in undisturbed earth or, where rock occurs, on a thoroughly compacted layer of #57 stone or sand fill of a minimum thickness of 6 inches under the barrel or bell of the pipe.
- K. Where sewers or force mains are to be connected to existing manholes or other structures, and where no stub or opening has been provided for the connection, the Contractor shall make an opening of minimum diameter through the side wall of the structure utilizing a professional coring machine and installing a boot for inserting the sewer pipe. The boot and stainless steel strap shall be sized and installed to create a water tight seal.
- L. Lateral connection made to the sewer prior to back filling shall be laid on a slope not exceeding 2 feet vertical to 1 foot horizontal, and not less than 1/8 inch per foot, so that the lateral shall have a solid bearing on undisturbed earth as stipulated for pipe sewers. The lateral shall make such a horizontal angle with the sewer line that a proper connection with the wye or tee branch or slant is obtained without trimming the pipe and with no danger of jointing material being forced into the sewer. All laterals shall be closed by means of suitable stoppers or end caps.

- M. Wye or tee branches shall be field located for service to all subdivided lots or inhabitable structures unless otherwise directed by the Architect/Engineer. Wye branches shall be installed so that the lower lip of the branch is not more than 2 inches below the outside top of the pipe. Tees shall be installed with the branch 45° to vertical. After installation, wye or tee branches shall not be covered with backfill until determination and record has been made of the locations of each with reference to the nearest manhole downstream and the direction in which the wye faces.
- N. All laterals shall be properly marked on ground surface at the point where laterals terminate with treated timber markers. Timber markers shall consist of a 2 inch by 4 inch timber extending from the end of the lateral vertically to within 2 inches of the ground surface. All such markers shall be securely anchored and maintained in a proper vertical position until backfilling has been completed. The top end of such markers shall be marked or left exposed until an "as built" survey has been made.
- O. The top rim of manhole frames and covers shall be set to conform to grades and transverse slopes. Generally along outfall lines, the manhole frames and covers shall extend approximately 6 inches above finished grade or to a designated elevation for flood protection. Generally where lines are located along streets, the manhole frames and covers shall be set flush with the surface.
- P. The Contractor shall install a continuous run of plasticized metallic tape above the top of the sewer main at 12 inches to 18 inches below finished grade. Tape shall be suitable for detection with metal pipe location equipment labeled "sewer buried below," and brightly colored to contrast with the soil.
- Q. A 14 gauge copper tracer wire with underground coating shall be installed along the route of pressure sewers. The wire shall be located 12 inches above the pipe but no deeper than 48 inches.
- R. All PVC pressure pipe shall have a minimum of 36" cover. Areas where the cover is not maintained may require the use of extra strength (D.I.) pipe as directed by the engineer.
- S. All sewer mains will be installed at a constant grade and line as shown on the plans. If after video inspection "sags" are found in the line, then the depth of the sag will be determined by the utility owner. If the sag is determined to be deeper than the following chart then the line will be removed and replaced to meet the minimum requirements of these specifications.

<u>Pipe Size</u>	<u>Max. Sag Depth</u>
8"	0.50"
10"	0.50"
12"	0.75"
15"	0.75"
18"	0.75"

3.02 PRESSURE TESTS

- A. **FORCE MAINS:** The Contractor shall test by hydrostatic pressure to 150 pounds per square inch. Each section tested shall be slowly filled with water, care being taken to expel all air from the pipes. The required pressure shall be applied for not less than two hours. No pipe installation will be accepted until the leakage during the pressure test is less than the number of gallons listed below for each 1000 feet of pipe.

6" - 1.5 gallons	12" - 2.75 gallons
8" - 1.75 gallons	14" - 3.00 gallons
10" - 2.75 gallons	16" - 3.5 gallons

- B. **GRAVITY MAINS:** On All sewer mains less than 8' deep, the Contractor shall pressure test the gravity mains with air. Each section including manholes shall be pressurized to 3.5 psi. The allowable pressure drop of 0.5 psi on any portion of the system shall not be less than the times shown on the following chart.

<u>PIPE SIZE</u>	<u>MINIMUM TIME</u>
4"	3 MIN.
6"	4 MIN.
8"	6 MIN.
10"	7 MIN.
12"	8 MIN.

If the main will not maintain the specified pressure, the Contractor will isolate the weak joint and repair. The test will be repeated until successful. The service lines must be installed at least to the back of the curb prior to testing. These pressure drops represent a maximum infiltration/exfiltration rate of 25 gallons per inch of pipe diameter per mile per 24 hour period.

3.03 ALLOWABLE INFILTRATION/EXFILTRATION

- A. If any visible flow is observed in the pipe during installation or final inspection a weir test will be conducted.

- B. The leakage inward or outward (infiltration or exfiltration) of the entire system including the sewer mains, service sewers, manholes and wet wells shall not exceed 25 gallons per inch of pipe diameter per mile per day for any section of the system.
- C. The weir shall be installed in each manhole. The manhole will then be filled with water to a depth of 3' from the top of the pipe, which should be at the bottom of the weir. The water level will stand for one (1) hour to stabilize then filled (if necessary) to the initial level. During the next hour the water level will be observed and the amount flowing through the weir or the amount of water required to maintain the level will be measured. This measured amount should not exceed the allowable.

3.04 INSPECTION

- A. Upon complete installation of the gravity sewer, the Contractor must enter a waiting period of not less than 10 days prior to inspection. In order to initiate the waiting period, the Contractor must notify the Design Engineer and the Owner's inspector in writing of the status of the sewer.
- B. After completion of the waiting period all sewer mains must pass a 5% deflection mandrel pulled by hand. If a 5% deflection mandrel will not pass through any section, that section will be replaced or rerounded at the expense of the Contractor. Mandrel to be supplied by the Owner's inspector or by the Contractor, if requested by the Owner.
- C. Once the mandrel and physical inspection is complete the contractor will schedule a time when the owner may internally inspect the sewer main utilizing a sewer camera and generating a video inspection of the system. If any defects are found in the system as a result of the internal inspection, then that section of the sewer main and any mains feeding into that system will not be accepted.
- D. No sewer main will be accepted if there is any evidence of sagging or bowing in the line which will adversely affect the performance of the pipe. Nor will any sewer mains be accepted if they are laid on a grade substantially less than specified on the Construction Plans. No line will be accepted if laid on less grade than the minimum stated in this specification.
- E. All manholes will be inspected for general appearance, cracks, leaks, proper installation of frame and cover, steps and inverts. Any manholes, which do not conform to the specifications, will not be accepted until the deficiency is corrected by the Contractor.
- F. All 4" sewer services will be tested for continuity and minimum bends by passing a standard tennis ball. Each sewer service shall be temporarily capped during construction. During the inspection, a tennis ball will be dropped down the open end of

the sewer service. If the ball does not appear in the lower manhole the contractor will excavate the service, correct the blockage and repeat the test until successful.

- G. All manhole and wetwell liner systems shall be tested using the “Spark Test” to locate incomplete welds or penetrations in the liner not adequately sealed for gas containment.

3.05 CLEANING

- A. Contractor to clean the completed system of any debris or obstructions prior to Final Inspection.

END OF SECTION

SECTION 02821 GRASSING

PART 1 – GENERAL

1.01 APPLICABLE STANDARDS

- A. Conform to Section 700 and other applicable articles of the "Standard Specifications Construction of Transportation Systems", of the Department of Transportation, State of Georgia, dated April 18, 2013. Omit all references to measurement and payment.

1.02 SOIL SAMPLES

- A. The Contractor shall take soil samples from several areas of the site to be grassed and have them analyzed by the Georgia Extension Service. The results of the analysis shall determine the best fertilizer mixture to use on the site.

PART 2 – MATERIALS

2.01 FERTILIZER

- A. Commercial Fertilizer: Fertilizer for lawns shall be a complete fertilizer, the nitrogen content of which shall be derived from either organic or inorganic sources and meeting the following minimum requirements of plant food by weight, unless the soil analysis and report indicates a need for a different fertilizer mixture in which case the recommended mixture shall be furnished and applied. All State and Federal laws relative to fertilizer must be complied with.

10% Nitrogen 12% Phosphoric Acid 12% Potash

- B. Ground Limestone: Lime shall be ground dolomitic limestone containing not less than 85% of total carbonates and shall be ground to such fineness that 50% will pass through a 20 mesh sieve. Coarser material will be acceptable, provided the specified rates of application are increased proportionately on the basis of quantities passing the 100 mesh sieve.
- C. Sodium Nitrate shall be a commercial product in dry powder form and shall be delivered in the original, unopened containers each bearing the manufacturer's guaranteed statement of analysis. It shall contain not less than 16% Nitrogen.

2.02 LAWN MATERIALS

- A. Kentucky 31 Fescue (Fescue elatior: var. arundinacea): Seed shall be 98% minimum purity and 85% germination.
- B. Bermuda Grass (Cyanodon Dactylon): Seed shall be 98% minimum purity and 85% germination.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Prepare the seed bed by thoroughly cultivating, disking and hand raking as necessary to produce a smooth even grade free from hollows or other inequalities. Before any seeding is attempted the soil must be in a well pulverized, smooth, friable condition of uniformly fine texture.

3.02 FERTILIZING AND LIMING

- A. Approximately two (2) days prior to the start of seeding operations, apply ground limestone at the rate of 20 pounds per 1000 sq. ft. of lawn area. Either in conjunction with the above operation or immediately afterwards apply the specified Commercial Fertilizer over all lawn areas at the rate of 30 pounds per 1000 sq. ft. of lawn area. Work limestone into the top 6 inches of ground and the fertilizer into the top 2 inches of ground.
- B. When the grass has started to cover well (approximately 4 weeks after sowing seed) apply 1 1/2 pounds of Ammonium Nitrate to all lawn areas and immediately water using a fine spray. At the end of the maintenance period and prior to the final inspection apply 10 pounds of the specified Commercial Fertilizer per 1000 sq. ft. of lawn area and immediately water.

3.03 SEEDING

- A. Before any seeding is attempted the soil must be in a well pulverized, smooth, friable condition of uniformly fine texture. Lawn areas shall be seeded evenly with a mechanical spreader at the rate of 2 lbs. of seed per 1000 sq. ft., 50% in one direction and the remainder sown at right angles to first sowing. The seeded areas shall be lightly raked, rolled with a suitable weight roller and watered with a fine spray.
- B. Fescue planting season shall be as approved by Engineer.
- C. Bermuda Grass seeding shall be planted only between May 1 to September 1.

- D. When grassing is required between curbs and sidewalks, behind sidewalks in areas adjacent to private property, the Engineer may change the type of seeding to that required to match any type of grass which may be planted and growing on the adjacent lawn. No increase in the Contract Sum will be made for this substitution.

3.04 WATERING

- A. Soak soil to a minimum depth of 6 inches immediately after seeding. Do not wash away soil or seed. Keep all surfaces continuously moist thereafter until 30 days after the lawn has been seeded. Use fine spray nozzles only.

3.05 RESPONSIBILITY

- A. Maintenance of grass areas shall consist of watering, weeding, cutting, repair of any erosion and reseeding or resodding as necessary to establish a uniform stand of the specified grasses, and shall continue until final acceptance.
- B. All grassed areas that do not show satisfactory growth within 15 days after sowing shall be re sown and re-fertilized as directed until a satisfactory blanket is established. Approximately 3 weeks after sowing the last seed, but not before the seed has taken hold and the grass is growing well, apply sulfate of ammonia or sodium nitrate at the rate of 300 pounds to the acre and water immediately. The lawns shall be considered established when they are reasonably free from weed, green in appearance and the specified grass is vigorous and growing well on each square foot of lawn area. Full coverage is required in 60 days.
- C. All grassed areas shall be protected until accepted. All eroded and damaged areas, regardless of cause, shall be immediately repaired and reseeded. Protect lawn areas against traffic.
- D. Grassed areas shall be covered evenly with a loose layer of clean wheat, rye, oats, Seresia Lespedeza or Coastal Bermuda Hay. Two tons of dry mulch shall be applied to each acre seeded. Hay shall be placed during calm weather with no wind.
- E. As soon as the grass becomes established, a final inspection of the work will be made, provided a written request for such inspection is given to the Engineer. Satisfactory coverage is defined as coverage of the areas seeded with grass that is alive and growing, leaving no bare spots larger than one (1) square foot with 98% coverage.
- F. All temporary valves, cutoffs and piping shall be removed by the Contractor at final acceptance of the grassing.

END OF SECTION

B. MECHANICAL SPECIFICATIONS

SECTION 03100 CONCRETE FORMWORK

PART 1 - GENERAL

1.01 SCOPE

Furnish and install the concrete formwork as required by the concrete outlines shown and indicated on the Drawings and specified in this Section, complete.

1.02 FORM DESIGN

Provide the design of all forms for this work. Formwork shall comply with ANSI A10.9 and OSHA Construction Standards, Part 1926, Subpart Q, Concrete, Concrete Forms, and Shoring. In addition, the form designs shall meet the requirements of ACI 347.

1.03 SUBMITTALS

- A. Do not provide submittals for the structural design of forms.
- B. Form Tie Assemblies: Manufacturer's product data sheets fully describing the form tie assemblies.
- C. Form Releasing Agent: Manufacturer's product data sheets fully describing the form coating.
- D. Plywood Panels: Certification that the plywood panels for use on this work meet the specified standard.

1.04 STORAGE AND PROTECTION

All form materials and accessories shall be stored above ground on framework or blocking, shall be protected from precipitation and shall have adequate air circulation and ventilation.

PART 2 - PRODUCTS

2.01 FORM MATERIAL

- A. Smooth Form Finish: Forms for this finish shall be applied to surfaces specified in Section 03300 of these Specifications. Some of these surfaces will receive a rubbed stone finish as specified in Section 03300 of these Specifications.
 - 1. Form facing material shall produce a smooth, dense, uniform texture on the concrete. Form facing shall be one of the following:
 - a. Plywood, meeting the requirements of U.S. Department of Commerce Product Standard (PS). PS 1 - Construction and

Industrial Plywood, B-B Concrete Form Panels. The arrangement of the facing material shall be orderly with the number of seams kept to a practical minimum.

- b. Patented forms may be used, subject to acceptance by the Engineer, provided they produce a smooth, even surface. This acceptance is for the finish these forms will leave on the contact surfaces and will not relieve the Contractor of the responsibility for the design and structural soundness of the forms. Patented forms shall be lined with the specified plywood. Plywood panels and form liners shall not be used more than three times unless further use is acceptable to the Engineer.
- B. Rough Form Finish: Forms for this finish shall be applied to the surfaces specified in Section 03300 of these Specifications. Forms for this finish may be the same as specified for the Smooth Form Finish or may be constructed of used plywood panels, unlined steel forms or straight dressed lumber.

2.02 ACCESSORIES

- A. Form ties for use in all liquid containment structure walls shall be one of the following:
 - 1. Form clamp assemblies with smooth tie rods with a waterstop at their centers; or “she bolt” tie assemblies with a waterstop at their centers.
 - 2. Both of the assemblies shall permit tightening of the forms and be of such type that leaves no tie metal, or any other tie material, within 1-1/2-inch of the surface after use. The assemblies shall provide cone-shaped depressions at the surface of the concrete at least 1-inch in diameter to allow filling and patching with the specified grout.
- B. Form ties for use in all other walls shall be one of the assemblies specified in Article 2.02, paragraph A., except that waterstops are not required.
- C. Form releasing agents for liquid containment vessels in water treatment plants shall be equal to Sealtight Duogard by W.R. Meadows.
- D. Form releasing agents shall permit coating the concrete surface without additional surface preparation.
- E. Form releasing agents shall be a non-staining form coating compound.

PART 3 EXECUTION

3.01 FORM CONSTRUCTION

A. Formwork shall be in accordance with ACI 347 and as follows:

1. Forms shall conform to shape, lines and dimensions of members indicated and shall be sufficiently rigid and tight to prevent leakage of mortar. Forms shall be properly braced or tied together so as to maintain position and shape. Construct forms so that they can be removed readily without hammering or prying against the concrete. Forms for exposed concrete shall be carefully made and accurately placed to obtain correct shape and lines.
2. Joints shall be butted tight. Arrangements of panels shall be orderly and symmetrical and use of small pieces shall be avoided. Forms shall be chamfered 1-inch for external corners of concrete, including top of walls, which will be exposed to view in the finished work.
3. Provide adequate formwork in its entirety. Forms shall safely support loads they will sustain and shall maintain their dimensional and surface correctness to produce members required by the Drawings. Form ties shall be spaced close enough to avoid bulges and variations in the required cross-sectional dimensions shown on the Drawings for the members being cast.
4. Box out for chases, recesses or other openings required in the completed work.
5. Install all the items (sleeves, inserts, hangers, anchors, etc.) to be supported by the formwork as required by the work.
6. Install pipe sleeves, wall pipes and wall sleeves, as shown or specified, for all piping penetrating walls and slabs. The use of block-outs in walls is prohibited. Pipe sleeves shall be used in slabs for plumbing pipes and wiring conduits.
7. Provide a sufficient number of cleanout doors at the base of walls and columns to facilitate cleaning and the application of grout to the column bases.
8. The use of reinforcing steel, partially embedded in concrete, as toe pins or form spacers is prohibited.

3.02 TOLERANCES FOR FORMED SURFACES

A. Variation from Plumb

1. In the Lines and Surfaces of Columns, Piers, Walls:
 - a. In any 10 Feet of Height: 1/4-inch (walls 1/2-inch).

- b. Maximum for the Entire Height: 1-inch.
 - 2. For Exposed Corner Columns, Construction and Expansion Joint Grooves and Other Conspicuous Lines:
 - a. In any 20 Foot Height: 1/4-inch.
 - b. Maximum for the Entire Height: 1/2-inch.
- B. Variation from the Level or from the Grades Shown on the Drawings:
 - 1. In Slab Soffits, Beam Soffits and Tops of Slabs, Measured Before Removal of Supporting Shores:
 - a. In any 10 Foot Length: 1/4-inch.
 - b. In any Bay or in any 20 Foot Length: 3/8-inch.
 - c. Maximum for the Entire Length: 3/4-inch.
 - 2. In Exposed Lintels, Sills, Parapets, Horizontal Grooves, and Other Conspicuous Lines:
 - a. In any Bay or in any 20 Foot Length: 1/4-inch.
 - b. Maximum for the Entire Length: 1/2-inch.
- C. Variation of the Linear Building Lines from Established Position in Plan and Related Position of Columns, Walls, and Partitions:
 - 1. In any Bay: 1/2-inch.
 - 2. In any 20 Foot Length: 1/2-inch.
 - 3. Maximum for the Entire Length: 1-inch.
- D. Variation in the Sizes and Location of Sleeves for Plumbing Pipes and Electrical Conduits, Floor Openings and Wall Openings: +1/4-inch.
- E. Variation in Cross-Sectional Dimensions of Columns and Beams and in the Thickness of Slabs and Walls: -1/4-inch, +1/2-inch.
- F. Variation in Sizes of Pipe Sleeves, Wall Pipes and Wall Sleeves: None.
- G. Variation in Location of Pipe Sleeves, Wall Pipes and Wall Sleeves: +1/8-inch.
- H. Footings
 - 1. Variations in Dimensions in Plan: -1/2-inch, +2-inches.

2. Misplacement or Eccentricity: Two percent of the footing width in the direction of misplacement but not more than: 2-inches.
3. Thickness: Decrease in specified thickness - none; increase in specified thickness 25 percent unless otherwise approved by the Engineer.
4. Tolerances above apply to concrete dimensions only, not to positioning of vertical reinforcing steel, dowels, or embedded items.

I. Variation in Steps

1. In a Flight of Stairs:
 - a. Rise: +1/4-inch.
 - b. Tread: +1/4-inch.
2. In Consecutive Steps:
 - a. Rise: +0-inch, -1/8-inch.
 - b. Tread: +1/8-inch.

3.03 Application of Form Coating

Before the placing of reinforcing, faces of all forms to be in contact with the concrete shall receive a thorough coating of the liquid form-releasing agent specified, applied in compliance with the manufacturer's instructions.

3.04 Inspection

Inspect all the work in accordance with Section 03300 of these Specifications.

3.05 Removal of Forms

- A. Forms shall be removed in a manner that will ensure the complete integrity of the structure. The forms and shoring shall remain in place for the following minimum periods of time after the casting of the concrete is completed:

	Form Removal, Days	Shoring, Days
Beams and Slabs (Soffits)	7	14
Walls	1	0
Columns	1	0

- B. Formwork for beam and slab soffits shall be designed so that they can be removed without removal of sufficient original shores to adequately support the

work until such time that the concrete strength reaches its specified 28-day strength.

- C. Removal of forms shall be coordinated with the selected specified method of curing concrete.
- D. Wood forms shall be completely removed from all the work to avoid termite infestation.

END OF SECTION

**SECTION 03200
CONCRETE REINFORCEMENT**

PART 1 GENERAL

1.01 SCOPE

Furnish and install the concrete reinforcement as shown and indicated on the Drawings and specified in this Section, complete in place.

1.02 SUBMITTALS

A. SHOP DRAWINGS

1. All shop drawings shall be of the same size. Reproductions of the Drawings for use as shop drawings is not permitted. Shop drawings shall include placing drawings, bending details, and bar lists with bar marks. All details and notes appearing on the Drawings, giving information for the placing of reinforcing steel, shall be shown on the shop drawings. Shop drawings will not be reviewed without such information.
2. Wall reinforcing shall be shown in elevation.
3. Show location and size of all penetrations greater than 6-inches in diameter or across the opening with the corresponding added reinforcing around the penetrations.
4. Submittals shall be complete for each structure. Partial submittals are not permitted and will be returned unmarked. Each submittal shall clearly indicate the structure and Drawing numbers that the work is for. The identifying numbers of the shop drawings for each structure shall be in numerical order.
5. Location and arrangement of accessories shall be clearly indicated.
6. All shop drawings shall be checked by the fabricator and Contractor before being submitted to the Engineer. The shop drawings shall bear clear indication that they have been reviewed and approved by the Contractor.

B. Mill tests of reinforcing steel shall be submitted prior to use for each 15 tons or less shipped to the site. Tests shall be conducted in conformance with ASTM A 615, and methods prescribed therein.

1. Cost of mill tests shall be borne by Contractor.
2. Three copies of each test report stating whether the material meets the requirements of the ASTM specifications shall be submitted to the Engineer.

3. Certified copies of the mill tests may be considered evidence of compliance provided such tests are regularly conducted by the reinforcement supplier by experienced, competent personnel using adequate testing equipment. In case of doubt as to the adequacy or accuracy of the mill tests, the Engineer may require the Contractor to furnish, at no additional cost to the Owner, test results from an independent testing laboratory acceptable to the Engineer on mill samples or delivered steel reinforcement.

PART 2 PRODUCTS

2.01 REINFORCING BARS

- A. Bar reinforcement shall be deformed-type bars conforming to ASTM A 615. Reinforcement shall be manufactured from new billet steel of American manufacture, Grade 60.
- B. Reinforcing steel for welded connections conform to ASTM A706. Welding procedure shall conform to ANSI/AWS D1.4 "Structural Welding Code – Reinforcing Steel." Do not tack weld.
- C. Reinforcing steel shall be shop fabricated to shapes and dimensions indicated on the Drawings and in compliance with applicable provisions of ACI 315 and ACI 318.
- D. Bars shall be bent cold. Bars shall be pre-fabricated to detail and delivered on the job plainly tagged and ready to set.

2.02 WELDED WIRE FABRIC

Welded wire fabric shall be in flat sheets conforming to ASTM A 185, with wire conforming to ASTM A 82.

2.03 ACCESSORIES

- A. All chairs and bolsters shall have plastic-covered or galvanized steel legs at formed slabs and beams. For slabs on grade, bare metal is acceptable.
- B. For slabs on grade 10-inches or less, all reinforcing shall be supported on chairs and/or bolsters as required to properly position the bars or welded wire fabric. The chairs and/or bolsters shall be supported on precast concrete pads bearing on the subgrade. The concrete pads shall be at least 6 x 6-inches and be no more than 1-1/2-inches thick. Pads shall be cast from Class "A" concrete or from mortar made up of one part cement and two parts sand, with tie wires embedded.
- C. For slabs on grade greater than 10-inches, reinforcing shall be supported directly on concrete brick bearing on the subgrade or the system noted above for slabs 10-inches or less.

PART 3 EXECUTION

3.01 STORAGE OF MATERIALS

Reinforcing steel delivered to the site, not immediately placed in forms, shall be protected from mud and excessive rust-producing conditions by storing in a well-drained area and supported off the ground. All reinforcing shall be properly tagged with their bar marks and location in the structure clearly noted.

3.02 TOLERANCES

A. Allowable tolerances for fabricating steel reinforcement shall be as follows:

Item	Maximum Tolerance, Inches	
Sheared Length of Bars	+1	-1
Depth of Truss Bars	+0.0	-1/2
Outside Dimensions of Stirrups, Ties and Spirals	+1/2	-1/2
Location of Bends	+1	-1

B. Allowable tolerances for placing steel reinforcement shall be as follows:

Item	Maximum Tolerance, Inches	
Concrete Cover from Outside of Bar to Finished Surface	+1/4	-0.0
Lateral Spacing of Bars in Plane of Reinforcement in Beams and Joists	+1/4	-0.0
Lateral Spacing of Bars in Plane of Reinforcement in Slabs and Walls	+1	-1
Spacing of Stirrups, Ties and Spirals Along Longitudinal Axis of Member	+1/2	-1/4
Height of Bottom Bars in Slabs, Beams and Joists	+1/4	-1/4
Height of Top Bars in Slabs, Beams and Joists	+1/4	-1/4
Depth 8" and Less	+1/2	-1/2
Depth 9" - 24"	+1	-1
Depths 25" & Greater		

3.03 FIELD FABRICATION

Field fabrication of reinforcing steel is not permitted.

3.04 PLACEMENT AND ANCHORAGE

A. Space metal chairs, bolsters, spacers, and hangers in accordance with ACI 315.

- B. Reinforcement, at the time concrete is placed, shall be free from rust scale or other coatings that will destroy or reduce bond. Bars with kinks or bends not shown on the plans shall not be used.
- C. Reinforcement shall be accurately placed in accordance with the Drawings and shall be adequately secured in position with not less than 16-gauge annealed wire or suitable clips at intersections. Reinforcement shall be held securely at the required distance from the forms. Nails shall not be driven into outside forms to support reinforcement.
- D. Install welded wire fabric reinforcement for concrete slabs on ground and as otherwise indicated. Lap all joints 6-inches and wire securely. Extend mesh to within 2-inches of sides and ends of slabs. Sheets that do not lay flat when in their intended position will be rejected. Tags designating the wire size and spacing shall be left on each sheet until ready for use. Tuck ends of welded mesh well down into edge of beams or walls. Do not leave unreinforced border strips. Welded wire fabric shall not contain loose rust. All welded wire fabric shall be supported and tied in its proper location.
- E. Conduits: Where conduits are permitted in slabs, low conduit shall be wired to the upper side of bottom reinforcing and top conduit shall be wired to lower side of top steel. Where parallel conduits occur, they shall be separated by at least 2-inches clear.

3.05 CONCRETE COVER

Reinforcement shall be protected by concrete cover as shown and noted on the Drawings.

3.06 SPLICING

- A. Splicing of reinforcement shall be as shown and indicated on the Drawings. Splices not shown on the Drawings shall be Class "B" splice, in accordance with ACI 318. Any changes to the location and type of splices desired by the Contractor must be specifically requested and must meet with the acceptance of the Engineer before they can be used.
- B. Splices shall not be made at point of maximum stress and shall provide sufficient lap to transfer stress between bars by bond.
- C. Mechanical splices may be used instead of lap splices provided that their location and type meet with the acceptance of the Engineer.
- D. No more than 50% of horizontal wall reinforcing shall lap in a single vertical plane.

3.07 INSPECTION

Inspect all the work in accordance with Section 03300 of these Specifications.

END OF SECTION

SECTION 03250 CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 SCOPE

The work under this Section includes, but is not necessarily limited to, furnishing, and installing all concrete accessories as indicated on the Drawings, herein specified, and as necessary for the progress and complete performance of this work.

1.02 SUBMITTALS

The waterstop manufacturer shall submit documented test results demonstrating that the waterstop will not permit water leakage when subjected to pressure and joint movement.

1.03 QUALITY ASSURANCE

The waterstop manufacturer shall demonstrate five years (minimum) continuous, successful experience in production of waterstops.

1.04 STORAGE AND PROTECTION

Store waterstops under tarps to protect from oil, dirt, and sunlight.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Waterstops for construction joints shall be Greenstreak Waterstop Style 732 or 724 manufactured by Greenstreak, St. Louis, Missouri (or approved equal).
- B. Waterstops for expansion joints shall be Greenstreak Waterstop Type 732 as manufactured by Greenstreak, St. Louis, Missouri (or approved equal).

2.02 MATERIALS AND CONSTRUCTION

- A. Waterstops
 - 1. Waterstops shall be extruded from an elastomeric plastic compound of which the basic resin shall be prime virgin polyvinyl chloride meeting U.S. Army Corps of Engineers Specification CRD-C572. The PVC compound shall not contain any scrapped or reclaimed material or pigment whatsoever.
 - 2. Provide factory installed hog rings, grommets, or embedded wire loop to facilitate tying off waterstop at 12-inches on center along the length of the waterstop.

3. Provide factory made PVC waterstop fabrications for all changes of direction, intersections and transitions, leaving only straight butt joint splices for the field.
- B. Dovetail Slots
 1. No. 22 gauge, galvanized steel, 1-inch wide back.
 2. Crimped anchors shall be furnished by other trades whose work abuts concrete.
- C. Inserts for General Trades
 1. Malleable iron, strength as required.
 2. Include bolts, nuts, and washers.
- D. Expansion Joint Filler
 1. Asphalt impregnated fiberboard, ASTM D 1751, for interior work.
 2. Self-expanding corkboard, ASTM D 1752, for exterior work.
- E. Construction Joint Form for Building Floor Slabs on Grade: 16-gauge, tongue and groove galvanized metal.
- F. Control Joint Form for Building Floor Slabs on Grade
 1. 20-gauge galvanized steel.
 2. Depth shall be 1/4 the slab thickness or more.
- G. Flashing Reglet: 26-gauge galvanized steel. Coordinate with waterproofing subcontractor.

2.03 OTHER MATERIALS

All other materials not specifically described, but required for a complete and proper installation of concrete accessories, shall be as selected by the Contractor subject to the approval of the Engineer.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General: Install concrete accessories as indicated on the Drawings, specified in various other Sections and as necessary for the proper and complete performance of this work.

B. Waterstops

1. Waterstops shall be installed in all construction joints in walls and slabs which are to hold water and also where shown on the Drawings. The waterstop shall extend the entire length of the joint and all splices shall be installed and tested in accordance with the manufacturer's recommendations.
2. Waterstops for all joints shall be continuous around all corners and intersections. For PVC waterstops, provide factory formed corners and intersections where angle intersections occur, and only straight splices shall be made in the field. Splices shall be made in accordance with the manufacturer's recommendations and shall be subject to the approval of the Engineer.
3. No holes will be permitted in waterstops.
4. PVC waterstops shall be securely fastened to formwork or reinforcing steel every 12-inches or less on both edges as required to concrete placement.

C. Piping, Mechanical and Electrical Equipment Support

1. Inserts for hangers will be supplied by the trade whose work is supported.
2. Locations of the inserts shall be given to the Contractor by the various trades.
3. Installation of the cast-in-place inserts shall be by the Contractor.

D. Dovetail Slots: Install dovetail slot at 24-inches on center where masonry adjoins concrete or as noted on the Drawings.

END OF SECTION

**SECTION 03300
GENERAL CONCRETE**

PART 1 GENERAL

1.01 QUALITY STANDARDS

A. Any procedure and material operation specified by reference to the following publications shall comply with the requirements of the current specification or standard:

1. American Society for Testing Materials (ASTM):
 - A185 Welded Steel Wire Fabric for Concrete Reinforcement.
 - A615 Deformed Billet Steel Bars for Concrete Reinforcement.
 - C31 Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field.
 - C33 Specification for Concrete Aggregate.
 - C39 Compressive Strength of Molded Concrete Cylinders.
 - C94 Specification for Ready Mixed Concrete.
 - C143 Slump of Portland Cement Concrete.
 - C150 Portland Cement.
 - C172 Sampling Fresh Concrete.
 - C192 Making and Curing Concrete Test Specimens in the Laboratory.
 - D1751 Preformed Expansion Joint Fillers for Concrete Paving.
2. American Concrete Institute:
 - ACI 301 Specification for Structural Concrete for Buildings.
 - ACI 305 Recommended Practice for Hot Weather Concreting.
 - ACI 318 Building Code Requirements for Reinforced Concrete.

1.02 QUALITY CONTROL

- A. The Contractor shall submit to the Engineer, for review a design mix for each class of concrete listed under CLASSES OF CONCRETE, prior to placing any concrete.
- B. Verification tests of design mixes and aggregates are required by the Engineer. Verification test specimens shall be made in accordance with ASTM C39 by an

Independent Test Laboratory. Compressive strength shown by verification tests shall be at least fifteen percent in excess of the strengths listed under CLASSES OF CON-CRETE. The Independent Testing Laboratory shall report the test results to the Engineer, in writing and shall note any failure to meet the specification.

- C. Verification tests of design mixes made not more than one year prior to the date of submittal will be acceptable provided they were made from materials identical to those to be used in the project.
- D. Mill Test: Conducted in accordance with ASTM A615 recommendations on each 15 tons, or less reinforcing shipped to the job. Two (2) copies of test to be sent to the Engineer.
- E. Inspection and Testing of Concrete:
 - 1. The cost of slump tests and sampling, molding, storing, materials, transporting concrete test specimens shall be paid by the Contractor. The laboratory or inspection agency shall be selected by the Owner. Costs of all laboratory testing services required because of failure to meet the requirements of these specifications shall be paid by the Contractor.
 - 2. One set of four (4) acceptance cylinders shall be prepared for each day's placing of each strength of concrete and if more than 50 cubic yards of concrete is placed in any day, there shall be an additional set of cylinders prepared for each 50 cubic yards placed or for any fraction thereof. One cylinder shall be broken at seven days and two at twenty-eight days, with one cylinder held in reserve.
 - 3. Responsibilities in Inspection:
 - a. Laboratory's Duties
 - 1. The reception and marking of specimens in the laboratory, laboratory curing, preparation for breaking and testing of cylinders shall be the responsibility of the laboratory and shall be performed by qualified laboratory personnel, observing all requirements of applicable ASTM Standards. Compression test specimens shall be tested in accordance with ASTM C39.
 - 2. Prior to the commencement of concrete work, the laboratory shall provide initial instruction in the performance of sampling and testing duties for an employee designated by the Contractor and shall provide him with copies of all ASTM Standards pertinent to his duties.
 - b. Contractor's Duties:
 - 1. The Contractor shall deliver to the laboratory all materials to be used in required testing. He shall supply

wheelbarrows, shovels, mixing boards, shaded work space and similar equipment required for molding test cylinders. He shall provide stable, insulated storage boxes, equipped with thermostatically controlled heat, for storage of cylinders in the first 24 hours after molding.

2. He shall designate an employee, who alone shall perform all operations of sampling concrete, molding test specimens, protecting test specimens for the first 24 hours after molding, and packing and shipping of test specimens. The employee shall make a record of a slump test in connection with each truckload of concrete. The designated employee shall receive initial instruction in the performance of his sampling and testing duties from a representative of the testing laboratory and shall have available copies of all ASTM Standards pertinent to his duties. Sampling shall conform to ASTM C172. Slump tests shall conform to ASTM C143. Compression test specimens shall be made and cured in accordance with ASTM C31.
3. Each set of test cylinders shipped to the laboratory shall be accompanied by a report giving information as to location in the structure of concrete sampled, time and date of sampling, air temperature, slump, class designated nominal strength, air content if applicable, temperature of concrete, truck number, and time batched. Each report shall be signed by the employee making the test and by the Contractor or his representative, certifying that the test specimens have been made by the one designated, fully instructed employee and have been made in accordance with applicable standard specifications.
4. Should any concrete fail to meet the specified strength, have a slump in excess of that required by the design mix for each class of concrete listed under CLASSES OF CONCRETE, or result in voids, honeycombs or otherwise fail to meet the requirements, the Engineer may order the concrete removed, further tests made, or other remedial measures taken, all at the Contractor's expense.

1.03 SHOP DRAWINGS

- A. After making his check the Contractor shall submit to the Engineer one (1) blue line copy of each of placing plans, bending details and bar lists covering all reinforcing steel.
- B. Full information for checking and for proper installation without reference to other drawings shall be included. At splices the amount of lap shall be shown. Location and arrangement of accessories shall be clearly shown. Elevations shall be drawn for all reinforced masonry and reinforced concrete walls to a scale no smaller than 1/4 inch = 1 foot.

- C. Work shall not proceed before the Contractor has received shop drawings approved by the Engineer. The Contractor shall be responsible for the conformation of all typical and special reinforcing steel details.
- D. Engineer's review is for conformance to the design concept and contract documents. Markings or comments shall not be construed as relieving the Contractor from compliance with the project plans and specifications, nor departures therefrom. The Contractor remains responsible for details and accuracy, for selecting fabrication processes, for techniques of assembly, and for performing his work in a safe manner.
- E. Proposed construction joint shall be clearly indicated on shop drawings and subject to approval of the Engineer.

1.04 INSPECTION

- A. The Contractor shall give the Engineer 24 hours advance notice before starting to place concrete in any portion of the structure to permit observation. An authorization of the Engineer shall be secured before concrete is placed. Any concrete placed in violation to this provision shall be replaced by new concrete if required by the Engineer.
- B. Prior to notification of the Engineer, the Superintendent shall personally inspect the work and verify that it is ready for observation.
- C. At the time of observation, all reinforcing in the area where concrete is to be poured shall be in place, tied and ready for the placement of concrete. All anchors, sleeves, inserts, etc., shall be securely held in position.

1.05 STORAGE

- A. Reinforcing steel delivered to the job and not immediately placed in forms shall be placed in racks or other supports at least eighteen (18) inches above ground.

PART 2 MATERIALS

2.01 CEMENT

- A. Portland cement shall conform to ASTM C150, Type I.

2.02 AGGREGATES

- A. Aggregates for standard weight concrete shall conform to ASTM C33, maximum size: 3/4 inch.

2.03 WATER

- A. Mixing water shall be potable.

2.04 REINFORCING STEEL

- A. Reinforcing bars shall be American manufactured conforming to the requirements of ASTM A615 "Deformed Billet Steel Bars for Concrete Reinforcement", Grade 60.
- B. Welded wire fabric or cold drawn wire for concrete reinforcement shall be of American manufacture and shall conform to the requirements of the ASTM A185 "Welded Steel Fabric for Concrete Reinforcement".
- C. Accessories shall conform to the requirements of C.R.S.I. Manual.

2.05 READY MIXED STRUCTURAL CONCRETE:

- A. Ready mix concrete shall be mixed and delivered in accordance with these specifications and requirements set forth in ASTM C94. In addition, these following conditions must be met:
 - 1. Concrete shall be normal weight with an ultimate compressive strength at 28 days, and slump as follows:
 - 2. Air entrained concrete shall be used for all structural concrete with the air content not less than 3 percent and no more than 5 percent.
- B. Classes of Concrete:
 - Class A f'_c = 3000 psi, Slump 4 inches +/- 1 inch
 - Class AA f'_c = 4000 psi, Slump 3 inches +/- 1 inch
 - Class B f'_c = 5000 psi, Slump 5 inches +/- 1 inch

2.06 EXPANSION JOINT MATERIAL

- A. Expansion joint material at slabs on grade shall be premolded asphalt saturated cellulose fiber or mineral strips conforming to ASTM D1751.

2.07 WALL TIES

- A. Ties shall be made with break back ends or other means of removing the tie end to a depth of at least 1 inch from the concrete surface after the forms are removed.

2.08 LIQUID FORM SEALER

- A. Form sealer shall be a standard product compatible with the finish required for exposed concrete and shall contain no paraffin oil or mineral oil.

PART 3 – EXECUTION

3.01 FORMWORK

- A. Forms shall conform to the shapes, lines and dimensions of the members as indicated, and shall be substantial and sufficiently tight to prevent leakage of mortar. They shall be braced or tied together so as to maintain position and shape.
- B. Formwork shall be observed by the Engineer before pouring concrete. Before placing the reinforcement, surfaces of wood forms in contact with the concrete, unless lined, shall receive a thorough coating of form sealer. The Engineer shall have the right to reject any forms that do not appear to him to be sufficient as to alignment and of producing the required finished surface. Should misalignment of forms or screed, excessive deflection of forms or displacement of reinforcing occur during concrete placing, corrective measures shall be immediately made to the extent, if necessary, that placing operations shall be stopped and concrete removed from within forms. The surfaces to required dimensions and cross section. Exposed lines and surfaces shall not vary from dimensions shown on plans by more than 1/4 inch in twenty feet.
- C. Forms may be constructed of wood or metal. Earth forms for footings may be permitted if local conditions are favorable, and approved by the Engineer. Form work for exposed concrete shall be form grade plywood.
- D. Studs, waler, and ties shall be so spaced that the load of wet concrete will not stress ties beyond the printed working load recommended by the manufacturer not cause spans of form material to deflect from a true surface.
- E. The Contractor shall maintain a continuous check upon formwork during the placing of concrete. An instrument check shall be periodically made or "Tattle Tail" rods or other devices shall be used to detect any settlement in forms.
- F. Conduits in Concrete: Conduits shall not displace reinforcing steel from its intended position, nor impair the strength of the structure.
- G. The Contractor shall assume all responsibility for removal of formwork. Elevated concrete slabs shall attain 70% of the specified ultimate strength before removing the forms. After removing forms, slabs shall be reshored at mid span and at all points under shores supporting forms for the work above. No floor shall be loaded in excess of the live load for which designed unless adequate shores are place beneath members supporting the concrete of load.

3.02 PLACING REINFORCING STEEL

- A. Reinforcement shall be shop fabricated, accurately positioned, and secured with not less than 16-gauge annealed wire or suitable clips.
- B. No bars, partially embedded in concrete shall be field bent, unless noted otherwise.

- C. Reinforcing bars shall be accurately placed and secured in position by approved chairs, spacers, or ties to maintain the position of the reinforcing steel prior to and during placing of concrete.
- D. Reinforcing steel support chairs and bolsters for use in concrete to be exposed shall have galvanized steel leg.
- E. No splices shall be made, except as shown on approved Shop Drawings or approved in writing by the Engineer.
- F. The placement of reinforcement shall be observed by the Engineer before pouring of concrete. Should there be any delay in the work, reinforcement previously placed shall be reinspected and cleaned, if necessary, before concrete placement is resumed.
- G. Metal reinforcement shall be protected by concrete cover. Where not otherwise shown, the thickness of concrete over the reinforcement shall be as follows:

Footings	3" clear sides and bottom
Slabs	3/4" clear, top, and bottom
Beams	2" clear, all around
Walls	2" clear, both faces
Columns & Piers	2" clear
- H. All splicing or reinforcement not shown shall be approved by the Engineer. Splices shall not be made at a point of maximum stress and shall provide sufficient lap to transfer the stress between bars by bond. Hook and bending details, column tie arrangements, etc., shall be as shown by the S.R.A.I. Manual or the ACI Detail Engineering Manual.
- I. Wire mesh reinforcing shall be placed one inch from top of concrete slabs on ground. Lap all joints 12 inches and extend mesh to within 1 inch of sides and ends of slabs.

3.03 CONCRETE MIXING AND PLACING

- A. Ready mix concrete shall conform to ASTM C94. Not more than one hour shall elapse between the time mixing water is added to the batch and the concrete is poured. No water shall be added on the job.
- B. No concrete shall be placed until all embedded items and reinforcing have been placed in the forms and observed by the Engineer. At least 24-hour notice shall be given the Engineer of an impending pour, so that he may observe the work, prior to placing.
- C. Concrete shall be conveyed from the mixer to the place of final deposit by methods that will prevent segregation or loss of materials.

- D. Concrete shall be deposited in its final position to avoid segregations and separation do to rehandling or flowing. The placing shall be carried on at such a rate that concrete is at all times plastic and flows readily into the spaces between bars. When placing is once started, it shall be carried on as a continuous operation, until placement of that section is completed.
- E. Concrete shall be worked into and around bars and embedded items with spades, rods, trowels, and vibratos, so as to produce a solid homogeneous mass, free of voids, pockets or honeycombs.
- F. Construction joints shall be installed and located as indicated. Where a joint occurs, the surface of the concrete shall be thoroughly cleaned and all laitance removed and shall be left rough or mechanically roughened, thoroughly wetted and slushed with a coat of neat cement grout immediately before placement of new concrete.
- G. All embedded items, including anchor bolts and dowels, shall be in place, preset and held in position, before any concrete is placed.
- H. No concreting shall be performed when ambient temperatures are below 40°F or if the temperature is predicted by the local U.S. Weather Bureau will fall below 40°F within 24 hours after the time of installation.
- I. No concrete shall be installed against frozen ground. All foundation cavities and slab areas that have frozen, shall be thoroughly clean of all loose earth prior to pouring concrete.
- J. All newly poured concrete shall be protected from freezing or near freezing weather during the cure period.
- K. Hot weather precautions shall be taken whenever the maximum air temperature exceeds 80°F during the day. Hot weather concreting shall be performed in accordance with ACI 305.

3.04 EXPANSION/CONTROL JOINT INSTALLATION

- A. Expansion joints shall be placed a maximum of 20 ft. intervals and at all intersections with steps, curbs other walks or abutting structures. Joints shall extend from the surface to the subgrade at right angles to the sidewalk.
- B. Expansion joint filler shall be 1/2 inch thick and as wide as the full width and depth of the sidewalk. All expansion joints shall be filled with semi-rigid epoxy, specifically manufactured for the sealing of control joints in concrete slab construction, to create a water tight slab.
- C. Control joints (tooled or saw-cut) shall be placed at no less than 12 and no more than 15 ft. intervals, in a square grid, throughout the full length and width of the concrete slab. All control joints shall be filled with semi-rigid epoxy, specifically manufactured for the sealing of control joints in concrete slab construction, to create a water tight slab.

3.05 ANCHORAGE

- A. Slots, inserts, and connections elements for anchoring items to concrete shall be built into forms before placing concrete.

3.06 SLABS ON GRADE

- A. Concrete shall be compacted, screeded to grade, and prepared for the specified finish. Slabs shall be placed in panels in alternate checkerboard pattern or in alternate lanes divided into panels. Each panel shall be approximately square terminated by slab joints.
- B. Contraction joints shall be true to line 1/8 inch wide, and of depth equal to approximately 1/4 of the slab thickness. Joints shall be sawed or formed.

3.07 CURING

- A. Provisions shall be made for maintaining concrete in a moist condition for at least 10 days after the placement of the concrete, or by one of the following methods:
 - 1. Spraying with water or ponding.
 - 2. Using moisture retaining covers.
 - 3. Concrete curing compound, W.R. Meadows CS 309 or Guardian Chemical Co., Master Builders or Triple Cure by Cobra Chemicals.
- B. The spraying water shall be applied on unformed surfaces within one hour after the forms are stripped and the spraying shall be continuous. The moisture retaining cover shall be applied on unformed surfaces immediately after the concrete is finished. If there is any delay, the concrete shall be kept moist until the application is made. If the surfaces are formed, the forms shall be removed and the concrete sprayed lightly with water before the cover is applied.
- C. When concrete surfaces are to receive applied finishes of materials, all curing compounds shall be checked for compatibility with other material to be applied to the concrete surfaces before application.

3.08 CONCRETE FINISHES

- A. All poured joints, voids, honeycombs, and other imperfections shall be patched within the same working day that forms are removed.
- B. Troweled Finish:
 - 1. Troweled finish shall be applied to the surface of all floors unless ceramic tile, quarry tile or pavers are called for on finish schedule.

2. Floor slabs shall be screened to an even surface by the use of straight edge and screeding strips accurately set to the proper grade. The concrete shall be floated with a wood float in a manner which will compact it and produce a surface free from depressions or inequalities of any kind. Floors shall be level with a tolerance of 1/8 inch in 10 feet except where drains are indicated. After the concrete has hardened sufficiently to prevent fine materials from working to the top and has been allowed to stand until all water sheen has disappeared, it shall be steel troweled. Final troweling shall be done after the concrete is hard enough that no mortar accumulates on the trowel and a ringing sound is produced as the trowel is drawn over the surface. The drying of the surface moisture before troweling shall proceed naturally and shall not be hastened by the dusting on of dry sand or cement.
- C. Non slip Finish: All exterior platforms and step treads shall be made non slippery by application at not less than 1/4 lb. per sq. ft. of aluminum oxide or emery aggregate graded from particles retained on a #50 mesh screen to particles passing an 1/8 inch screen placed during the finishing process. Abrasive aggregate shall be sprinkled by hand as soon as the freshly placed cement will support the weight of workmen and floated into the surface.
- D. Unfinished Slabs: Depressed slab areas to receive ceramic quarry tile or pavers shall be finished to remove all laitance and to leave a slightly roughened, surface to insure bond. The surface of the slab shall not vary in any direction more than 1/8 inch when tested with a ten-foot straight edge. The straight edge shall be lapped one half its length as the test is being made.

3.09 CONCRETE FLOOR HARDENER

- A. All concrete floor slabs shall be cured with concrete floor hardener, "Clear Bond", as manufactured by Guardian Chemical, "Triple Cure" by Cobra Chemicals, or "Sealtight Cs 309" by W.R. Meadows. The floor hardener shall be applied in strict accordance with the manufacturer's recommendations.
- B. Walks shall be tooled, full 1 inch deep into separate slabs as indicated. Surface edges of each slab shall be rounded to approximately 1/4 inch radius.
- C. Final finish shall be a medium or light broom finish and all tool marks completely removed.

END OF SECTION

SECTION 03301
CONCRETE FOR BUILDINGS

PART 1 – GENERAL

1.01 Codes with the provisions of the following codes, specifications and standards, except as otherwise shown or specified:

ACI 301 "Specifications for Structural Concrete for Buildings."
ACI 311 "Recommended Practice for Concrete Inspections."
ACI 318 "Building Code Requirements for the Reinforced Concrete."
ACI 347 "Recommended Practice for Concrete Form work."
ACI 304 "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete."
Concrete Reinforcing Steel Institute, "Manual of Standard Practice."

1.02 SUBMITTALS

- A. Laboratory test reports for concrete materials and mix design.
- B. Certificate of design conformance.

PART 2 – PRODUCTS

2.01 AGGREGATE

- A. Course Aggregate: ASTM designation C33. Maximum nominal course aggregate shall be ½" maximum size for concrete block fill and 1" maximum size for other concrete.
- B. Fine Aggregate: ASTM designation C3 washed sand.

2.02 PORTLAND CEMENT

- A. Federal Specification SS C 192, Type 1 or ASTM C150 72 Type 1.

2.03 CURING MATERIALS

- A. Membrane forming curing compounds: Non yellowing acrylic, resin base or chlorinated rubber base type conforming to Federal Specifications TT C 800 non pigmented.

2.04 AIR ENTRAINING ADMIXTURE

- A. ASTM C260

2.05 REINFORCEMENT

- A. Bars: Conforming to ASTM designation A615, Grade 60.
- B. Mesh: ASTM A185. Welded steel wire fabric.

2.06 WATER

- A. Water shall be potable and free from deleterious substances.

2.07 COLD JOINTS

- A. Burke keyed cold joint form or equal.

2.08 EXPANSION JOINTS

- A. ASTM D1751 Resilient, non extruding, asphalt impregnated fiberboard.

PART 3 – EXECUTION

3.01 FORMWORK

- A. Forms shall be designed, constructed and maintained to insure that after removal of forms the finished concrete members will have true surfaces free of waviness or bulges, conforming accurately to the indicated shapes, dimensions, line elevations and positions. Form surfaces that will be in contact with concrete shall be thoroughly cleaned before each use. Forms shall be coated with a chemical form release; non oil, non staining.
- B. Form ties shall be factory fabricated, removable or snap off metal ties of design that will not allow form deflection and will not spill concrete upon removal.
- C. Exposed external corners shall be beveled or chamfered by moldings placed in the forms.

3.02 REINFORCEMENT

- A. Reinforcement shall be fabricated to shapes and dimensions shown and shall be placed where indicated. Reinforcement shall be free of loose or flaky rust and mill scale, or coating including ice and any other substance that would reduce or destroy the bond.
- B. Reinforcement detailing and placement including concrete protection for steel reinforcement shall conform to ACI Standard 318 and 315.

3.03 JOINTS

- A. Pre-molded expansion joint filler: At expansion joints in concrete slabs to be exposed, pre-molded expansion joint filler strips shall be installed at the proper level.
- B. Construction joints other than slabs on grade: Concrete shall be placed continuously so that the unit will be monolithic in construction. Fresh concrete may be placed against adjoining units provided the set concrete is sufficiently hard not to be injured thereby. Joints not indicated shall be made and located to least impair strength and appearance of the structure. Construction joints, if required, shall be located near the midpoint as spans for slabs or beams.

3.04 CONCRETE MIX DESIGNS

- A. Concrete mix shall be designed for a 3000 psi compressive strength at 28 days.
- B. Mix proportions shall be determined in compliance with ACI Standard 318.

3.05 SLUMP LIMITS

- 1. 3" maximum slump for slabs and walks.
- 2. 4" minimum slump for curbs and footings.

3.06 BATCHING AND MIXING

- A. Concrete of the ingredients and design mixes shall be measured, batched and mixed at the plant in conformance with ASTM designation C94.

3.07 PREPARATION FOR PLACING CONCRETE

- A. Water shall be removed from excavations before placing concrete. Hardened concrete, debris and foreign materials shall be removed from interior of forms and from inner

surfaces of mixing and conveying equipment. Reinforcement shall be secured in position.

3.08 PLACING CONCRETE

- A. Concrete shall be handled from mixer to transport vehicle to place of final deposit in a continuous manner, as rapidly as practicable, without segregation or loss of ingredient until the approved unit of operation is completed.

3.09 DEPOSITING IN COLD OR HOT WEATHER

- A. Concrete, when deposited shall have a temperature not below 55°F and not above 90°F. In freezing weather suitable means shall be provided for maintaining concrete after depositing at a temperature not lower than 70°F for 3 days, or 50°F for 5 days after placing, except when high early strength Portland cement or concrete is used temperature must be maintained at not less than 70°F for 2 days or at 50°F for 3 days.
- B. Cooling of concrete to outside temperature shall not be at a rate faster than one degree each hour per first day and two degrees each hour thereafter until outside temperature is reached. Methods of heating material and protecting concrete shall be approved by Engineer. Salt, chemicals or other foreign materials shall not be mixed with concrete for the purpose of preventing freezing.
- C. Deposit in hot weather (90° and above), take special care in placing concrete during hot weather. Forms must be thoroughly wetted just before concrete is placed and exposed surfaces of concrete shall be kept continually damp by sprinkling for 7 days.

3.10 COMPACTION

- A. Immediately after placing, each layer of concrete shall be compacted by internal concrete vibrator supplemented by hand spading, rodding and tamping. Tapping or other external vibration for forms will not be permitted.

3.11 BONDING

- A. Before depositing new concrete on concrete that has set, the surfaces of the set concrete shall be thoroughly cleaned to expose the coarse aggregate and be free of laitance, coatings, foreign matter and loose particles. Forms shall be retightened. The cleaned surfaces may be moist but shall be without free water when concrete is placed.

3.12 CURING

- A. Concrete shall be protected against moisture loss, rapid temperature change, mechanical injury from rain or flowing water for a period of 7 days. Concrete shall be maintained in a moist condition at temperatures above 50°F throughout the specified curing period. Concrete shall be protected from rapid temperature change and rapid drying for the first 24 hours following the removal of temperature protection. Curing shall be accomplished by the following methods:
 - 1. Impervious sheet curing All surfaces shall be thoroughly wetted with a fine spray of water and be completely covered with water proof paper, or polyethylene sheeting, or with polyethylene coated burlap having the burlap thoroughly water saturated before placing.
 - 2. Membrane forming compound curing conforming to ASTM C3009 The compound shall be applied on damp surfaces as soon as the moisture film has disappeared. The curing compound shall be applied in a two coat, continuous operation at a coverage of not more than 400 square feet per gallon for each coat. Membrane curing compound shall not be used on surfaces that are to receive any subsequent treatment that depends on adhesion or bonding to the concrete. Non-residual may be used on approval.

3.13 REMOVAL OF FORMS

- A. Forms shall be removed in a manner to completely insure the safety of the structure. Forms may be removed after 24 hours, provided the concrete is sufficiently hard not to damage thereby.

3.14 FINISHES AND PATCHING OF CONCRETE OTHER THAN FLOOR SLABS

- A. Within 12 hours after forms are removed, surface defects shall be remedied as specified herein. Temperature of concrete, ambient air and mortar during remedial work including curing shall be above 50°F. Fins and loose material shall be removed. Honeycomb, aggregate pockets, voids over ½" in diameter and holes left by the rods or bolts shall cut out to solid concrete, thoroughly wetted, brush coated with neat cement grout and filled mortar. Mortar shall be a stiff mix of 1 part blended Portland and white cements to 2 parts fine aggregate passing the No. 16 sieve and a minimum amount of water. When dry, the color of the mortar shall approximately match the adjoining concrete color. Mortar shall be thoroughly compacted in place.
- B. Hand rubbed finish shall be used on 45° sloped exposed concrete.

3.15 FINISHING CONCRETE SLAB SURFACES

- A. Trowel finish Immediately after slab is placed, screed top surface of concrete slab, tamp concrete with tamping tools to bring grout to surface. Darby to produce true level. Squeeze off excess water and laitance. Test surface with 10 foot straight edge so that depressions do not exceed 1/4" in center of span of straight edge in any direction. Machine float slabs to proper elevations and allow to stand until all water sheen has disappeared before troweling. Delay finish troweling until concrete is so hard that no mortar accumulates on a trowel and ringing sound is produced as the surface is finished with the trowel. Do not dust cement finishing. Finish surfaces neatly around columns, walls, etc. When finished, slab depression shall not exceed 1/4" in the length of a 10 foot straight edge in any direction.
- B. Broom finish slabs Walks and paving Immediately after slab is placed, screed top surface of slab; tamp concrete with jitterbug, darby or wood float to produce true level or sloped smooth finish. After initial set, groom with stiff fiber broom to remove laitance and smooth spots. Repeat brooming the following day. Remove excess material and protect.

3.16 CLEANUP

- A. Upon completion of the work, forms equipment protection covering and any rubbish resulting therefrom shall be removed from the premises. Finished concrete surfaces shall be left in a clean and perfect condition, satisfactory of the Engineer.

END OF SECTION

**SECTION 03302
CAST-IN-PLACE CONCRETE**

PART 1 GENERAL

1.01 SCOPE

Furnish and install the cast-in-place concrete as shown and indicated on the Drawings and as specified in this Section, complete.

1.02 SUBMITTALS

- A. Mix designs for all groups and classes of concrete.
- B. Strength and slump tests results.
- C. Certificates of compliance for each of the following:
 - 1. Cement
 - 2. Aggregates
 - 3. Fly ash
 - 4. All admixtures

PART 2 PRODUCTS

2.01 CEMENT

Cement shall be standard Portland Cement, of American manufacture, conforming to ASTM C 150, Type I. Only one brand of commercial Portland cement shall be used in the exposed concrete of the structure. Cement reclaimed by cleaning bags or from leaking containers shall not be used in this work. Each bag shall weigh approximately 94 pounds and contain one cubic foot.

2.02 CONCRETE AGGREGATES

- A. Fine aggregate shall be sand having clean, hard, durable, uncoated grains and free from deleterious substances and shall conform to ASTM C 33.
- B. Coarse aggregate shall be crushed stone having clean, hard, durable, uncoated particles conforming to ASTM C 33.

2.03 WATER

Water used in mixing concrete shall be clean and free from deleterious amounts of acids, alkalies or organic materials.

2.04 EXPANSION JOINT FILLER

See Section 03250 of these Specifications for expansion joint filler.

2.05 WATERSTOPS

See Section 03250 of these Specifications for waterstops.

2.06 VAPOR BARRIER

Vapor barrier shall be polyethylene sheeting, minimum 6 mil thickness, conforming to ASTM C 171.

2.07 ADMIXTURES

- A. Water reducing admixture shall conform to ASTM C 494, Type A.
- B. Water reducing, retarding admixture shall conform to ASTM C 494, Type D.
- C. Non-Corrosive, Non-Chloride Accelerator: The admixture shall conform to ASTM C 494, Type C.
- D. Air entraining admixture shall conform to ASTM C 260.
- E. Fly ash shall conform to ASTM C 618, Type F.
- F. High range water reducer (HRWR) shall conform to ASTM C 494, Type F or G and shall be one of the following:
 - 1. Rheobuild 1000 and 716, manufactured by Master Builders
 - 2. Daracem 100, manufactured by W.R. Grace
 - 3. Sikament 320, manufactured by Sika Corporation
 - 4. Eucon 37, manufactured by Euclid Chemical Company
- G. Calcium Chloride: Calcium chloride or admixtures containing more than 0.1 percent chloride ions are not permitted.

2.08 CURING AND SEALING COMPOUNDS

- A. Curing compound shall be acrylic based, conforming to ASTM C 309.
- B. Sealing compound shall be one of the following:
 - 1. Masterseal 340, manufactured by Master Builders
 - 2. Sikaguard 70, manufactured by Sika Corporation

3. Super Rez Seal, manufactured by Euclid Chemical Company

PART 3 EXECUTION

3.01 CONCRETE QUALITY

- A. Two groups of concretes are required. Group I is concrete with a HIGH RANGE WATER REDUCER (HRWR), Group II is concrete without HRWR.

1. Group I: All Group I concrete shall contain the specified fly ash. The combined weight of cement and fly ash shall contain no less than 20 percent nor more than 25 percent of fly ash. The combined weight of cement and fly ash shall be used as the weight of cement in the determining of the water-cement (w/c) ratio. The following classes of concrete are required:

Class of Concrete	Compressive Strength @ 28 Days	Slump Range	Maximum W/C Ratio
A	4,500	1" - 2"	0.4

- a. The slump range in the above table is required prior to adding the High Range Water Reducer (HRWR). Slump tests shall be made prior to adding the HRWR. The HRWR shall be added to the concrete at the batch plant. The slump range required after the addition of the HRWR is 7 to 10-inches. HRWR shall be capable of maintaining 7 to 10-inch slump in excess of 60 minutes of continuous mixing at 4 to 6 rpm in a truck mixer and workability up to 90 minutes. After introduction of HRWR, concrete temperature shall be maintained within 3 degrees F for 90 minutes when concrete temperatures are in excess of 90 degrees F. Except for the air- entrainment admixture, no other admixture shall be used with the HRWR. Upon 72 hours notice, the HRWR manufacturer shall supply jobsite technical service to the Contractor. The manufacturer shall be consulted for mix proportions and dosage rates. No added chlorides shall be used. The initial set shall not be in excess of six hours at temperatures above 50 degrees F. HRWR shall be used with due consideration given to the air temperature at the time of batching and casting.
- b. Air Content: All concrete shall have an air content of 4.0 percent to 7.0 percent.
- c. Group I concrete shall be used in all walls and columns for liquid containment structures.
2. Group II: The following classes of concrete are required:

Class of Concrete	Compressive Strength @ 28 Days	Slump Range	Maximum W/C Ratio
A	4,000	3" - 5"	0.45
B	3,000	3" - 5"	0.56

- a. Air Content: All concrete shall have an air content of 2.5 to 5.0 percent.
- b. Admixture Usage: All concrete placed at air temperatures above 50 degrees F shall contain a water reducing admixture or water reducing-retarding admixture. All concrete placed at air temperatures below 50 degrees F shall contain the specified non-corrosive non-chloride accelerator.
- c. Group II, Class A concrete shall be used for all work not specified as Group I concrete.
- d. Fly ash is required in all slabs for liquid containment structures, either on grade or formed. Provisions for fly ash use in Group I concrete shall apply.
- e. The use of fly ash is not required for the remainder of Group II concrete, but is permitted. If used, the provisions for fly ash use in Group I concrete shall apply.

3.02 MIX DESIGNS

- A. Mix design shall be proportioned in accordance with ACI 211.1 making maximum use of the coarse aggregate. The proportioning shall be based on the requirements of a well-graded high density plastic workable mix within the slump range and strengths required. The mix shall contain no less than 1,850 pounds of coarse aggregate per cubic yard of concrete, shall be based on conventional conveying and shall not be altered for use in pumping. Pumping equipment, if used, shall be of sufficient size and design to pump the mix designed for conventional conveyance.
- B. Coarse Aggregate
 - 1. Coarse aggregate for all concrete in liquid containment structures shall be Size No. 467.
 - 2. Coarse aggregate for all other concrete work shall be Size No. 57.
 - 3. Size No. 467 may be used in lieu of Size No. 57 in concrete members whose minimum size dimension is 8-inches or larger.
- C. If trial batches are used, the testing laboratory shall make strength tests from trial batches in the laboratory using materials and mix designs proposed for use by the Contractor. The testing laboratory shall prepare trial batches in accordance with ACI 211.1.
- D. If field experience method is selected, the proposed mix design shall be accompanied by complete standard deviation analysis and at least 30 consecutive strength test that represent the proposed mix. The strength tests shall have been performed within 12 months of submittal.
- E. The proposed mix design and supporting data shall be submitted, in triplicate, to the testing laboratory for their review and comments at least 21 days prior to the expected start of concreting operations. The testing laboratory will forward

two copies of the submittal to the Engineer with their comments. The Engineer will review the submittal and return one copy to the Contractor with the Engineer's comments.

- F. Compression test specimens made to verify the mixes shall be made in accordance with ASTM C 192. All compression test specimens shall be tested in accordance with ASTM C 39.

3.03 PLANT MIXING

A. Proportioning Concrete

1. Proportions shall be in compliance with approved design mix for each class of concrete.
2. The mixing plant shall be provided with adequate equipment and facilities for accurate measurement and control of the quantities of material and water used in the concrete.
3. Concrete materials shall be measured by weight except that admixture shall be measured by volume.

B. Batching

1. Provide all necessary equipment to accurately determine and control actual amount of materials entering into the concrete mix. Individual ingredients shall be weighted separately for each batch. Accumulative weighing will be allowed if equipment is in acceptable working order as determined by the testing laboratory and approved by the Engineer. Accuracy of all weighing devices shall be such that successive quantities can be measured to within one percent of the desired amount.
2. Completely discharge contents of the mixer before each new batch is loaded. Use of retempered concrete is not permitted.
3. Ready-mixed concrete shall be mixed and delivered in accordance with requirements of ASTM C 94 and the following:
 - a. A separate water metering device (not truck tank) shall be used for measuring water added to the original batch.
 - b. Use of wash water as a portion of the mixing water is not permitted. Wash water added to empty drums after discharging shall be dumped before a new batch is received.
 - c. Centrally mixed concrete shall be mixed for the length of time specified herein, not "shrink-mixed"
 - d. Mixing drums shall be watertight.

- e. Concrete shall be discharged within one hour from the time concrete was mixed, if centrally mixed, or from time the original water was added, if transit-mixed.
- f. Furnish delivery ticket with each load of concrete delivered under these Specifications. Delivery ticket shall show clearly the class and strength of concrete, size of coarse aggregate, water per cubic yard, its slump, quantities of all admixtures, the date and time of departure from the batching plant, and the time of placement.

3.04 CONVEYING EQUIPMENT

- A. If concrete is to be transported in carts or buggies, the carts or buggies shall be equipped with pneumatic tires.
- B. Equipment for chuting or other methods of conveying concrete shall be of such size and design as to insure a practically continuous flow of concrete at delivery without segregation of concrete.

3.05 CONVEYING

- A. Concrete shall be conveyed from mixer to place of final placement by methods which will prevent separation or loss of the material.
- B. Runway supports shall not bear upon reinforcing steel or fresh concrete.
- C. All conveying equipment shall be thoroughly cleaned before each run of concrete is begun.

3.06 DELIVERY AND PROTECTION OF MATERIALS

- A. Deliver ready-mixed concrete in compliance with requirements of ASTM C 94.
- B. The following tests shall be made at the work site prior to placement of concrete:
 - 1. Slump Tests: ASTM C 143.
 - 2. Air Content: ASTM C 173 or C 231
 - 3. Test Cylinders: ASTM C 31

3.07 SEVERE-WEATHER PROVISIONS

- A. Hot Weather Concreting: Protect in accordance with ACI 305R except as modified herein.
 - 1. Provide adequate methods of lowering temperature of concrete ingredients so that the temperature of concrete when placed does not exceed 90 degrees F.

2. Concrete shall not be placed when the air temperature is expected to exceed 100 degrees F within 12 hours after casting.
 3. When the air temperature is 75 degrees F and above, forms and reinforcing shall be thoroughly wetted with water so that the concrete will be placed against wet and cooled surfaces. All excess water shall be removed before casting the concrete.
 4. Protection and Curing - Slabs (On Grade and Formed)
 - a. Protect slabs from damage due to dry winds and high temperatures.
 - b. Protect slabs from direct sun at temperatures of 85 degrees F and above.
 - c. Moist curing of all slabs shall start as soon as the surface of the fresh concrete is hard enough to permit curing without damage to the surface of the concrete.
 5. Protection and Curing - Formed Surfaces: As soon as the concrete has set, wet the forms, and keep the forms wet during the curing period. Provide for keeping the top of the walls, and other top surfaces, moist during the curing period.
- B. Cold-Weather Concreting: Protect in accordance with ACI 306R except as modified herein.
1. Provide adequate equipment for heating concrete materials and protecting concrete from damage during freezing or near-freezing weather. No frozen materials, or materials containing ice, shall be used.
 2. All concrete materials and all reinforcement, forms, fillers, and ground with which concrete is to come into contact shall be free from frost.
 3. Whenever the temperature of the surrounding air is below 40 degrees F and falling, all concrete placed in the forms shall have a temperature of between 70 and 80 degrees F, and adequate means shall be provided for maintaining a temperature of not less than 70 degrees F for three days, or 50 degrees F for five days, or for as much more time as is necessary to insure proper curing of the concrete. If high early strength concrete is used, the requirement for maintenance of 50 degrees F may be reduced to three days.
 4. Use only the specified non-chloride accelerator. Calcium chloride or admixtures containing more than 0.1 percent chloride ions are not permitted.

5. Housing, covering, or other protection used in connection with curing shall remain in place and intact at least 24 hours after the artificial heat is discontinued.

3.08 CONSTRUCTION JOINTS AND EXPANSION JOINTS

- A. Formed Construction Joints in Containment Structures and Where Otherwise Shown: Prior to placing concrete next to the joint, the joint surface shall be thoroughly cleaned and dampened with water. Remove all free water so that the surface of the joint shows signs of drying before placing the adjacent concrete.
- B. Construction joints in Beams, Girders and Slabs Where Waterstops are not Specified or Shown to be Installed: These joints shall be located at points of minimum shear and their locations shall be approved by the Engineer before they are bulkheaded. These joints shall be roughened and thoroughly cleaned of all foreign matter and laitance and dampened with water. Remove all free water and slush with a coat of neat cement grout before placing the adjacent concrete. Place the adjacent concrete before the neat cement grout takes its initial set.
- C. Construction Joints in Beams, Girders and Slabs: Where waterstops are specified or shown to be installed. These joints shall be treated as specified in paragraph A. above.
- D. Construction Joints in Columns: These joints, unless otherwise shown on the Drawings, shall be located at the bottom of the girder, beam or slab it receives, and at the top of slabs when the column continues through a slab level. These joints shall be treated as specified in paragraph B. above.
- E. Expansion Joints: Expansion joints shall be installed where shown on the Drawings.

3.09 WATERSTOPS

Waterstops shall be provided where specified and as indicated and noted on Drawings and shall be made continuous throughout their length.

3.10 INSPECTION OF WORK BEFORE PLACING CONCRETE

- A. Inspect the area to receive concrete for any deficiencies which would prevent proper placing of concrete. Do not proceed with placing concrete until such deficiencies are corrected.
- B. Do not place in the concrete any item that is not required to be in the concrete by the Drawings and Specifications. Insert all the items shown on the Drawings or specified properly positioned and secured. Openings other than those which are facilitated by sleeves shall be properly formed and positioned.
- C. Remove hardened, or partially hardened, concrete on forms or reinforcement before placing concrete.

- D. Do not place concrete on earth until the fill or excavation has been prepared as set forth under applicable sections of the Specifications for that work.
- E. Give the Engineer at least 48 hours notice before any concrete is to be placed. Concrete shall not be placed until the Special Inspector has performed all applicable inspections listed and described in Table 1705.3 of the 2012 edition of the International Building Code. In addition to the inspections required by Table 1705.3, the special inspector shall also certify that the formwork, reinforcing, and all inserts required for mechanical and electrical work, instrumentation, plumbing, process piping, metal embeds, and any other inserts or miscellaneous specialties required for the work are supported in their proper position. The Special Inspector shall certify that the formed enclosure is clean, and the surfaces to receive concrete are prepared as specified. The Special Inspector shall be employed by the owner and shall submit reports as soon as is practicable after work has been inspected. Report issuance shall conform to section 1704.2.4 of the 2012 IBC.

3.11 PLACING

- A. Place concrete as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Do not place concrete on work that has partially hardened or been contaminated by foreign material, and do not use retempered concrete. In no case shall Group II concrete be placed when the elapsed time after addition of water and cement to batch exceeds one hour. For Group I concrete, this elapsed time may be extended if sufficient data from this construction indicates a time extension is permissible and if approved by the Engineer.
- B. Concrete shall be placed in a manner to avoid the displacement of reinforcing, and coating or spattering the reinforcing steel. The placing of concrete within form work shall be regulated so that the pressure within form work does not exceed the design pressure. In placing concrete each layer shall be placed following the preceding layer to prevent lines of separation or "cold joints" in the work. After the concrete reaches its initial set, jarring the formwork or placing strain or vibration on the ends of projecting reinforcing bars shall be avoided.
- C. Group I concrete shall not be dropped more than 10 feet. Group II concrete shall not be dropped more than four feet. All concrete placed over PVC waterstops shall drop no more than 6-inches until there is at least one foot of concrete above the PVC waterstop, at which point the drop distances may be increased to those noted above.
- D. Once concrete placing has started, it shall be carried on as a continuous operation until placing of the concrete between construction joints is completed.
- E. Concrete shall be placed in layers not over 12-inches deep and each layer shall be compacted with the aid of mechanical internal-vibrating equipment supplemented by hand spading. Vibrators shall in no case be used to transport concrete. Use of form vibrators are not permitted. Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the concrete. At least one spare working vibrator shall be on the job site as a

back-up. Duration of vibrator use shall be limited to that necessary to produce satisfactory consolidation without causing objectionable segregation. Vibrator shall not be lowered into courses that have begun to set. Apply vibrator at uniformly spaced points not further apart than the visible effectiveness of the machine. Type and use of vibrators shall be in accordance with ACI 301.

- F. Provide vapor barrier under all building slabs on soil, sand, or stone. Use largest sheets practicable to reduce number of joints. Lap joints a minimum of 24-inches. Remove torn and punctured sheets and replace with new sheets prior to placing concrete. Placing of concrete shall be done in a manner that will not damage the vapor barrier material. The sub-base material shall be as shown and/or noted on the Drawings.

3.12 PROTECTION

Protect freshly placed concrete from damage or injury due to water, falling objects, persons or anything that may mar or injure finish surface on concrete. Only light use of slabs will be permitted for the first 14 days after placing of the concrete.

3.13 CURING

- A. Curing shall conform to ACI 308 except as modified herein.
- B. All Slabs on Grade: After placement and finishing, concrete shall be maintained in a moist condition for at least seven successive days during which the temperature of the concrete is 50 degrees F or above. For temperatures of 50 degrees F and below, curing period shall be 14 successive days. Concrete shall be kept moist by any one, or combination, of the following methods:
 - 1. Ponding or Immersion: Continually immerse the concrete in water throughout the curing period. Water shall not be more than 20 degrees F less than the temperature of the concrete.
 - 2. Fog Spraying or Sprinkling: Provide uniform and continuous application of water throughout the curing period.
 - 3. Pervious Sheeting: Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 6-inches over adjacent sheeting. Sheeting shall be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.
 - 4. Impervious Sheeting: Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12-inches minimum. Provide sheeting not less than 18-inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Inspect surface of concrete daily for

wetness. The surface shall be kept continuously wet during the curing period.

- C. All Other Concrete: After placement, concrete shall be maintained in a moist condition for the same periods as specified above for slabs on grade.
 - 1. Concrete in Formed Surfaces - Slabs, Beams, Columns and Building Walls: Keep forms and exposed surfaces wet with water during the curing period. If forms are removed before the end of the curing period, apply a curing compound within one hour after form removal.
 - 2. Concrete in Formed Surfaces - Containment Vessel Walls: Keep forms wet with water during the curing period. If forms are removed before the end of the curing period, continue the moist curing in accordance with Paragraph A. of this article of these Specifications.

3.14 PATCHING

- A. As determined by the Engineer, any concrete which is out of alignment or level, has a defective surface or has defects which reduce its structural adequacy, shall be considered as not conforming with the Drawings and Specifications and shall be rejected.
- B. Do not take any remedial action on concrete with any defect without the permission of the Engineer.
- C. Unless the Engineer grants permission to patch the rejected concrete, remove the rejected concrete and replace it with concrete that conforms to the Drawings and Specifications. The location of cut lines and the extent of removal will be determined by the Engineer.
- D. If the Engineer grants permission to patch the rejected concrete, it shall be done in accordance with the following:
 - 1. Permission to patch rejected concrete will not be a waiver of the Engineer's right to require complete removal of the rejected concrete if the patching does not, in the Engineer's judgement, restore the concrete to the requirements of the Specifications and Drawings.
 - 2. Patching shall be accomplished after the curing is completed.
 - 3. Defective areas shall be chipped away to a depth of not less than 1-inch, in all cases to sound concrete, with edges perpendicular to the surface. Feather edges will not be permitted. Remove all loose material and thoroughly clean the chipped surfaces with a high pressure air hose delivering air at 100 psi. The area to be patched and an area at least 6-inches wide surrounding it shall be dampened. A bonding grout shall be prepared using a mix of approximately one part cement to one part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream, and then well brushed into the surfaces as noted below in paragraph 5.

4. The patching mixture shall be made of the same materials and of approximately the same portions as used for the original concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than one part cement to two and one-half parts sand by damp, loose volume. White Portland cement shall be substituted for a part of the gray Portland cement to produce a color matching the color of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.
5. After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least one hour before being finally finished. The patched area shall be kept damp for seven days. Finishing tools that produce a finish matching the surrounding shall be used.
- E. Tie holes left by withdrawal of rods or the holes left by removal of ends of wall ties shall be filled solid with mortar after first being wetted. For holes passing through the wall, a plunger-type grout gun shall be used to force the mortar through the wall starting at the back face. A piece of burlap or canvas shall be held over the hole on the outside and when the hole is filled, the excess mortar shall be struck off with the cloth flush with the surface. Holes not passing through the walls shall be filled with a small tool that will permit packing the hole solid with mortar. Any excess mortar at the surface of the wall shall be struck off flush with a cloth. Mortar shall consist of one part cement, two and one-half parts sand and no more water than necessary for handling and packing.

3.15 FINISHES ON FORMED SURFACES

- A. Upon completion of patching, surfaces of concrete shall be finished as follows:
 1. Brushed Finish Surface Coating
 - a. The brush finish surface coating shall be applied over a Smooth Form Finish (see Section 03100).
 - b. The materials used shall be applied in two separate coats to provide a uniform finish on exposed surfaces that have received the initial rubbed finish. The materials shall be mixed and applied strictly in accordance with the written recommendations of the product manufacturer. The actual application of the material shall be performed by workers who have been instructed in the preparation and application of the material. The final brushing of the material during application shall be performed in such a

manner as to present a uniform and attractive appearance, with the final brushing generally being done in one direction. The materials shall be especially manufactured for the purpose of waterproofing exterior concrete surfaces, and enhancing the appearance of the concrete surface. The final color of the finish shall be pearl gray, or near that of good quality cured natural concrete. Texture of material shall be approved by the Engineer. Material shall be Thoroseal as manufactured by Thoro System Products.

- c. The following surfaces shall receive a brushed finish surface coating:
 - i. All exterior wall concrete surfaces to levels not less than 6-inches below finish grade.
 - ii. All interior wall concrete surfaces within buildings and other such surfaces exposed to view in the finished work (except floor slabs).
 - iii. The interior side on containment tank walls to a level not less than 12-inches below normal liquid level, including top of walls.
- 2. Smooth Form Finish is required for all concrete surfaces exposed to view in the completed work and all liquid containment structure walls whether exposed to view or not in the completed work. Accomplish the required patching and the following touch-up:
 - a. Remove all burrs.
 - b. Remove all form marks.
 - c. Smooth out lines of indentations.
- 3. Rough Form Finish shall be produced by filling all tie holes and honeycomb and in other respects leaving the surface as formed. All concrete surfaces which will be covered by earth and which will not be visible in the completed structure (except as noted above for liquid containment structure walls which shall have a Smooth Form Finish), may receive a Rough Form Finish.

3.16 STEEL TROWELED FINISH - FLOOR SLABS

- A. Steel troweled finish shall be applied to the surface of all building and liquid containment structure floor slabs and interior equipment pads.
- B. Concrete shall be placed, consolidated, struck-off and leveled to the proper elevation. After the surface has stiffened sufficiently to permit the operation and the water sheen has disappeared, the surface shall be wood floated, by hand or

power floated, at least twice, to a uniform sandy texture. Floors shall be leveled such that depressions between high spots do not exceed 1/4-inch under a 10-foot straightedge except where drains occur, in which case the floors shall be pitched to the drains as indicated on the Drawings.

- C. After the concrete has received a wood float finish, it shall be troweled at least twice to a smooth dense finish. The drying of the surface moisture before floating or troweling shall not be hastened by the dusting on of dry sand or cement. The first troweling shall be done by a power trowel and shall produce a smooth surface relatively free of defects. Additional troweling shall be done by hand after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand troweling operations. The finished surface shall be free of any trowel marks or other imperfections; shall be uniform in texture and appearance, and shall be in true plane within the tolerance specified. Any deviation from this condition which remains after the troweling is completed shall be corrected by grinding.

3.17 BROOM FINISH

- A. Broom finish shall be applied to:
 - 1. All exterior sidewalks, walkways, and platforms.
 - 2. All steps and landings, both interior or exterior.
- B. The surface shall be given a floated finish as specified above, then finished with a flexible bristle broom or burlap belt drawn across the surface. Surface must be hardened sufficiently to retain the scoring or ridges. Scores or ridges shall be transverse to traffic or at right angles to the slope of the slab.

3.18 SURFACE PREPARATION FOR FINISH GROUT

The surface shall be given a wood float finish and moist cured. After the curing period, the finish grout shall be applied where indicated and noted on the Drawings.

3.19 TESTING LABORATORY

- A. The testing laboratory shall have access to all places where concrete materials and concretes are manufactured, stored, proportioned, mixed, placed and tested. Duties shall include, but not necessarily be limited to the following:
 - 1. Make, store, transport, cure, and test compression specimens made during placing of concrete. Compression test specimens shall be tested in accordance with ASTM C 39. Test reports shall show all pertinent data, such as class of concrete, exact location of pour, air temperature, date of pour, time of pour, truck number for ready-mixed concrete, date on which specimen was broken, age of specimen, compressive strength of specimen, concrete slump test results and air content of concrete from which the specimen was made. One copy each of all tests shall be sent to the Contractor and two copies each to the Engineer.

2. Each strength test requires four standard test cylinders.
 3. Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 75 cubic yards of concrete, nor less than once for each 5,000 square feet of surface area for slabs or walls.
 4. Each class of concrete shall be tested with at least five strength tests.
 5. From each set of four cylinders, two shall be tested at 28 days and shall comprise a strength test under the definition of these Specifications. One cylinder shall be broken at seven days and will be used as an aid in determining the early strength of the concrete and the 28 day strength, and one cylinder retained in reserve for later testing if required.
 6. Test for unit weight of concrete when the first load of each class of concrete is delivered and thereafter at the discretion of the testing laboratory.
- B. Periodically inspect the batching plant and file a report with the Engineer stating whether the supplier's equipment and methods meet the requirements of these Specifications.
- C. Temperature and Placing Record: Temperature record shall be made each day during the concreting operations. Records shall also include location, quantity and starting and finishing time of placement for all concrete work. Copy distribution shall be as specified above for test reports.

3.20 Evaluation of Compression Tests

- A. Evaluation of compression test results shall be as follows: For each class of concrete, compression-strength tests for laboratory-cured cylinders shall be considered satisfactory if the averages of the results of all sets of three consecutive compression-strength tests equal or exceed the 28 day design compression-strength specified; and, no individual cylinder strength test falls below the required compression strength by more than 500 psi. Strength tests of specimens cured under field conditions may be required by the Engineer to check the adequacy of curing and protecting of the concrete placed. Specimens shall be molded by the field-testing laboratory at the same time and from the same samples as the laboratory-cured specimens.
- B. Faulty Concrete: Failure to comply with any of the specified conditions shall constitute faulty concrete. Unless otherwise directed by the Engineer, faulty concrete shall be removed and replaced with concrete as specified, at no expense to the Owner.
- C. Additional Test: If permitted by the Engineer, additional tests shall be subject to the approval of the Engineer and at no expense to the Owner. Load tests, if permitted by the Engineer, shall be conducted in accordance with the loading criteria as required by the design of the structure, as determined by the Engineer.

- D. Neither the results of laboratory verification tests nor any provision in the Contract Documents shall relieve the Contractor of the obligation to furnish concrete of the class and strength specified.

END OF SECTION

SECTION 03602 NONMETALLIC GROUTING

PART 1 GENERAL

1.01 SCOPE

This Section describes nonmetallic grout and grouting methods to be used in the setting of motors, compressors, pumps, aerators, vessels, tanks, pipe supports, structures and other miscellaneous items of equipment that require grout between their baseplate, bedplate or soleplate and the top of the concrete surface to which they are to be anchored.

1.02 GENERAL

- A. The Contractor shall furnish all labor, grouting materials, water, equipment, forms and other items necessary or convenient to the Contractor for the proper preparation, placement and curing of grout.
- B. Non-shrink, epoxy and sand-cement grouts shall be stored, mixed, handled and placed in accordance with the recommendations of the grout manufacturer and the American Concrete Institute (ACI), as applicable.
- C. No grout shall be placed until the place of grouting has been inspected and approved by the Engineer.

1.03 SUBMITTALS

- A. Prior to placement of any non-shrink or epoxy grout, the Contractor shall submit to the Engineer complete engineering and product data on the grout, including manufacturer's recommendations for mixing, placement and curing.
- B. The Contractor shall also submit to the Engineer written evidence that the grout, cement and aggregate is in conformance with the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the grout, cement and/or aggregate supplier may be considered evidence of compliance provided such tests are performed in accordance with the appropriate ASTM or Corps of Engineers testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the Engineer may require that the Contractor furnish test reports from an independent testing laboratory on samples of grout, cement and/or aggregate.

1.04 STORAGE

All grout shall be stored above ground and shall be protected at all times from moisture, high humidity, oil and extremes of temperature. Grout or cement which has been resacked or has become caked or lumpy shall not be used.

1.05 SAFETY

Proper precautions shall be taken to protect workers during handling of epoxy resins and hardeners. All mixing and placement of epoxy grouts shall be done in well-ventilated areas. The specific safety recommendations of the manufacturer shall be strictly adhered to.

PART 2 PRODUCTS

2.01 NONSHRINK GROUT

Column baseplates, all pumps, compressors, motors, and other heavy equipment items shall be grouted in place with a nonmetallic, noncorrosive, nongaseous, non-shrink grout requiring no cutback or protective coating. Non-shrink grout shall show zero shrinkage from the placement volume or initial expansion volume as determined by ASTM C 827, and shall have an initial set time at 70 degrees F of not less than 45 minutes as determined by ASTM C 191. When tested in accordance with ASTM C 109, non-shrink grout shall have a one-day compressive strength of not less than 2,000 psi and a 28-day compressive strength of not less than 8,000 psi at a flow of not less than 100 percent determined in accordance with Corps of Engineers Specification CRD-C-621. The grout shall contain no corrosive ions, calcium chloride, oxidizing catalysts, gas-forming agents, harmful aluminum, or corrosive chemicals and shall be resistant to oil, water, and sewage. The grout shall be premixed and shall require only the addition of water prior to placement. The grout shall be delivered to the job site in unopened, plastic-lined bags and shall have the manufacturer's mixing instructions printed on the back of each bag. Non-shrink grout shall be Masterflow 928 Grout as manufactured by Master Builders Company, or Five Star Grout as manufactured by Five Star Products, Inc.

2.02 SAND-CEMENT GROUT

- A. Pipe support baseplates, tanks and miscellaneous small items of equipment shall be grouted in place using a sand-cement grout consisting of one part Portland cement, two parts fine aggregate and a maximum of 4.5 gallons of water per sack (cubic foot) of cement. Portland cement shall be Type III conforming to ASTM C 150. Fine aggregate shall be natural siliceous sand, consisting of hard, clean, sharp, dense, durable, and uncoated particles.
- B. Fine aggregate shall be free from organic material and injurious amounts of deleterious substances and shall be graded as follows:

Sieve Size No.	Percent (by weight) Passing
4	100
8	95 - 100
16	60 - 100
30	35 - 70
50	15 - 35
100	2 - 15

- C. Except as modified herein, fine aggregate shall conform to the requirements of ASTM C 144.
- D. Fine aggregate to be used with epoxy binders shall be dried prior to use to remove any free moisture.

2.03 NONSHRINK EPOXY GROUT

Non-shrink epoxy grout shall be used in special equipment grouting applications requiring high bonding or tensile strength where shown on the Drawings. This grout shall be a pre-measured and prepackaged product containing thermosetting epoxy resins and inert fillers; and shall be delivered to the work site in unopened containers. Non-shrink grout shall be Ceilcote 648 CP Grout (Master Builders, Inc.) or Five Star Epoxy Grout (Five Star Products, Inc.).

2.04 WATER

Water used in the preparation of non-shrink and sand-cement grout shall be clean, potable water, free from oil, alkali, acid, organic matter, and other deleterious substances.

PART 3 EXECUTION

3.01 FOUNDATION PREPARATION

- A. Prior to setting equipment or placing grout, the foundation to receive grout shall be chipped or sandblasted so as to expose the coarse aggregate and create a roughened condition. All surfaces to be in contact with the grout, including the bottom of the baseplates or sole plates, shall be thoroughly cleaned until free of all oil, grease, laitance, dust, curing compounds and other foreign substances. If the surface is to receive non-shrink or sand-cement grout, the roughened surface shall be washed with liberal amounts of clean water and shall be soaked for a least 24 hours immediately preceding grouting. Prior to placement, all free water shall be removed using an air hose or other suitable method.
- B. Surfaces to receive an epoxy grout shall be completely dry and free from all visible moisture. Where it is impractical to obtain a moisture-free surface, the Engineer may authorize the use of epoxy grout on damp surfaces provided the epoxy formulation is moisture-compatible. When applying grouts to damp surfaces all free water shall be removed and the epoxy formulation shall be carefully selected so that localized boiling of entrapped moisture due to excessive exotherm does not occur.

3.02 MIXING

- A. The specific recommendations and instructions of the grout manufacturer shall be strictly adhered to in all proportioning, mixing and placing of grout. The grout shall be mixed as close to the point of use as is practical. A mechanical mortar mixer may be used for mixing large quantities of non-shrink or sand-cement grout. No more grout shall be mixed than can be placed in the time preceding

initial set. Grout that has stiffened prior to placement shall be discarded. Only that amount of water required to produce the necessary degree of flowability shall be used. The grout mixture shall not be retempered by adding water.

- B. Components of epoxy grout systems shall be accurately proportioned and thoroughly mixed so as to produce a uniform and homogeneous mixture. Accuracy of proportioning of epoxy compounds shall be + five percent of the manufacturer's specified mixing ratio. Mixing of small quantities (up to one quart) of epoxy grout may be accomplished by hand using spatulas, palette knives, or similar devices. For larger volumes, mechanically driven tumbling or paddle type mixers shall be used. Paddle type mixers shall be driven by a low speed (400-600 rpm) motor to prevent introduction of excessive amounts of entrained air into the mixture. Mixing shall continue until the mixture is uniform and homogeneous, but in no case less than three minutes. The manufacturer's recommended temperature range for mixing the epoxy grout shall be followed in all field mixing.
- C. After mixing, epoxy grout shall be allowed to stand for approximately five minutes to allow initial air release.

3.03 PLACEMENT

- A. Grout shall be carefully placed by troweling, ramming, or pouring, as is most suited to the application, so that all voids and cavities between the foundation and equipment baseplate or bedplate are filled. Air-relief holes shall be provided, if necessary, to eliminate entrapped air. If a pourable or flowable grout is required, suitable forms shall be provided for containing the grout. Forms shall be securely anchored and caulked to prevent leakage of grout. Grout shall be placed from one side only. Forms shall be of sufficient height to allow at least 6-inches of head on the grout above the bottom of the baseplate on the side where the grout is to be placed. Grout shall be placed until it protrudes from the entire perimeter area. Baseplates shall be located so as to provide a minimum clearance of 1-inch between the foundation and the bottom of the baseplate. The temperature of the foundation and baseplate or soleplate shall be maintained above 45 degrees F during placement and for at least 24 hours thereafter. Heating of foundation and baseplate surfaces shall be accomplished using heated enclosures, heat lamps or radiant heaters so as to achieve uniform heating. Use of direct flame shall be prohibited. Concrete structures shall be heated a minimum of four hours prior to grouting to ensure proper heating of the concrete mass. Temperature of heated surfaces shall not exceed 100 degrees F at the time of placement. When placing nonshrink or sand-cement grout under unusually hot or cold weather conditions, grouting practices shall comply with the requirements of ACI 305 and 306, respectively.
- B. Epoxy grout formulations shall possess exotherm properties compatible with the anticipated substrate and placement conditions. Where large masses of epoxy are involved or if ambient or substrate temperatures are high, relatively low exotherm formulations shall be used. Conversely, where very small quantities or thin films of epoxy are involved or if ambient or substrate temperatures are low, a high exotherm formulation shall be used.

- C. When placing epoxy grouts by pouring, care shall be taken to ensure that segregation of aggregate and epoxy binder or entrapment of entrained air does not occur prior to initial set. To prevent this condition, epoxy grout shall be placed in successive lifts under the baseplate or bedplate not to exceed 1-inch in thickness.

3.04 FINISHING AND CURING

- A. Forms shall be left in place until the grout is hardened enough so that it cannot flow. Unconfined edges of grout shall be cut off flush or beveled and shall be troweled to produce a smooth finish. Wedges and shims used in levelling rotating, vibrating or other heavy items of equipment shall be removed after the grout has hardened three days. All voids shall be regouted using the same grouting material. Removal of shims and wedges from column baseplates and pipe support baseplates is optional. Anchor bolts shall not be pulled up to final torques until shims and wedges have been removed and the grout is hard enough to permit equipment operation.
- B. After placement, exposed edges of water-cured grout shall be wet cured by covering with wet burlap, wet sand, or polyethylene film for at least seven days. During cold weather grout shall be maintained at a temperature for a period of time following placement that will ensure proper hardening and curing.

END OF SECTION

**SECTION 04100
MASONRY MORTAR**

PART 1 GENERAL

1.01 SCOPE

The work covered by this Section consists of furnishing all labor, equipment and material required to ensure the proper proportioning of materials for masonry mortar and related work as described herein and or shown on the Drawings.

1.02 SUBMITTALS

Product Data: For each different masonry mortar product specified, Submit to ME Sack Engineering.

1.03 STORAGE AND PROTECTION

- A. Cementitious materials shall be delivered to the site in unbroken bags or other approved containers, plainly marked and labeled with the manufacturer's name and brand.
- B. Cementitious materials shall be handled in a manner which will prevent the inclusion of foreign materials and damage by water or dampness.

1.04 QUALITY ASSURANCE

- A. Materials shall conform to the current editions of the following standards:
 - 1. Masonry Cement: ASTM C91.
 - 2. Aggregate for Masonry Mortar: ASTM C 144.
 - 3. Portland Cement: ASTM C 150, Type I.
 - 4. Hydrated Lime for Masonry Purposes: ASTM C 207, Type S.
 - 5. Mortar for Unit Masonry: ASTM C 270.
- B. The Contractor shall submit to the Engineer written evidence that the cement, lime, and aggregate is in conformance with the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the cement, lime and/or aggregate supplier may be considered evidence of compliance provided such tests are performed in accordance with the appropriate ASTM testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the Engineer may require that the Contractor furnish test reports from an independent testing laboratory on samples of cement, lime and/or aggregate.

- C. In addition to these submittals, the Contractor shall submit to the Engineer test results in compliance with ASTM C 270, Section 9 for each type of mortar to be used in the work. The test report shall also include the average compressive strength of three 2-inch cubes of laboratory prepared mortar. Mortar mix ingredients and proportions shall not be changed during the course of the work without the Engineer's approval. Extreme care shall be taken to assure that the same proportion of each ingredient is used in each batch. Mortar color shall be proportioned by weight in individual containers prior to mixing. Measuring mortar color by volume during mixing shall not be allowed.

PART 2 PRODUCTS

2.01 MATERIALS

- A. **Masonry Cement**
 - 1. Masonry cement shall be a mixture of Portland cement and Type S hydrated lime. The mix shall not contain inert or noncementitious mineral fillers. If package mix is used, other hydraulic cements may be substituted for a part of the Portland cement. However, the Portland cement shall not be less than 30 percent of the total. Packaged mixes shall conform to the requirements of ASTM C 91.
 - 2. The composition of the masonry cement shall be printed on each bag in terms that show compliance with these requirements.
 - 3. If a packaged mix is not used, the Portland cement shall conform to ASTM C 150, Portland Cement, Type I and hydrated lime shall conform to ASTM C 207, Type S. The hydrated lime may be used in dry or paste form.
- B. **Sand:** Aggregate for use in masonry mortar shall be clean, free from salt or other deleterious materials and conform to ASTM C 144, Aggregate for Masonry Mortar.
- C. **Water:** Water for mixing shall be potable, clean, and free from oil, acids, salts, and other deleterious matter.
- D. **Color:**
 - 1. Masonry cement used in interior non-load bearing smooth face CMU wall construction shall be grey.
 - 2. Masonry cement used in the split faced CMU veneer shall be colored. Colors shall be submitted to the owner (via ME Sack Engineering) for approval.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mixing and Placing

1. All mortar materials shall be accurately measured by volume and thoroughly mixed until they are evenly distributed throughout the batch. Mix mortar as follows: first, add approximately 3/4 of required water, 1/2 the sand and all the cement and lime; mix and add remainder of sand. Mix briefly; then add remainder of water in small quantities until workability of batch is satisfactory to masons. Mortar color when used shall be added to the 3/4 of required water prior to adding sand. After all materials have been added, mix for a minimum of five minutes. Completely empty drum before recharging for next batch.
2. All mortar shall be mixed in a powered, batch-type mechanical mixer. This requirement will not be waived except for minor jobs and then only upon the approval of the Engineer.
3. Mortars mixed for more than one hour shall not be used. A mortar which shows a tendency to become dry before this time shall have water added to it and shall be re-mixed. The use of a continuous mixer or retempered mortar shall not be permitted.
4. Mortar for pointing shall have integral waterproofing added in accordance with the manufacturer's instructions.

B. Mix Proportions: All mortar shall conform to the requirements of ASTM C 270 and shall conform to section 2103.9 of the 2012 IBC.

1. Mortar Uses

- a. Use Type S for all load bearing masonry and in foundation walls where masonry materials occur.
- b. Use Type N for all interior non-load bearing masonry.
- c. Use Type S for all face brick work, backup and parging.
- d. Type M may be used in lieu of Type N or S.
- e. Type S may be used in lieu of Type N.

END OF SECTION

**SECTION 04200
MASONRY**

PART 1 – GENERAL

1.01 DESCRIPTION

- A. Provide all labor, materials, equipment and services required for complete execution of masonry work as shown on drawings and specified herein.
- B. Related work specified elsewhere:
 - 1. Section 07900: Caulking and Sealants

1.02 PROJECT HANDLING

- A. All masonry units shall be stacked on raised pallets or platforms so that they will not be in contact with the ground.
- B. While stacked on the job, masonry units shall be covered and protected with a waterproof covering.
- C. Any straw used for packing shall be removed from the units before they are stacked on the job site.
- D. All partially completed walls not being worked on shall be protected at all times by a waterproof covering. This includes covering of incomplete walls at the end of each day for overnight protection.
- E. Use only wooden bodied wheelbarrows for conveying masonry units. The use of metal bodied wheelbarrows shall not be allowed.

PART 2 – PRODUCTS

2.01 CONCRETE BLOCK

- A. Hollow Concrete Blocks: Grade N. units to meet ASTM C90 75.
- B. Solid Concrete Blocks: Type II, grade N units to meet ASTM C145 75.

2.02 MORTAR

- A. Mortar shall be Grade M or Grade S.
- B. Masonry Cement: ASTM Designation.
- C. Portland Cement: ASTM Designation C150 74.
- D. Sand: ASTM Designation C144 76.
- E. Water: Fresh, clean and free from acid, alkalies, sewage or organic matter.
- F. Mixing:
 - 1. Shall be in accordance with ASTM C270 73.
 - 2. Shall be by mechanical means.
 - 3. Mortar shall be used and placed in final position within 2½ hours after mixing.
 - 4. Keep proportions constant.

2.03 MASONRY ACCESSORIES

- A. Continuous Joint Reinforcement:
 - 1. Joint reinforcement with wall ties shall be standard galvanized truss type.
 - 2. Approved Manufacturers: Masonry Reinforcing Corporation of America; Dur O Wall; A.A. Wire Products Co.; Hohmann & Barnard Inc., or Heckman Building Products, Inc.

PART 3 – EXECUTION

3.01 MASONRY WORK

- A. Mortar joints shall be concave.
- B. Bond all concrete block masonry with continuous wall reinforcement at 16" o.c. forming corners and intersections.

3.02 INSTALLATION

- A. Lay all masonry work in sizes and percentages as outlined.
- B. Lay concrete block in running bond.
- C. Provide full mortar bed smooth or slightly furrowed. Butter ends of all masonry units with mortar to fill head joints.
- D. Lay no masonry units during freezing weather or when the temperature is forecast to go below freezing within 24 hours.

- E. All masonry units work shall be laid true to dimension, plumb, square and in bond and anchored with vertical joints in line plumb and true.
- F. No exposed, broken, chipped or cracked units allowed.
- G. Build in grounds, conduits, switch boxes, anchors and nailing blocks.
- H. Form chases, slots and patch masonry work for all trades.
- I. Bond or tie with reinforcement all intersections of masonry walls.
- J. Take care to wipe all exposed masonry units with rough cloth or brush as work progresses to prevent mortar stains.
- K. Flashing: Furnished by sheet metal section unless otherwise noted on drawings. Place by this section where it is to be built into masonry.
- L. In laying all masonry units avoid over plumbing and pounding of the corners and jambs to fit stretcher units after being set in position. Where an adjustment must be made after the mortar has been set, the mortar shall be removed and replaced with fresh mortar.
- M. Leave cavities clean of all mortar droppings.
- N. When intersecting walls are carried up separately tooth or block the perpendicular joints with no more than 8" off sets.

3.03 POINTING AND CLEANING

- A. At the completion of the work, all holes or defective mortar joints in exposed masonry shall be pointed and all defective joints shall be cut out and repointed.
- B. Exposed masonry shall be protected against staining from wall covering or other sources and excess mortar shall be wiped off the surface as the work progresses.
- C. All exposed masonry shall be cleaned at the completion of the work by the application of Sure Klean #101 lime solvent. Protect exposed concrete walls by masking and taping with a 4 mil. polyethylene film. Apply in accordance with manufacturer's detailed instructions printed on or attached to each container. Approved manufacturers: Acme Brick Co. DC 6 Brick Cleaner.

END OF SECTION

**SECTION 04220
CONCRETE UNIT MASONRY**

PART 1 GENERAL

1.01 SCOPE

- A. The work covered by this Section consists of furnishing all labor, equipment and material required for the correct placement and construction of concrete masonry units and related work as described herein and/or shown on the Drawings.
- B. Work for Other Trades: Bolts, anchors and shelf angles shall be the responsibility of the Contractor. However, the subcontractors requiring such work are responsible for furnishing complete information to the Contractor.

1.02 SUBMITTALS

Certification: Furnish manufacturer's written certification accompanied by suitable laboratory or mill test reports that masonry units furnished meet or exceed the requirements of these Specifications.

1.03 STORAGE AND PROTECTION

Store masonry units above ground on level platforms which allow air circulation under stacked units. Cover and protect against wetting prior to use. Handle units on pallets or flatbed barrows. Do not permit free discharge from conveyor units or transporting in mortar trays.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

- A. Concrete block shall have 8 x 16-inch face with 4, 6, 8, 10 or 12-inch nominal width, as required.
- B. Hollow masonry units shall comply with "Specification for Hollow Load-Bearing Concrete Masonry Units," ASTM C 90, Grade N. Hollow masonry units shall be one of the following:
 - 1. Light weight, concrete weighing less than 105 pcf. Minimum net compressive strength of 1,900 psi.
- C. Architectural Concrete Masonry Units: Provide Concrete Block load bearing units in accordance with Article 2.01, Paragraph A. of this Section manufactured by Metromont, with water repellant admixture. Nominal face dimensions 8 x 16-inches; thickness as indicated; external corners square with two finished faces. Minimum compressive strength shall be 1,900 psi. Provide all special shapes as

required to complete concrete masonry work, including wraparound corner units.

- D. Color: Provide colored masonry units, as indicated on the Drawings, by Metromont.

2.02 CONCRETE BRICK

Concrete brick shall comply with "Specifications for Concrete Building Brick," ASTM C 55, Grade N.

2.03 REINFORCEMENT

- A. Block wall reinforcement shall be of the prefabricated type for use in masonry mortar joints. Wall reinforcement shall be of ladder design for composite wall construction with No. 9 gauge deformed hot-dipped galvanized side rods and No. 9 gauge galvanized cross rods. Joint reinforcement shall comply with "Standard Specification for Cold Drawn Steel Wire for Concrete Reinforcement", ASTM A 82.
- B. Dovetail anchors shall be hot-dipped galvanized steel, triangular shaped wire tie, sized to extend within 1-inch of masonry face complying with ASTM A 82.

2.04 WEEPHOLE MATERIAL

Weepholes shall be absorbent rope made from cotton, 1/4 to 3/8-inch in diameter in length to produce 18-inches in cavity of 4-inch cmu veneer.

PART 3 EXECUTION

3.01 ERECTION AND WORKMANSHIP

- A. Scaffolding shall be provided, as required. Scaffolding shall not be overloaded and shall be inspected regularly by the Contractor to verify that it is amply strong, well braced, and securely positioned. The Contractor shall be always unconditionally responsible for the safety of the scaffolding.
- B. Masonry shall not be laid when the temperature is below 40 degrees F. Walls shall be carried up level and plumb all around. Unfinished work shall be stepped face for joining with new work; toothing shall not be permitted. Heights of masonry shall be checked by the Contractor with an instrument at each floor and at sills and heads of openings to maintain the level of the walls.
- C. Masonry units shall be handled with care to avoid chipping, cracking, and spalling of faces and edges. Drilling, cutting, fitting, and patching to accommodate the work of others shall be performed by qualified masons. Masonry shall be cut with a masonry saw outside of buildings. Chipping or breaking with a hammer will not be permitted.

- D. Door and window openings, louvered openings, anchors, pipes, ducts, and conduits shall be built in carefully as the work progresses. Ties and anchors shall be placed accurately. Metal work specified elsewhere shall be placed in position as the work progresses. Grouting of ties and anchors into hardened mortar or grout shall not be permitted.
- E. Masonry units shall be laid in running bond. The first course of masonry shall be laid in a full bed of mortar; and the succeeding courses shall be shoved (not laid) in beds of mortar to fill the joints full without subsequent flushing and filling. Unless shown or specified otherwise, all joints shall be 3/8-inch thick. Where ties, anchors and bolts occur within the cells of the units, such cells shall be filled with mortar or grout as the work progresses.
- F. Concrete masonry units shall be dry when laid. Each unit shall be adjusted to final position in the wall while the mortar is still soft and plastic. Any unit disturbed after mortar has stiffened shall be removed and re-laid with fresh mortar. Vertical cells to be filled with grout shall be aligned to provide a continuous unobstructed opening of the dimensions shown. Chases shall be plumb and shall be minimum one unit length from jambs of opening.
- G. Exterior or exposed masonry joints shall be finished with smooth concave contour. Procedure used in striking joints shall be as follows: first strike the bed joints; next strike the head joints; then strike bed joints as required to remove any spots, etc., from intersection of bed and head joints. After mortar has initial set but before mortar is hard, restrike the head joints to provide clean, smooth intersection of the head and bed joints. Interior and exterior joints to receive masonry coating shall be tooled flush.
- H. At the end of each day's work, the tops of exposed masonry walls shall be covered with a strong, nonstaining waterproof membrane well secured in place. Surfaces not being worked on shall be properly protected at all times. Unfinished work shall be stepped for joining with new work. Before new work is started, all loose mortar shall be removed and the exposed joint thoroughly wetted, not less than 30 minutes before laying new work.
- I. Control joints shall be installed where concrete masonry units abut dissimilar materials and shall be installed vertically in exterior walls at 30 feet on center, unless shown otherwise on the Drawings.

3.02 WALL REINFORCEMENT

- A. Place wall reinforcement in first masonry bed joint above finished floor and in alternate bed joints (16-inches on center) thereafter.
- B. Masonry joint reinforcement shall be placed so that longitudinal wires are located over face shell mortar beds and are fully embedded in mortar for their entire length with minimum mortar cover of 5/8-inch of exterior side of walls and 1/2-inch at other locations. Reinforcement shall be placed in first and second bed joint above and below openings. Reinforcement in the first bed joint immediately above and below openings shall be continuous. In the second bed joint it shall extend two feet beyond each side of the opening.

- C. Reinforcing shall be lapped a minimum of 6-inches at splices. Corner and abutting wall reinforcement shall be prefabricated corner and tee sections.

3.03 CLEANING

- A. During construction, care shall be taken to keep exposed face of masonry clean of mortar and other stains. Joints shall be raked as they reach thumbprint hardness. The exposed work shall then be brushed with a soft fiber brush to remove adhering mortar. A wooden paddle shall be used to remove more tenacious material. Bases of walls shall be protected from splash stains by covering the adjacent floor or ground with sand, sawdust, or polyethylene film.
- B. At completion of work, holes in exposed masonry shall be pointed and defective joints shall be cut out and tuck pointed solidly with mortar.
- C. If necessary, exposed masonry surfaces shall be scrubbed with warm water and soap and fiber brush and thoroughly rinsed with clear water. Work which may be damaged, discolored or stained shall be protected during the cleaning process. The use of sapolio or wire brushes or acid for washing down walls shall not be permitted.
- D. Protect all finished work against freezing, for a period of not less than 48 hours, by means of enclosures, temporary heat or such other protective methods as may be required and directed by the Engineer.

3.04 WEEPHOLES

Install Weepholes in head joints in exterior wythes of first course of masonry immediately above embedded flashing.

END OF SECTION

**SECTION 04230
REINFORCED UNIT MASONRY**

PART 1 GENERAL

1.01 SCOPE

The work covered by this Section consists of furnishing all labor, equipment, and materials required for the correct placement and construction of reinforced masonry units and related work as described herein and/or shown on the Drawings.

1.02 ADDITIONAL REQUIREMENTS

Requirements of Section 03200 of these Specifications apply to work of this Section.

1.03 SUBMITTALS

- A. Mill Certificates: Submit steel producer's certificates of mill analysis, tensile and bend tests for reinforcement steel required for the Project.
- B. Shop Drawings: Submit shop drawings for fabrication, bending and placement of reinforcement bars. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures". Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and assemblies as required for fabrication and placement of reinforcement for unit masonry work.

1.04 Product Delivery, Storage, and Handling

Store masonry units above ground on level platforms which allow air circulation under stacked units. Cover and protect against wetting prior to use. Handle units on pallets or flatbed barrows. Do not permit free discharge from conveyor units or transporting in mortar trays.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General: Refer to Section 04220 of these Specifications for masonry accessories not included in this Section.
- B. Reinforcement: Provide deformed bars of following grades complying with ASTM A 615, except as otherwise indicated.
- C. Shop fabricate reinforcement bars which are shown to be bent or hooked.

PART 3 EXECUTION

3.01 PLACING REINFORCEMENT

- A. Clean reinforcement of loose rust, mill scale, earth, ice or other materials which will reduce bond to mortar or grout. Do not use reinforcement bars with kinks or bends not shown on the Drawings or final shop drawings, or bars with reduced cross-section due to excessive rusting or other causes.
- B. Position reinforcement accurately at the spacing indicated. Support and secure vertical bars against displacement. Horizontal reinforcement may be placed as the masonry work progresses. Where vertical bars are shown in proximity, provide a clear distance between bars of not less than the nominal bar diameter or 1-inch, whichever is greater.
- C. Splice reinforcement bars where shown. Do not splice at other points unless acceptable to the Engineer. Provide lapped splices, unless otherwise indicated. In splicing vertical bars or attaching to dowels, lap ends, place in contact and wire tie. Provide not less than the minimum lap indicated, or if not indicated, as required by governing code.
- D. Anchoring: Anchor reinforced masonry work to supporting structure as indicated. Anchor reinforced masonry walls to non-reinforced masonry where they intersect.

3.02 Installation, General

- A. Refer to Section 04220 of these Specifications for general installation requirements of unit masonry.
- B. Temporary Formwork: Provide formwork and shores as required for temporary support of reinforced masonry elements.
- C. Construct formwork to conform to shape, line and dimensions shown. Make sufficiently tight to prevent leakage of mortar, grout, or concrete, if any. Brace, tie, and support as required to maintain position and shape during construction and curing of reinforced masonry.
- D. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and all other reasonable temporary loads that may be placed on them during construction. Allow not less than the following minimum time to elapse after completion of members before removing shores or forms, provided suitable curing conditions have been obtained during the curing period.
 - 1. Ten days for girders and beams.
 - 2. Seven days for slabs.
 - 3. Seven days for reinforced masonry soffits.

3.03 Installation of Reinforced Concrete Unit Masonry

A. General:

Do not wet concrete masonry units (CMU). Lay CMU units with full-face shell mortar beds. Fill vertical head joints (end joints between units) solidly with mortar from face of unit to a distance behind face equal to not less than the thickness of longitudinal face shells. Solidly bed cross-webs of starting courses in mortar. Maintain head and bed joint widths shown, or if not shown, provide 3/8-inch joints.

B. Walls:

1. Pattern Bond: Lay CMU wall units in running bond with vertical joints in each course centered on units in courses above and below, unless otherwise indicated. Bond and interlock each course at corners and intersections. Use special-shaped units where shown, and as required for corners, jambs, sash, control joints, lintels, bond beams and other special conditions.
2. Maintain vertical continuity of core or cell cavities, which are to be reinforced and grouted, to provide minimum clear dimension indicated and to provide minimum clearance and grout coverage for vertical reinforcement bars. Keep cavities free of mortar. Solidly bed webs in mortar where adjacent to reinforced cores or cells.
3. Where horizontal reinforced beams (bond beams) are shown, use special units or modify regular units to allow for placement of continuous horizontal reinforcement bars. Place small mesh expanded metal lath or wire screening in mortar joints under bond beam courses over cores or cells or cells of non-reinforced vertical cells, or provide units with solid bottoms.
4. Brace walls against wind and other forces during construction. Allow sufficient time between lifts to preclude displacement of solid masonry units or cracking of face shells of hollow masonry units. If blowouts, misalignment, or cracking of face shells should occur during construction, tear down and re-build the wall.

C. Grouting:

1. Use "Fine Grout" per ASTM C 476 for filling spaces less than 4-inches in one or both horizontal directions.
2. Use "Coarse Grout" per ASTM C 476 for filling 4-inch spaces or larger in both horizontal directions.
3. Grouting Technique: Use low-lift grouting techniques subject to requirements which follow:

- a. Provide minimum clear dimension of 2-inches and clear area of 8 square inches in vertical cores to be grouted.
- b. Place vertical reinforcement prior to laying of CMU. Extend above elevation of maximum pour height as required for splicing. Support in position at vertical intervals not exceeding 192 bars diameters nor 10 feet.
- c. Lay CMU to maximum pour height. Do not exceed five feet in height or if bond beam occurs below five feet height, stop pour at course below bond beam.
- d. Pour grout using chute or container with spout. Rod or vibrate grout during placing. Place grout continuously; do not interrupt pouring of grout for more than one hour. Terminate grout pours 1-1/2-inches below top course of pour.
- e. Bond Beams: Stop grout in vertical cells 1-1/2-inches below bond beam course. Place horizontal reinforcing in bond beams; lap at corners and intersections as shown. Place grout in bond beam course before filling vertical cores above bond beam.

END OF SECTION

**SECTION 05120
STRUCTURAL METALS**

PART 1 GENERAL

1.01 SCOPE

- A. This Section covers all items fabricated from metal shapes, plates, sheets, rods, bars, or castings and all other wrought or cast metal except component parts of equipment and items covered by other sections.
- B. Fabricated metal items, which are detailed on the Drawings but not mentioned specifically therein, shall be fabricated in accordance with the applicable requirements of this Section.
- C. Division 13 Section "Pre-Engineered Metal Buildings".

1.02 FACTORY TESTING

- A. Prior to delivery, all basic materials specified herein shall be tested and inspected by an approved independent commercial testing laboratory. Payment for such services will be made by the Contractor. If approved by the Engineer, certified tests performed by the manufacturer's testing laboratory at no cost to the Owner will be acceptable.
- B. If so desired by the Engineer, inspection of the fabrication shall be made at the place of manufacture. Access shall be permitted to all places where the work is being done.

1.03 SUBMITTALS

- A. Detailed shop drawings, product data sheets and erection and installation details for miscellaneous metal items shall be submitted in accordance with Section 01340 of these Specifications.
- B. All shop drawings shall be of the same size. Reproductions of the Drawings for use as shop drawings is not permitted. Submittals shall indicate thickness, type, grade, class of metal, dimensions and shall show construction details, reinforcement, anchorage, welds, fasteners, and installation with relation to other construction.
- C. Submittals shall be complete for each structure. Partial submittals are not permitted and will be returned unmarked. Each submittal shall clearly indicate the structure and Drawing numbers that the work is for. The identifying numbers of the shop drawings for each structure shall be in numerical order.
- D. All shop drawings shall be checked by the fabricator and Contractor before being submitted to the Engineer. The shop drawings shall bear clear indication that they have been reviewed and approved by the Contractor.
- E. Welding certificates.

1.04 STORAGE AND PROTECTION

- A. Store structural metals above ground on platforms or other supports and protect from weather with suitable covering. Do not permit water ponding or moisture collection on stored items.
- B. Handle steelwork to prevent damage to members and to shop paint coat and to prevent accumulation of mud, dirt, or other foreign materials capable of interfering with field paint application.

1.05 QUALITY ASSURANCE

- A. Structural steel manufacturers shall provide written certification to the Engineer that all materials furnished comply with all applicable requirements of these Specifications.
- B. Welding: Qualify procedures and personnel according to AWS Specifications for steel and aluminum welding.
- C. Steel: Comply with applicable provisions of the following Specifications and documents:
 - 1. AISC's "Code of Standard Practice for Steel Buildings and Bridges".
 - 2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2".
 - 3. AISC's "Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design".
 - 4. AISC's "Specification for the Design of Steel Hollow Structural Sections".
 - 5. AISC's "Specification for Allowable Stress Design of Single-Angle Members."
 - 6. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".

PART 2 PRODUCTS

2.01 MATERIALS AND CONSTRUCTION

- A. All materials shall be new and undamaged and shall conform to pertinent AISC, ANSI, ASTM, or other industry standards. Unless specified otherwise in other sections, all materials in fabricated metal items shall conform to the following requirements:
 - 1. Structural steel shapes shall conform to ASTM A992 Fy: 50 ksi.

2. Steel plates and bars shall conform to Specifications of Structural Steel ASTM A 36.
 3. Structural steel tubing shall conform to ASTM A 500 Grade B. Steel pipe ASTM A53, Type E or S, Grade B.
 4. Stainless steel shall conform to the following AISI Type 304 for sheets and plates; AISI Type 316 for bolts and stainless steel items in corrosive areas.
 5. Galvanizing shall be hot dipped in accordance with Specifications for Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plate, Bars and Strip ASTM A 123.
 6. Gray cast iron shall conform to ASTM A 48, Class 30B.
 7. Ductile iron shall conform to ASTM A 536, Grade 65-40-18.
 8. Aluminum alloy shall conform to the following Aluminum Association Specifications and designations:

6061-T6	Structural Shapes, Tubes and Pipes in Corrosive Areas, Sheets, Plates, Wire, Rods, Bars, Bolts and Screws
6063-T6	Tubes and Pipes in Non-Corrosive Areas
6066-T6	Weldings and Extrusions
6151-T6	Forgings and Forging Stock
 9. High strength steel bolts, nuts and washers shall conform to ASTM A 325.
 10. All embedded anchor bolts or anchor bolt materials shall be ASTM A 193, Grade B8; ASTM A 276, Type 304; or IFI-104, Grade 304 stainless steel, threaded per ANSI B1.1. Nuts shall be heavy hex nuts, ANSI B18.2, semi-finished pattern and shall be ASTM A 194, Grade 8 or IFI-104, Grade 304 stainless steel. Flat washers shall be 18-8 stainless steel and shall conform to ANSI B27.2.
 11. Electrodes for welding structural steel shall conform to "Specification for Mild-Steel Covered Arc-Welding Electrodes", AWS A5.1, E-70 series. Electrodes for welding aluminum shall conform to AWS A5.10.
- B. Stairs and Platforms: Stairs and platforms shall be fabricated from steel conforming to ASTM A 36 and shall be hot dipped galvanized after fabrication, unless noted otherwise. Stair and platform design, fabrication and installation shall conform to OSHA regulations.
- C. Checkered Floor Plates: Unless otherwise shown, checkered floor plates shall be 6061-T6 aluminum alloy with raised diamond pattern on the upper surface. Floor plate shall have a minimum thickness of 1/4-inch and shall be designed for a deflection of not more than 1/300 of span under a uniform load of 100 pounds per square foot. However, in no case shall the thickness of the floor plates be less than that shown on the Drawings for the specified clear span.

D. Welding and Brazing - General

1. All welds shall be sound and free from embedded scale and slag. All butt welds shall be continuous and where exposed to view shall be ground smooth. All continuous welds shall be gas and liquid-tight. Intermittent welds shall have an effective length of at least 2-inches and shall be spaced not more than 6-inches apart.
2. All welding of steel and aluminum, including materials, welding techniques, general safety practices, appearance and quality of welds and methods of correcting defective work, shall conform to the latest requirements of AWS Specifications. Structural steel welding shall conform to the requirements of the AWS Structural Welding Code. The general recommendations and requirements of the AWS Structural Welding Code shall also apply to welded aluminum structures. The welding process and welding operators shall meet qualification tests and welding performance tests in accordance with the latest provisions of ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications. Welding process and qualification procedures for welding of pipe shall conform to the latest requirements of ANSI B31.1, Section 327, Welding and Section 328, Brazing and Soldering. All costs associated with the qualification or testing of welders and welding operators shall be borne by the Contractor.
3. The Owner may inspect any weld by radiographic or other means. Welds not in accordance with the requirements specified herein shall be repaired or replaced at the Contractor's expense. Excessive porosity, non-metallic inclusions, lack of fusion, incomplete penetration and cracking shall constitute grounds for rejection of welds.

E. SHOP FABRICATION

1. Structural steel shall be fabricated in conformity with dimensions, arrangement, sizes and weights or thicknesses shown on the Drawings or stipulated in the Specifications.
2. All members and parts, as delivered and erected, shall be free of winds, warps, local deformations or unauthorized bends. Holes and other provisions for field connections shall be accurate and shop checked, so that proper fit will result when the units are assembled in the field.

F. GALVANIZING

1. All galvanizing shall be done by the hot-dip process, after fabrication in conformity with requirements of ASTM A 123, A 153, A 384 and A 385. Articles to be galvanized shall be pickled before galvanizing.
2. Areas of galvanizing damaged by welding or burning or otherwise damaged shall be thoroughly stripped and cleaned and recoated with zinc to the required thickness by the hot-dip process.

3. Galvanized articles shall be free from uncoated spots, blisters, flux, black spots, dross, projections and other defects not consistent with acceptable galvanizing practice.
4. Zinc and cadmium plating shall be subject to visual examination to determine uniformity of coating. The Engineer may require that the coating uniformity be tested in accordance with ASTM A 239.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Structural Aluminum
 1. General Except as specifically noted on the Drawings, or specified herein, all materials and work for structural aluminum shall conform with the applicable provisions of the latest edition of "Specifications for Aluminum Structures", published by the Aluminum Association, Inc., New York, New York.
 2. Lay Out: Hole centers may be center punched and cutoff lines may be punched or scribed. Center punching and scribing shall not be used where such marks would remain on fabricated material. A temperature correction shall be applied where necessary in the layout of critical dimensions. The coefficient of expansion shall be taken as 0.000013 per degree F.
 3. Cutting: Material 1/2-inch thick or less shall be sheared, sawed, or cut with a router. Material more than 1/2-inch thick shall be sawed or routed. Cut edges shall be true and smooth, and free from excessive burrs or ragged breaks. Edges or plates carrying calculated stresses shall be planed to a depth of 1/4-inch, except in the case of sawed or routed edges of a quality equivalent to a planed edge. Re-entrant cuts shall be avoided wherever possible. If used, they shall be filleted by drilling prior to cutting. Flame cutting of aluminum alloys is not permitted.
 4. Heating: Structural material shall not be heated except as provided herein. Material may be heated to a temperature not exceeding 400 degrees F for a period not exceeding 30 minutes to facilitate bending. Such heating shall be done only when proper temperature controls and supervision are provided to ensure that the limitations on temperature and time are carefully observed. The Engineer shall be so informed if this method is to be used.

5. Punching, Drilling and Reaming: Rivet or bolt holes may be punched or drilled to finished size before assembly. The finished diameter of holes for unfurnished bolts shall be not more than 1/6-inch larger than the nominal bolt diameter. All holes shall be cylindrical and perpendicular to the principal surface. Holes shall not be drifted in such a manner as to distort the metal. All chips lodged between contacting surfaces shall be removed before assembly.
6. Bolting: All bolts for bolting aluminum shall be Type 304 or 316 stainless steel as specified herein.
7. Welding:
 - a. Dirt, grease, forming or machining lubricants or any organic materials shall be removed from the areas to be welded by cleaning with a suitable solvent or by vapor degreasing. Additional operations to remove the oxide coating just prior to welding are required when the inert gas tungsten arc welding method is used. This may be done by etching or scratch brushing. The oxide coating need not be removed if the welding is done with the automatic or semi-automatic inert gas shielding metal arc. Suitable edge preparation to assure 100 percent penetration in butt welds shall be used. Oxygen cutting shall not be used. Sawing, chipping, machining or shearing may be used.
 - b. Any welding of aluminum shall be done using a non-consumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG). No welding process that requires the use of a welding flux shall be used unless prior approval has been obtained from the Engineer. Preheating for welding is permissible provided the temperature does not exceed 400 degrees F for a total time of 30 minutes. Welding of any structure which is to be anodized shall be done using filler alloy rods which will not discolor when anodized.
 - c. The welding process and welding operators shall both meet a qualification test conforming to the qualification methods described in the ASME Boiler and Pressure Vessel Code, Section IX, Welding Qualifications.

3.02 PREPARATION

Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

3.03 ERECTION

A. Structural Steel

1. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design."
2. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 - a. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 - b. Weld plate washers to top of base plate.
 - c. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
 - d. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces: protect grout and allow to cure.
3. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges".
4. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - a. Level and plumb individual members of structure.
 - b. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
5. Splice members only where indicated.
6. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
7. Do not use thermal cutting during erection.
8. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

B. Connections

1. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - a. Joint Type: Snug tightened.
2. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 - a. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design" for bearing, adequacy of temporary connections, alignment, and removal of paint or surfaces adjacent to field welds.
 - b. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - c. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.04 PAINTING

- A. Aluminum surfaces to be placed in contact with wood, concrete, or masonry construction shall be coated with bitumastic coating.
- B. Where aluminum surfaces come in contact with dissimilar metals, except stainless steel, the aluminum surfaces shall be kept from direct contact with said metal by the use of neoprene gaskets, 10 mil polyethylene film or insulating washers. Paint or galvanizing will not be considered as adequate protection.
- C. Unpainted aluminum surfaces shall be cleaned of all fabrication marking, grease, dirt, and oil. Anodized surfaces shall be cleaned with a mild soap and water solution and no acid, caustic or abrasive cleaning agents shall be used.
- D. Structural and miscellaneous metals shall be cleaned, shop primed and painted in accordance with the requirements of Section 09900 of these Specifications.

3.05 INSPECTION AND TESTING

- A. Testing Agency: Contractor will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.
- B. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.
- C. Bolted Connections: Bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts".
 1. For bolts indicated as "snug tight", inspect to verify that connected elements are in direct contact.
- D. Welded Connections:
 1. Field welds that fail visual inspection will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.06 CLEANING

- A. Prior to the acceptance of the work under this Section, thoroughly clean all installed materials, equipment, and related areas in accordance with the requirements of Section 01710 of these Specifications.
- B. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- C. Touchup Painting Structural Steel: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP3 power-tool cleaning.
 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

END OF SECTION

**SECTION 05400
COLD-FORMED STEEL STRUCTURAL FRAMING**

PART 1 GENERAL

1.01 SCOPE

Furnish and install the cold formed steel structural framing as shown and noted on the Drawings and as specified in this Section, complete.

1.02 REFERENCED PUBLICATIONS

A. The publications listed below form a part of these Specifications.

1. American Iron and Steel Institute (AISI)

Specification for Design of Cold-Formed Steel Structural Members – 2007
Edition with Supplement No. 1.

1.03 DESIGN REQUIREMENTS

- A. Where shown on the Drawings, framing shall be fabricated from cold formed steel structural members (CFSSM), galvanized, minimum 18 GA.
- B. CFSSM framing shall have out to out dimensions as shown and noted on the Drawings. Unless noted otherwise, intermediate members shown on the Drawings are pictorial only and are not intended to size or locate such members.
- C. Design loads: All dead load carried by CFSSM. All live loads as required by the International Building Code 2012 and all design conditions for erection of steel structures, as required by OSHA.
- D. Design shall be based on elastic behavior.
- E. Roof live loads shall not be reduced to any member.
- F. Equipment Load: Design each truss for 500# equipment load at any location along truss bottom chord.

1.04 SUBMITTALS

- A. Provide for the design of the CFSSM by a structural engineer registered in the State of Georgia, who shall also seal and sign the submittals noted below.
- B. Design Certification: Submit to the Engineer certification that the design of the CFSSM for this work is accomplished by the responsible registered structural engineer whose name, seal and signature appears on the certification.
- C. Diagrams showing all the load conditions required by the building code noted on the Drawings and all other loads shown, indicated or noted on the Drawings.

These diagrams shall also show all the reactions to the load conditions. The seal and signature of the responsible registered structural engineer shall be applied on these diagram sheets. These diagrams shall be separate from the calculations required for the analysis and design of the structure. Calculations are not required to be submitted to, or reviewed by, the Engineer.

- D. A complete set of erection and detail shop drawings, including, but not limited to, anchor bolt sizes and layout, all framing, all openings for vents and louvers. The submittal shall be made in one complete package. The seal and signature of the responsible registered structural engineer shall be applied to these drawings.
- E. Certificates of Compliance: Attesting that all materials comply with the requirements of these Specifications.
- F. The Engineer will review, comment, and return to the Contractor the required number of marked copies of all items under paragraphs B, C, D, and E. For paragraph D., the Engineer will not comment on erection procedures and does not require their submittal. The Engineer's review and comments for paragraph D. will be for layout and clearances only and will not relieve the Contractor of the responsibility of providing a design and product that meets all the requirements of these Specifications.
- G. Products for use on this work shall not be fabricated until all the required submittals have been made, reviewed by, and stamped by the Engineer with the notation "NO EXCEPTIONS TAKEN".

1.05 DELIVERY AND STORAGE

Deliver, store, and handle all building components so that they remain dry and undamaged.

PART 2 PRODUCTS

2.01 FABRICATION

The truss framing shall be shop fabricated and test assembled before shipment to the job site.

2.02 MATERIALS AND CONSTRUCTION

- A. All materials shall be completely fabricated and prepared for shipment, including any necessary crating or handling provisions. All parts of the framing are to be accurately made so that in erection all parts will easily fit together. All cutting, punching, and forming shall be performed at the shop. All shop connections shall be bolted. All parts shall be marked and referenced on erection drawings and instructions.
- B. Connections
 - 1. All field connections shall be bolted.
 - 2. Type and location of anchors shall be included in the Submittal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The added roof framing shall be constructed by a steel erector regularly engaged in the construction of CFSSM. Construct the CFSSM in accordance with the shop/erection drawings and the printed instructions.
- B. Keep primary members plumb and stayed in both directions and maintain a safe work place as required by all applicable codes, standards and all applicable OSHA regulations.
- C. If defects or errors in fabrication or erection of any building component cannot be corrected in a manner acceptable to the Engineer, remove and provide non-defective components.
- D. Field modifications shall not be made unless they are acceptable to the Engineer.

3.02 INSPECTION AND TESTING

- A. Provide for inspection of the work by the responsible registered structural engineer and a certification by him, or her, that the framing has been installed according to his/her Drawings and Specifications. As an alternate, the special inspector for the project shall provide such documentation.
- B. Provide suitable access to the work for inspection by the Engineer or a testing laboratory of the Engineer's choosing.

END OF SECTION

**SECTION 05500
MISCELLANEOUS METALS**

PART 1 GENERAL

1.01 SCOPE

The work under this Section includes, but is not necessarily limited to, the furnishing and installation of all miscellaneous metals and related items as indicated on the Drawings, herein specified and as necessary for the proper and complete performance of this work.

1.02 SUBMITTALS

- A. Make all submittals in accordance with Section 01340 of these Specifications.
- B. Shop Drawings
 - 1. Submit shop drawings of all items to be furnished.
 - 2. Shop drawings for steel members shall be as specified in Section 05120 of these Specifications.
 - 3. Submit plan locating embedded connections in masonry and cast-in-place concrete for precast tees. (Precast supplier shall furnish locations unless noted otherwise on the Drawings).

1.03 DIVISION OF WORK

- A. General: The following list of items to be furnished under this Section is placed here to aid the various trades in estimating their portion of the Work. It is not a full and complete list and does not relieve the Contractor from providing a totally complete Project including all miscellaneous items.
- B. Miscellaneous Metal Items
 - 1. Loose angle and wide flange lintels.
 - 2. Stairs and landings including posts, bearing plates, and integral support beams.
 - 3. Beams, angles and other supporting grating over pipe trenches including embedded connections.
 - 4. Embedded connections and plates in masonry and cast-in-place concrete for precast plank and tees.
 - 5. Bumper posts and sleeves.
 - 6. Bearing plates for other items specified herein.

7. Railings.
8. Edge angles cast-in-concrete.

1.04 QUALITY ASSURANCE

- A. Qualifications: For fabrication and erection of the work of this Section, use only personnel completely trained and experienced in the type of work being performed and thoroughly familiar with the original design and the approved shop drawings.
- B. Codes and Standards: In addition to complying with all pertinent codes and regulations, comply with applicable standards for materials design and construction of the following:
 1. American Society for Testing Materials
 2. American Institute of Steel Construction
 3. American Iron and Steel Institutes "Specifications for the Design of Light Gage Cold Formed Steel Structural Members"
 4. Occupational Safety and Health Act
 5. American Welding Society
 6. National Association of Architectural Metal Manufacturers
- C. Conflicting Requirements: In the event of conflict between pertinent codes and regulations and the requirements of the referenced standards or these Specifications, the provisions of the more stringent shall govern.

PART 2 PRODUCTS

2.01 MATERIALS

- A. General: Materials shall be new, top quality of their respective kinds, standard sizes and fabricated in a shop whose principal business is manufacturing the items specified in this Section. Materials shall be free of defect impairing strength, durability, or appearance. Miscellaneous anchors, plates, clips, bolts, nuts, and the like shall be provided as necessary to complete the work, whether or not they appear on the Drawings or in the Specifications.
- B. Steel shall conform to ASTM A 36.
- C. Cast iron shall be soft, gray iron, true to pattern, smooth and straight, free from defects impairing strength, durability, or appearance.
- D. Malleable iron shall be high grade white iron castings, fulling annealed and of uniform ductile structure throughout.

- E. Use genuine wrought iron conforming to ASTM A 41 for bolts, rods, and bars; ASTM A 42 for plates, and ASTM A 162 for sheets.
- F. Aluminum alloys shall be of uniform quality and free from injurious defects and meet the properties and applicable specifications of the Aluminum Company of America.
- G. Stair Treads: Provide safety treads on all interior and exterior stairs and landings.
 - 1. Acceptable Manufacturers
 - a. Specified Manufacturer: Wooster Products, Inc.
 - b. Acceptable Manufacturers: American Safety Tread Company, Inc., or American Abrasive Metals Company.
 - 2. General
 - a. Treads shall have extruded aluminum arrow base, heat treated for increased strength.
 - b. Treads shall be anchored into concrete by strap anchors double riveted to the aluminum base or by a continuous "arrow" anchor extruded as an integral part of the tread base. Strap anchors shall be located at the end of each section of tread and on maximum 12-inch centers between.
 - c. Treads shall have heavy duty factory applied protective tape applied to all finished surfaces.
 - 3. Treads at Concrete Landings at the Top of Metal Stairs
 - a. Treads shall have a 1 x 1-inch nosing, be 6-inches wide, and the top of the tread shall align even with the top of the landing.
 - b. Treads shall be Type 104.
 - 4. Treads at all Other Concrete Landings and Concrete Stairs
 - a. Treads shall be 1/4-inch thick, 6-inches wide and shall incorporate nosing 1/4-inch underside.
 - b. Dovetail slots 3/16-inch deep shall be filled with a black abrasive consisting of a blend of aluminum oxide and carborundum.
 - c. Treads shall be Type 161.
 - 5. Coat all aluminum surfaces to be cast into concrete with a bitumastic coating. Set treads level, straight and flush with finished floor surface. Extend treads to within 3-inches of each end of stair tread. Miter all

corners where nosing turns. Do not remove protective tape until all construction and cleanup is complete.

Miscellaneous Metals

- H. Manhole Steps: Steps shall be fabricated of plastic. Steps shall be 10-inches deep x 10-inches wide, 5-inch tread depths, 1 x 1-inch tread section with 2-inch rail height, and shall be reinforced with 3/8-inch steel rods.
- I. Interior Trench Grating: Trench grating shall be light-duty grating equal to Neenah R-4468. Angle frame with integral cast anchor lugs shall be equal to Neenah R-4899.
- J. Exterior Trench Grating: Grating shall be heavy-duty grating equal to Neenah R-4525 F. Angle frame with integral cast anchor lugs shall be equal to Neenah R-4899.
- K. Bird screen shall be No. 2 mesh, brass or copper wire cloth, minimum wire diameter 0.063-inch.
- L. All other materials not specifically described but required for a complete and proper installation of the work of this Section, shall be new, first quality of their respective kinds and as selected by the Contractor subject to approval of the Engineer.

2.02 FABRICATION

- A. General
 - 1. Workmanship: Install items square and level, accurately fitted and free from distortion and defects.
 - 2. Temporary Bracing: Make provision for erection stresses by temporary bracing; keep work in alignment.
 - 3. Welding: Welding shall be continuous along entire area of contact. Welding shall be in accordance with "Code for Welding in Building Construction" of the American Welding Society. Grind exposed welds smooth and flush with adjacent finished surfaces.
 - 4. Painting: Prime paint metal fabrications in accordance with Section 09900 of these Specifications.
 - 5. Items fabricated from structural steel members which are to be architecturally exposed shall be given special attention for material selection with respect to rolling tolerances, surface finish and straightness.
 - 6. Normal structural steel fabrication tolerances will not be acceptable where in conflict with the intent and requirements of this Section.

7. Straightness tolerance, additive to deflection, shall not exceed +1/16-inch to 10 feet.
8. All cope, mitre, and butt caps on exposed surfaces shall be made to the closest possible tolerances consistent with metal shop equipment and practice in order to provide a pleasing appearance.
9. Galvanizing: Items specified to be hot-dip galvanized shall be coated after fabrication.
10. Fastenings shall be concealed where practicable. Thickness or metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water. Provide holes and connections for the work of other trades.

B. Aluminum Stairs

1. Unless noted otherwise, all stairs shall be of the grating type. The top surfaces of all bearing bars shall be striated to provide a non-slip surface and the leading edges of all treads and landings shall receive a 1-inch abrasive aluminum nosing. Components shall be of aluminum alloy 6063-T6 or 6063-T5.
2. Design and fabrication shall be provided by the supplier in accordance with the Drawings. Minimum design live load is 100 pounds per square foot and a concentrated live load of 300 pounds per square foot. Recommended standards of NAAMM and AISC shall be followed. Refer to the Drawings for stairs and landings receiving brick or tile pavers.

C. Aluminum Ladder: Meet OSHA requirements.

PART 3 EXECUTION

3.01 GENERAL

- A. Workmanship: Install items square and level, accurately fitted and free from distortion and defects.
- B. Coordination: Supply to appropriate trades, items requiring to be cast into concrete, embedded in masonry, complete with necessary setting templates.
- C. Touch-Up: After installation, touch-up field welds and scratched and damaged surfaces.
- D. Protection: Where required, provide approved protection against galvanic action between contacts of dissimilar metals or situations that will cause deterioration of metals in contact or associated in any way.

3.02 PAINTING

Painting shall be in accordance with Section 09900 of these Specifications.

3.03 CLEANING

Prior to acceptance of the work of this Section, thoroughly clean all installed materials and related areas in accordance with Section 01710 of these Specifications.

END OF SECTION

SECTION 05501 ANCHOR BOLTS

PART 1 GENERAL

1.01 SCOPE

- A. Adhesive anchor bolts shall be provided for mechanical equipment where indicated on the Drawings or as required by equipment manufacturer's anchor bolt setting plan.
- B. Expansion bolts shall be provided where indicated on the Drawings and as required to attach anchor ladders, handrails, stairs, ship's ladders, and structural steel shapes to hardened concrete or masonry.
- C. Embedded anchor bolts shall be provided where indicated on the Drawings or in the Specifications or where recommended by equipment manufacturers.

1.02 MATERIAL STORAGE

All material shall be stored in manner which will protect it from deterioration and damage.

PART 2 PRODUCTS

2.01 ADHESIVE ANCHOR BOLTS

- A. Adhesive anchor bolts shall consist of a stainless steel threaded rod meeting the requirements of ASTM F 593 (AISI 304). Installation shall be in conformance with the manufacturer's instructions and under the supervision of a manufacturer's field representative for maximum pullout and shear strength.
- B. All nuts shall be of stainless steel meeting requirements of ASTM F 594 Alloy Group I, Condition CW.
- C. All washers shall meet dimensional requirements of ASTM F 436. Material for washers shall be stainless steel, Type 304, 305, 384 or MX7.
- D. Adhesive anchor bolts shall be Epcon System Ceramic 6 Epoxy Adhesive by ITW Ramset/Red Head or HIT HY 150 Injection Adhesive by Hilti Fastening Systems.

2.02 EXPANSION ANCHOR BOLTS

- A. Expansion anchor bolts shall be stainless steel, AISI Type 304 or 316 and shall be of the wedge or self-drilling type. Expansion anchors shall conform to the applicable requirements of Federal Specifications FF-S-325. Installation methods shall be in conformance with the manufacturer's recommendations for maximum pullout and shear strength, but in no case shall the depth of the hole be less than five bolt diameters. The minimum distance between the center of

the expansion anchor and an edge or exterior corner shall not be less than 6 times the diameter of the hole in which it is installed.

- B. All nuts shall be of stainless-steel meeting requirements of ASTM F 594 Alloy Group I, Condition CW.
- C. All washers shall meet dimensional requirements of ASTM F 436. Material for washers shall be stainless steel, Type 304, 305, 384 or MX7.
- D. Expansion anchors shall be "Trubolt" by ITW Ramset/Red Head, or "KWIKBOLT II" by Hilti Fastening Systems.

2.03 EMBEDDED ANCHOR BOLTS

- A. Embedded anchor bolts, except those used for equipment anchoring, shall be carbon steel unless stainless steel is required on the Drawings or Specifications. Embedded anchor bolts used for anchoring equipment shall be stainless steel.
- B. Carbon steel anchor bolts shall meet the requirements of ASTM A 307 or ASTM A 193, Grade B8. Bolts shall be threaded per ANSI B1.1.
- C. Stainless steel anchor bolts shall meet the requirements of ASTM A 276, Type 304.
- D. All nuts shall be heavy hex nuts, ANSI B18.2, semi-finished pattern. Nuts for carbon steel bolts shall meet the requirements of ASTM A 194, Grade 8. Nuts for stainless steel bolts shall meet the requirements of ASTM A 276, Type 304.
- E. All washers shall conform to ANSI B27.2 and shall be 18-8 stainless steel.

PART 3 EXECUTION

3.01 ADHESIVE ANCHOR BOLT INSTALLATION

- A. Drilled Holes: Holes for adhesive anchors shall be drilled with a rotary percussion hammer drill with a carbide tipped masonry drill bit conforming to ANSI B94.12-77. Hole diameter and depth shall be as specified by the manufacturer.
- B. Hole Cleaning and Preparation: After drilling, dust and fragments shall be cleared out using a water jet, circular wire brush and compressed air. The hole may be damp but all water must be blown out.
- C. Curing: Anchor shall be unloaded and allowed to cure for manufacturer's recommended curing time.

3.02 EXPANSION BOLT INSTALLATION

- A. Drill expansion bolt holes into concrete through item being supported or locate by a template. Drill all holes by a tool designed by or approved by manufacturer of expansion anchors.

- B. Installation of expansion anchors shall be in compliance with manufacturer's recommendations for maximum holding power, but in no case shall depth of hole be less than four bolt diameters. Minimum distance between center of any expansion anchor and an edge or exterior corner of concrete shall be not less than 4-1/2 times diameter of hole in which it is installed.

3.03 EMBEDDED ANCHOR BOLT INSTALLATION

Anchor bolts shall be properly located and built into connecting work. Bolts shall be preset by the use of templates or such other methods as may be required to locate the anchor bolts accurately. All base plate anchor bolt nuts shall be turned down tight.

END OF SECTION

SECTION 05511 METAL STAIRS

PART 1- GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Preassembled steel stairs with concrete-filled treads.
 - 2. Handrails and railings attached to metal stairs.
 - 3. Handrails attached to walls adjacent to metal stairs.
- B. Related Sections include the following:
 - 1. Division 3 Section "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.

1.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal stairs capable of withstanding the following structural loads without exceeding the allowance design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each component of metal stairs.
 - 1. Treads and Platforms of Metal Stairs: Capable of withstanding a uniform load of 100 lbf/sq. ft. or a concentrated load of 300 lbf on an area of 4 sq. in., whichever produces the greater stress.
 - 2. Stair Framing: Capable of withstanding stresses resulting from loads specified above in addition to stresses resulting from railing system loads.
 - 3. Limit deflection of treads, platforms, and framing members to $L/360$ or $1/4$ inch, whichever is less.
 - 4. Handrails and Railings: Railings shall be capable of resisting a force of 50 lbf applied in any direction at the top and to transfer this load safely to the supports of the structure. Handrail assemblies shall also be capable of resisting a single concentrated load of 200 lbs. applied in any direction at any point along the top and to safely transfer this load to the supports of the structure. Intermediate railings shall be designed to withstand a horizontally applied normal load of 50 lb. On an area not to exceed 1 foot square.

1.03 SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details for metal stairs. Include plans, elevations, sections, and details of metal stairs and their connections.

Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.

1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Arrange for metal stairs specified in this Section to be fabricated and installed by the same firm.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of metal stairs (including handrails and railing systems) that are similar to those indicated for this Project in material, design, and extent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

1.05 COORDINATION

Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2- PRODUCTS

2.01 FERROUS METALS

- A. Metal Surfaces, General: Provide metal free from pitting, seam marks, roller marks, and other imperfections where exposed to view on finished units. Do not use steel sheet with variations in flatness exceeding those permitted by referenced standards for stretcher-leveled sheet.
- B. Steel Plates, Shapes, and Bars: ASTM A 36.
- C. Steel Tubing: Cold-formed steel tubing complying with ASTM A 500.
- D. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
- E. Rolled-Steel Floor Plate: ASTM A 786, rolled from plate complying with ASTM A 36 or ASTM A 283, Grade C or D.

- F. Uncoated, Hot-Rolled Steel Sheet: Commercial quality, complying with ASTM A 569; or structural quality, complying with ASTM A 570, Grade 30, unless another grade is required by design loads.
- G. Welding Rods and Bare Electrodes: Select according to AWS specifications using E70 xx, low-hydrogen electrodes.

2.02 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Machine Screws: ASME B18.6.3.
- D. Lag Bolts: ASME B18.2.1.
- E. Plain Washers: Round, carbon steel, ASME B18.22.1.
- F. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.03 PAINT

- A. Shop Primers: Provide primers that comply with Division 9 Section "Painting."
- B. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

2.04 GROUT

Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.05 CONCRETE FILL AND REINFORCING MATERIALS

- A. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of 3000 psi.
- B. Deformed Reinforcing Steel: ASTM A 615, Grade 60. Coordinate with Section 03300, "Cast-In-Place Concrete".

2.06 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, handrails, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
- B. Provide complete stair assemblies, including metal framing, hangers, struts, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by welding, unless otherwise indicated.
 - 2. Use connections that maintain structural value of joined pieces.
- C. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual", for class of stair designated, unless more stringent requirements are indicated.
 - 1. Service class, unless otherwise indicated.
- D. Shop Assembly: Preassemble stairs in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- E. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Shear and punch metals cleanly and accurately. Remove sharp or rough areas on exposed surfaces.
- F. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- G. Weld connections to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.

4. Weld exposed corners and seams continuously, unless otherwise indicated.
 5. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- H. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- I. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.07 STEEL-FRAMED STAIRS

- A. Stair Framing: Fabricate stringers of structural-steel channels, plates, or a combination of both, as indicated. Provide closures for exposed ends of stringers. Construct platforms of structural-steel channel headers and miscellaneous framing members as indicated. Bolt or weld headers to stringers; bolt or weld framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
- B. Metal Risers, Subtread Pans and Subplatforms: Form to configurations shown from steel sheet of thickness necessary to support indicated loads, but not less than 0.0677 inch.
1. Steel Sheet: Uncoated hot-rolled steel sheet, unless otherwise indicated.
 2. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
 3. Shape metal pans to include nosing integral with riser.
 4. At Contractor's option, provide stair assemblies with metal-pan subtreads filled with reinforced concrete during fabrication.
 5. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.

2.08 STEEL TUBE HANDRAILS AND RAILINGS

- A. General: Fabricate handrails and railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.
- B. Interconnect members by butt-welding or welding with internal connectors, at fabricator's option, unless otherwise indicated.

1. At tee and cross intersections, cope ends of intersecting members to fit contour of tube to which end is joined, and weld all around.
- C. Form changes in direction of handrails and rails as follows:
 1. By flush-radius bends.
- D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- E. Close exposed ends of handrail and railing members with prefabricated end fittings.
- F. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch or less.
- G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting railings and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
 1. Connect railing posts to stair framing by direct welding, unless otherwise indicated.
- H. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.
- I. For nongalvanized handrails and railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

2.09 FINISHES

- A. Comply with NAAMM'S "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal stairs after assembly.
- C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed products:

1. Interiors (SSPC Zone 1A): SSPC SP 3, "Power Tool Cleaning."
- D. Apply shop primer to prepared surfaces of metal stair components, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

PART 3- EXECUTION

3.01 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- E. Field Welding: Comply with the following requirements:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

3.02 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.
- B. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or

shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonmetallic, nonshrink grout, unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.03 INSTALLING STEEL TUBE RAILINGS AND HANDRAILS

- A. Adjust handrails and railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:
 1. Anchor posts to steel by welding directly to steel supporting members.
- B. Attach handrails to wall with wall brackets. Provide bracket with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as follows:
 1. Use type of bracket with predrilled hole for exposed bolt anchorage.

3.04 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

END OF SECTION

SECTION 05524
COMPONENT ALUMINUM HANDRAIL AND LADDERS

PART 1- GENERAL

1.01 SCOPE

- A. The work covered by this Section includes furnishing all labor, equipment and materials required to furnish and install component aluminum handrail and ladders, including all fittings, anchors, sleeves, and accessories, as shown on the Drawings, and specified herein.
- B. Unless specifically designated on the Drawings, all handrails and ladders shall be a component system meeting the requirements of this section of the Specifications.
- C. Handrails and ladders shall be furnished and installed where shown on the Drawings.
- D. Handrails shall be furnished with a toe board, except on the railings for stairs or where concrete curbs a minimum of 4-inches high are provided.

1.02 DESIGN REQUIREMENTS

- A. Component aluminum handrail and ladder system, including railings, posts, rungs, and gates, shall be designed, and constructed in strict compliance with the requirements of OSHA, the International Building Code and ANSI.
- B. Component aluminum handrail system shall also be designed:
 - 1. To withstand the working loads below with a minimum factor of safety of 1.5 based on the ultimate strength of the alloy used.
 - 2. For a minimum safe working load of both of the following loads:
 - a. 50 pounds per linear foot applied horizontally to the top rail and a vertical load of 100 pounds per foot applied simultaneously.
 - b. A 200 pound concentrated load applied in any direction at any point on the railing.
- C. Component ladder system shall also be designed as follows:
 - 1. Ladder rungs shall be designed to withstand a concentrated load of 250 pounds plus 30 percent impact. Maximum rung deflection shall not exceed L/360. The design load shall be applied at the center of the rung on a 4-inch-wide area.

2. Ladder side rails shall be designed to withstand a minimum live load of two 250-pound loads plus 30 percent impact concentrated between any two consecutive attachments.
- D. Splice joints shall be designed and constructed to provide strength equivalent to a straight section of pipe.

1.03 SUBMITTALS

- A. Submit complete shop drawings and product data in accordance with the requirements of Section 01340 of these Specifications.
- B. Submit, in accordance with the requirements of Section 01730 of these Specifications, manufacturer's recommendations and procedures for maintaining and repairing handrail, including methods, cleaning materials, refinishing materials and precautions as to the use of materials which may be detrimental to handrail finish.
- C. Submit certifications as required in Article 1.05 below.

1.04 STORAGE AND PROTECTION

- A. Keep handling to a minimum and maintain protective covering on handrail until the work is complete. The Contractor shall take care in handling the rails during shipment, unloading, erection, and during construction to prevent damage to the railing.
- B. Railing and post components shall be individually wrapped in paper or plastic film sleeves to protect the finish during shipment and installation and shall not be covered with any protective paper or other covering which can adhere to, or damage, the components.

1.05 QUALITY ASSURANCE

- A. The Contractor shall provide the Engineer with written certification that the aluminum handrail, ladders, and accessories are designed and manufactured in conformance with the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the aluminum handrail and ladder supplier may be considered evidence of compliance, provided such tests are performed in accordance with the appropriate ASTM testing standards by experienced, competent personnel. Tests for ladders shall show that design loads have been applied and released a minimum of 200,000 times to demonstrate fatigue resistance and a safe extended service life. Deflection shall be checked periodically and shall not exceed $L/360$ at any time under full design load. At completion of testing, the rung and attachments to the side rail shall be inspected for cracks, looseness, distortion, bending (permanent set) or other obvious damage. In case of doubt as to the accuracy or adequacy of mill tests, the Engineer may require that the Contractor furnish test reports from an independent testing laboratory on certified sample of handrail stock.

- B. Furnish a manufacturer's inspection certificate stating that the handrail and ladder system as installed meets the requirements of these Specifications and the Manufacturer's written instructions. Contractor shall correct all inadequacies found during the inspection process.

PART 2- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Component aluminum handrail and ladder system shall be "Tuf Rail" as manufactured by Thompson Fabricating Company of Birmingham, Alabama, or "AlumaRail" as manufactured by Alumagard of Denver, Colorado, "Interna-Rail" as manufactured by Hollaender Manufacturing Co. of Cincinnati, Ohio and "Wes Rail II" as manufactured by Moultrie Manufacturing Company of Moultrie, Georgia.

2.02 MATERIALS AND CONSTRUCTION

- A. Railing: Handrail railing and ladder side rails shall be an extruded tube manufactured from an aluminum alloy in accordance with ASTM B 221, Alloy 6105, Temper T5 or Alloy 6063, Temper T6. Railing shall have a minimum outside diameter of 1.90- inches. Railings shall have a minimum wall thickness of 0.145-inch.
- B. Handrail Posts
 - 1. Posts shall be an extruded tube manufactured from an aluminum alloy in accordance with ASTM B 221, Alloy 6105, Temper T5. Posts shall have a minimum outside diameter of 1.90-inches. Posts shall have a minimum wall thickness of 0.20-inch.
 - 2. The posts shall have an internal reinforcing dowel to assist in the transfer of the loadings from the post to the base. The dowel length shall extend 12-inches (or longer if required by the manufacturer to meet criteria) above the walking surface and recessed 1/4-inch from bottom of post and shall be tack welded in two locations to secure dowel in the post.
- C. Ladder Rungs: Rungs shall be designed to provide a non-slip power grip surface with a flat 1-inch wide serrated top surface and a semi-circular bottom. The straight sides and semicircular bottom shall have striations at approximately 5/16-inch centers for gripping surface. The rung shall be an aluminum extrusion, Alloy 6063-T6, of sufficient section modulus and moment of inertia to withstand the design loads. Finish shall be mill finish.
- D. Adhesive Anchor Bolts: Adhesive anchor bolts shall be designed with a safety factor of 4 on ultimate withdrawal and shear in 4,000 psi concrete. Adhesive bolts shall be spaced a minimum of 10d apart with 5d minimum edge distance without reduction of withdrawal and shear values used in calculations. Adhesive bolts shall be stainless steel.

- E. Fasteners: Handrail and ladder system shall be assembled using components that make rigid joints. Railing joints shall be assembled using stainless steel set screws. Other joints shall be assembled using stainless steel fasteners. No pop riveted, glued systems, or welded railing will be allowed.
- F. Anodizing: Unless noted otherwise, all railing and posts, and their components, shall be clear anodized on all exposed surfaces conforming to AAM12C22A41 (Class I), 0.7 mil.
- G. Brackets and Bases
 - 1. Side mount brackets shall be non-welded extrusions attached to posts with stainless steel set screws.
 - 2. Top mounted bases shall be al-mag castings, anodized. Castings shall be permanent mold or die cast. If bases are sand castings or machined, they shall be finished smooth prior to anodizing to approximate the finish of permanent molds or diecast satisfactory to the Engineer. Castings shall be attached to the post with stainless steel set screws and pressure plate. Cast bases shall slip over the outside of the pipe post so that the pipe and integral internal dowel may function together in transferring the load to the base flange. Aluminum bases of welded construction are not acceptable.
- H. Handrail system shall provide for draining of entrapped water from the railing systems by minimum 15/64-inch diameter weep holes or other approved means.
- I. Toeboards: Toeboards shall be of the same material and finish as the rails and posts. Toeboards shall be extruded design that clamp to the post to allow expansion and contraction. Toeboards shall have a minimum height of 4-inches.
- J. Gates: Gates shall be of the same material and finish as the rails and posts. Gates shall be equipped with a spring to assist in closing.
- K. Fall Prevention: Where the floor-to-floor vertical distance exceeds eight feet, provide a fall prevention system as follows:
 - 1. Manufacturer: 'SAF-T-CLIMB" fall Prevention System as manufactured by North Safety Products, Brea, California, (800) 421-3841.
 - 2. Construction: System components shall be made of 6061-T6 aluminum alloy with a mill finish.
 - 3. SAF-T-PIVOT Dismount Section: At the top of all ladders which do not terminate at a floor door or roof scuttle, such as one at a mezzanine or tank, install an 8-foot long SAF-T-PIVOT dismount section. The top of the dismount section shall be 4 ½-feet above the floor at the top of the ladder and shall have a removable stainless-steel pin which, when removed, will allow the sleeve to slip off the top. The pin shall be configured to firmly stay engaged to the dismount section and shall have an attached stainless steel ring attached to one end of a stainless steel

chain. The other end of the chain shall be attached to the bolt at the top of the guide rail. Install two additional rung clamps on the top two or three ladder rungs for additional support as recommended by the manufacturer.

4. Eyebolts: At the top of all ladders which terminate at roof scuttles or floor doors, furnish and install a stainless steel closed eyebolt in the center of each top ladder rail bracket. The eyebolt shall be made of 3/8-inch diameter steel, shall have an inside opening width of 2 ¼-inches, shall be oriented vertically, and shall have all the excess threaded portion removed and ground smooth.
5. Harness Sets: Provide one harness set in each of the five available sizes, total five sets, each of which shall be comprised of a Saf-T-Harness No. 730-201- XXX, a Saf-T-Lanyard No. 732-201-071, and a Saf-T-Lok Sleeve No. 602-100-01. Also provide five heavy duty aluminum hooks equal to Ives Model 405- A14. Hooks shall be installed at a location within the Project as directed by the Engineer and in a manner to support a vertical load of 50 pounds without noticeable deflection. Harness Sets are available from: North Safety Products, 26 Dansk Court, Toronto, Ontario M9W5V8, Tel: (800) 836-8006. Hooks are available from any Finish Hardware supplier.

PART 3- EXECUTION

3.01 INSTALLATION

- A. General: Handrail and ladder system shall be assembled and installed in strict compliance with the manufacturer's instructions. Maximum post spacing shall be 6'- 0". The handrail manufacturer may use less than 6'-0" if their system requires closer spacing to meet design criteria.
- B. Shop Assembly: Handrail manufacturer shall shop assemble the handrail and ladders in shippable modules not to exceed 30 feet in length. Field manufacturing of handrail and ladder modules will not be permitted.
- C. Set handrail modules plumb within 1/8-inch of vertical and align horizontally to within 1/8-inch in 12 feet. Set stair rail modules plumb within 1/8-inch of vertical and set rake rails aligned horizontally to 1/8-inch in 12 feet. Set ladder modules plumb within 1/8- inch of vertical.
- D. Handrail mounting shall be embedded, top mounting base, or side mounted as shown on the Drawings. Install expansion bolts to proper depth to develop full withdrawal and shear values. Check all fasteners and bolts in base connections and splices for tightness.
- E. Handrail and ladder components coming into contact with concrete or dissimilar metals shall be coated with bituminous protective coating or installed with a vinyl isolation gasket.

- F. Splice joints to facilitate removal of pipe railing shall be provided at all intersections, changes in direction or at intervals not to exceed 30 feet in straight runs of railing.
- G. Adequate provisions for expansion and contraction shall be incorporated in the rails. Expansion joints shall be placed at 60 foot intervals. Handrail shall not be continuous across concrete expansions joints.
- H. Open rail ends shall be closed by terminal end fittings.
- I. Unless noted otherwise, gates shall be provided in all handrail and ladder openings. Chains will not be permitted at handrail and ladder openings.
- J. Toeboards shall be shipped loose and field assembled to posts with clamps. The attaching system shall be such that contraction and expansion can occur while maintaining a straight line. Toeboards shall be set so that the bottom of the toeboard is within 1/4-inch above the walking surface.
- K. All defective, damaged, or otherwise improperly installed handrail, ladders, gates, and fall prevention systems shall be removed and replaced with material that satisfies the requirements of this Section.

3.02 CLEANING

Following installation, aluminum handrail, ladders, gates and fall prevention systems shall be cleaned using soap and clean water. Acid solutions, steel wool or harsh abrasives shall not be used. If stains remain after cleaning, remove finish, and restore in accordance with the manufacturer's written instructions to the satisfaction of the Engineer.

END OF SECTION

**SECTION 05530
ALUMINUM GRATINGS**

PART 1- GENERAL

1.01 SCOPE

- A. The work covered by this Section includes furnishing all labor, equipment and materials required to furnish and install all aluminum gratings and stairway treads, including all supporting angles, anchors and incidental fastenings where shown on the Drawings or specified herein.
- B. Unless specifically designated otherwise on the Drawings, all gratings and treads shall be aluminum.

1.02 DESIGN REQUIREMENTS

Aluminum grating shall be designed for an extreme fiber stress in bending of not more than 10,000 psi and a deflection of not more than 1/300 of the span length or 0.25-inch, whichever is smaller, under a uniform live load of 100 pounds per square foot. The depth and thickness of the main bearing bars shall not be less than that shown on the Drawings (1-inch minimum) and the clear spacing between main bearing bars shall not exceed 1-1/8-inches.

1.03 SUBMITTALS

Complete shop drawings and engineering data shall be submitted in accordance with the requirements of Section 01340 of these Specifications.

1.04 STORAGE AND PROTECTION

Aluminum gratings shall be stored and protected in accordance with the requirements of Section 01640 of these Specifications.

1.05 QUALITY ASSURANCE

The Contractor shall provide the Engineer with written certification that the aluminum grating and treads are in conformance with the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the grating or stair tread supplier may be considered evidence with the appropriate ASTM testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the Engineer may require that the Contractor furnish test reports from an independent testing laboratory on certified samples of aluminum bar stock. Cost for this testing to be borne by Contractor.

PART 2- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Grating shall be IKG, Seidelhuber, Liskey or Ohio Grating.

2.02 Aluminum Gratings

- A. Aluminum gratings shall be fabricated of I-shaped or rectangular 6061-T6 or 6063-T6 aluminum alloy bars welded or pressure locked together into rigid panels. Grating and banding bars shall be machine cut. Top surfaces of main bearing bars shall be grooved or serrated to provide a non-slip surface.
- B. Grating panels shall be simply supported by shelf angles on two sides of the openings and shall be reversible. The gratings shall be of the type that can be made in panels of the widths and lengths appropriate to the openings shown on the Drawings, no gratings will be accepted which require individual panels to be made up by binding narrow panels together with end or intermediate binding strips welded thereto. The ends of all grating panels and the edges of all openings shall be provided with banding strips of the same depth and thickness of the main bars, welded thereto and neatly finished at the intersections with the bars. After installation, there shall not be more than 1/4-inch clearance between sides of adjacent panels. Panels shall be furnished in sizes that weight does not exceed 80 pounds.
- C. The top surface of all bars shall be flush and all gratings shall lie flat with no tendency to rock when installed. Cross bars and edge bars of adjacent panels shall align for neatness. Maximum spacing between adjacent panels shall not exceed 1/4-inch. All main bearing bars shall be parallel. Cross bars shall be cut off flush with outside face of side bars.
- D. Grating panels shall be securely anchored in place with stainless steel "J" bolts or aluminum saddle or hook clamps. Galvanized hardware shall not be acceptable. A minimum of two fasteners over each support shall be provided.
- E. Main bearing bars shall be supported by aluminum shelf angles of the size and thickness as shown on the Drawings. There shall not be more than 1/4-inch clearance between the ends of the grating panels and the inside vertical face of the shelf angle.
- F. Grating panels shall be within 3/16-inch, plus or minus of authorized length and width, and shall have a maximum difference in length of opposite diagonals of 3/16-inch. Spacing of bearing bars shall be within 1/32-inch of authorized spacing.
- G. All surfaces shall be sound, smooth, clean, and free from defects. Completed sections shall be level and true so as to rest firmly on the bearing angles along the entire contact surface. Openings, where required, shall be neatly and accurately made to the dimensions required as shown on the Drawings. Poorly fitted or damaged grating shall be replaced. All angular, circular, or reentrant cuts shall be made by sawing or shearing. Flame cutting will not be permitted.
- H. Unless otherwise shown, openings to be covered with grating shall be bound on all four sides with a continuous shelf angle frame having welded corners and sufficient strap anchors for anchorage into the concrete.
- I. Where changes in channel direction, openings for gates, ends of grating runs, etc., prohibits adequate support for grating, additional cross angles shall be furnished to provide a seating surface.

- J. Grating shall be laid out so that openings in the gratings are centered on a joint between adjacent panels. Where joints occur normal to the direction of span, they shall be centered on structural support with not more than 1/8-inch between ends of adjoining panels.
- K. Solid plank grating shall be I-bar reinforcing designed to meet the deflection requirements specified herein. The solid plank shall have a non-slip surface.

PART 3- EXECUTION

3.01 INSTALLATION

- A. Gratings shall be installed in accordance with the manufacturer's recommendations and instruction.
- B. Gratings shall have no tendency to shift, rock or rattle and shall not exhibit excessive deflection under normal foot traffic.
- C. Stair treads shall be installed at the proper spacing and alignment and shall be level. Stairs shall not sway or vibrate under ordinary foot traffic. Additional bracing or supports shall be provided, if necessary.

3.02 SURFACE PREPARATION AND SHOP PAINTING

- A. Surface preparation and shop painting shall be in accordance with the requirements of Section 09900 of these Specifications.
- B. Aluminum surfaces to be embedded in concrete or otherwise placed in contact with masonry construction shall be given a heavy shop coat of a zinc chromate primer in accordance with Federal Specification TT-P-645. The paint shall be applied as received from the manufacturer without the addition of any thinner.
- C. Where aluminum surfaces come in contact with dissimilar metals, except stainless steel, the aluminum surfaces shall be kept from direct contact with said metal by the use of neoprene gaskets, 10 mil polyethylene film or insulating washers. Paint or galvanizing will not be considered as adequate protection.

3.03 FIELD PAINTING

Field painting shall be in accordance with the requirements of Section 09900 of these Specifications.

3.04 CLEANING

Prior to the acceptance of the work of this Section, thoroughly clean all installed materials and related areas in accordance with the requirements of Section 01710 of these Specifications.

END OF SECTION

**SECTION 05532
ALUMINUM PLATFORMS**

PART 1- GENERAL

1.01 SCOPE

Provide the structural design of and furnish and install the platforms as shown and indicated on the Drawings. Member sizes shown on these Drawings are minimum requirements.

1.02 DESIGN REQUIREMENTS

- A. Code: International Building Code, 2000, Edition.
- B. Design Loads
 - 1. Grating for platform, 150 psf.
 - 2. Beams supporting grating, 150 psf for each square foot of contributing area in addition to the dead load of the structure, all piping (empty or filled with water) and dead load plus live load of all equipment shown on the Drawings.
 - 3. All seismic and wind loads required by the referenced code.
- C. Design shall be based on elastic behavior. Deflections on walkway beams shall be limited to $L/300$. Lateral deflection shall be limited to $H/500$.
- D. Compression flanges of walkway beams shall be stabilized by suitable struts and/or bracing. The use of the grating to support compression flanges is prohibited.
- E. The design, fabrication, and erection of each of the components furnished under this Section of the Specifications shall meet the applicable requirements of Section 05120, Structural Metals.
- F. Handrails shall meet the requirements of Section 05524, Component Aluminum Handrails.
- G. Aluminum gratings shall meet the requirements of Section 05530, Aluminum Gratings.
- H. Design shall be in accordance with the Aluminum Association, Inc. Specifications.
- I. Field connections shall be bolted.

1.03 SUBMITTALS

- A. Provide for the design of the aluminum platforms, and walkways by a structural engineer registered in the state in which this Project is located who shall seal and sign the submittals noted below.
- B. Design Certification: Submit to the Engineer certification that the design of the aluminum platforms, and walkways for this work is accomplished by the responsible registered structural engineer whose name, seal and signature appears on the certification.
- C. Diagrams showing all the load conditions required by the building code noted and all other loads shown, indicated, or noted on the Drawings and as specified in this Section of these Specifications. These diagrams shall also show all the reactions to the load conditions. The seal and signature of the responsible registered structural engineer shall be applied on these diagram sheets. Calculations are not required to be submitted to, or reviewed by, the Engineer.
- D. A complete set of erection and detail shop drawings, including, but not limited to, anchor bolt sizes and layout, all framing, and connections. The submittal shall be made in one complete package. The seal and signature of the responsible registered structural engineer shall be applied to these drawings.
- E. Certificates of Compliance: Attesting that all materials comply with the requirements of these Specifications.
- F. The Engineer will review, comment, and return to the Contractor the required number of marked copies of all items under paragraphs B, C, D and E. For paragraph D., the Engineer will not comment on erection procedures and does not require their submittal. The Engineer's review and comments for paragraph D. will be for layout and clearances only and will not relieve the Contractor of the responsibility of providing a design and product that meets all the requirements of these Specifications.

PART 2- PRODUCTS

2.01 MATERIALS

- A. All products shall be new and undamaged.
- B. Framing members and grating shall conform to the Aluminum Association, Inc. (AAI) Specification 6061-T6.
- C. Connection bolts and anchor bolts shall conform to AISI Type 316 stainless steel.
- D. Base plates shall conform to AAI 6061-T6 or AISI Type 304 stainless steel.
- E. Shop welding shall conform to AAI 6066-T6.

PART 3- EXECUTION

3.01 INSTALLATION

Fabrication and installation shall be in accordance with Section 05120, Structural Metals.

END OF SECTION

SECTION 06001
CARPENTRY

PART 1 GENERAL

1.01 QUALITY ASSURANCE

- A. Lumber to have visible grade stamp, of an agency certified by the NFPA, The Southern Pine Association, The West Coast Lumberman's Association, American Plywood Association or other recognized lumber producing associations.
- B. Treated lumber shall be pressure treated with wood preservative. Cellular wood preservative or Osmose K 33 lumber.
- C. Plywood: Each panel of softwood plywood shall bear the grade trade mark of the American Plywood Association and shall meet requirements of Product Standard PS 1. Hardwood shall conform to requirements of Commercial Standard CS 35.
- D. Non sub grade, defective or machine marked pieces shall be installed.
- E. Perform finish carpentry work in accordance with recommendations of the Millwork Standards of the Architectural Woodwork Institute.

1.02 PRODUCT DELIVERY AND HANDLING AND STORAGE

- A. Protect sheet material from having corners broken and surfaces damaged while handling.
- B. Immediately upon delivery to job site, place materials in area protected from the weather at least 6 inches above ground on framework or blocking and cover with protective waterproof covering providing for adequate air circulation or ventilation.
- C. Protect seasoned materials against high humidity and moisture during storage and erection.

1.03 REFERENCES

- A. Architectural Woodwork Quality Standards, Guide Specifications and Quality Certification Program: Architectural Woodwork Institute.
- B. National Forest Products Association National Design Specification for Stress Grade Lumber and Its Fastening.

- C. Southern Pine Use Guide: Southern Forest Products Association.
- D. Manual for House Framing: National Lumber Manufacturers Association.
- E. Wood Structural Design Data 1978: Batuibak forest Products.
- F. Product Use Manual: Western Wood Products Association.
- G. Plywood Specification and Grade Guide: American Plywood Association.
- H. Standard Building Code: Southern Building Code Congress International, Inc.

PART 2 PRODUCTS

- 2.01 Lumber for rough carpentry shall be kiln dried and well seasoned with moisture content not to exceed 15% and shall be graded by the producing association.
- 2.02 Treated lumber shall be pressure treated with wood preservative for all lumber in contact with masonry or concrete and other locations indicated on the drawings. Cellar, Wolmanized, or Osmose K 33 lumber is approved.
- 2.03 FRAMING
 - A. Top plates, rafters and joists shall be No. 2 Southern Yellow Pine.
 - B. Miscellaneous framing shall be spruce, cedar or Southern Yellow Pine, grades as listed above.
- 2.04 WOOD TRUSS RAFTERS
 - A. GENERAL
 - 1. Truss rafters shall be of shape, span and spacing shown on the drawings.
 - 2. Wood truss rafters shall be prefabricated by a company with a minimum of five years experience in the manufacturing of successful truss rafters.
 - 3. Truss rafters shall be fabricated by a company approved by the connector plates manufacturer and in accordance with the plate manufacturer's standard method and specifications.

4. Submit complete shop drawings, design calculations, stress analysis, and joint analysis all bearing the seal of a professional engineer licensed to practice in the State of Georgia for approval.

B. MATERIAL

1. Connector plates shall be light metal plate connectors conforming to requirements of T.P.I. specifications of either the nailed type or nailed press in type.
2. Lumber for truss rafters shall be as specified below and be so stamped on each and every piece.
 - a. TOP CHORDS: SYP #2 KD MG
 - b. BOT CHORDS: SYP #2 KD MG
 - c. WEB MEMBERS: SYP #2 KD
 - d. OTHER: SYP #2 KD
3. Truss rafters shall be designed to carry loads for structure as shown with minimum loads on top chords and bottom chords as shown on drawings and deflecting under designed loads shall not exceed $1/360$ of span.

C. FABRICATORS

1. Trusses shall be designed, fabricated and connected to support applied dead loads and all wind and live loads required by the Standard Code, Current Edition. They shall be shop assembled so that wood members have full bearing, particularly at the peak and head joints.
2. Wood members must be firmly held in position in suitable jigs until the teeth or nails are embedded in the wood. Nailless teeth plates shall be pressed into place by a hydraulic clamp or by the double pass roller method.

2.05 LUMBER FOR FINISH CARPENTRY

- A. Moisture content of finish softwood lumber shall not exceed 6% for interior work and 10% for exterior.
- B. Moisture content of finish hardwood lumber shall not exceed 6%.
- C. Fascia and other wood trim shall be fir.

2.06 PLYWOOD

- A. Soffits: 3/8" thick, A C fir exterior plywood.

2.07 PLYWOOD SIDING

- B. Shall be APA 303 Siding Ext. premium grade, pine; reverse board and batten design, rough sawn 5/8" thick, grooves at 12" o.c.

PART 3 EXECUTION

3.01 FRAMING AND BLOCKING

- A. Refer to drawings for framing sizes, space and detail.
- B. Framing for locations not detailed shall be provided with supporting members in general 2" thick, depth shown and spaced not over 16" o.c. No. 2 Southern Yellow Pine or Douglas Fir, unless noted otherwise.
- C. Framing shall be cut and fitted, true to line and level, avoiding shims and wedges.
- D. Bolt wood members to concrete and masonry round, bolts, spaced 3' 0" o.c. and within 4" of each end of plates at splices and corners.
- E. Provide blocking, bucks and framing for other trades.

3.02 FINISH HARDWARE

- A. Installation:
 - 1. Install and make adjustments for correct working order.
 - 2. Any hardware damaged by improper adjustment or abuse will be replaced by the contractor at his expense.
 - 3. Fit all surface applied hardware.
 - 4. Provide clean, sized and place mortises and drilled holes for all mortise hardware such as locksets, flush bolts and pivots.

5. After hardware installation, protect exposed surfaces from wear and abuse by the use of heavy paper and masking tape and maintain until job completion.
 6. Center kick plates at bottom of doors and provide same margin at bottom as at sides.
- B. Removal for Painting: Remove all hardware, except that which is primed for painting before painter's finish is applied and replace and readjust for function after painter's finish has been completed and has dried hard.
- 3.03 Plywood siding shall be nailed at 6" o.c. along perimeter of the panel and at 12" o.c. at intermediate supports with 8d hot dipped galvanized common nails. All edges of panels must have solid backing.
- 3.04 Install metal trim and flashing as indicated on the drawings.
- 3.05 Each item specified in this section shall be installed plumb, rigid, square and level with all moving parts working.
- 3.06 Ensure all mechanical and electrical items affecting the Section of Work are properly placed and complete prior to commencement of installation.
- 3.07 Hand Doors.
- 3.08 Install hardware fixtures and accessories supplied under other Sections for installation. Install in strict accordance with manufacturer's recommendations.
- 3.09 CLEANING
- A. After completion of Finish Carpentry work, clean all surfaces remove all debris and leave spaces broom clean. Examine all doors and other moving parts, adjust as required.

END OF SECTION

**SECTION 06100
ROUGH CARPENTRY**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Framing with dimension lumber.
2. Framing with engineered wood products.
3. Wood furring, grounds, nailers, and blocking. Sheathing.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 6 Section "Metal-Plate-Connected Wood Trusses."

1.03 DEFINITIONS

- A. Rough Carpentry: Carpentry work not specified in other Sections and not exposed, unless otherwise specified.
- B. Exposed Framing: Dimension lumber not concealed by other construction and indicated to receive a stained or natural finish.

1.04 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Specification Sections.
- B. Product Data for the following products:
1. Engineered wood products.
 2. Air-infiltration barriers.
 3. Metal framing anchors.
 4. Construction adhesives.

C. Research or evaluation reports of the model code organization acceptable to authorities having jurisdiction that evidence the following products' compliance with building code in effect for Project.

1. Engineered wood products.
2. Air-infiltration barriers.
3. Metal framing anchors.
4. Power-driven fasteners.
5. Fire-retardant-treated wood.

D. DELIVERY, STORAGE, AND HANDLING

1. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.
2. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Wood-Preservative-Treated Materials:

Baxter: J. H. Baxter Co.
Chemical Specialties, Inc.
Continental Wood Preservers, Inc.
Hickson Corp.
Hoover Treated Wood Products, Inc.
Osmose Wood Preserving, Inc.

- c. Fire-Retardant-Treated Materials, Interior Type A:

Baxter: J. H. Baxter Co.
Chemical Specialties, Inc.
Continental Wood Preservers, Inc.
Hickson Corp.
Hoover Treated Wood Products, Inc.

- d. Fire-Retardant-Treated Materials, Exterior Type:
American Wood Treaters, Inc.
Hoover Treated Wood Products, Inc.
- e. Laminated-Veneer Lumber:
Alpine Structures.
Boise Cascade Corp.
Georgia-Pacific Corp.
Louisiana-Pacific Corp.
Trus Joist MacMillan.
Willamette Industries, Inc.
- f. Parallel-Strand Lumber:
Alpine Structures.
Trus Joist MacMillan.
- g. Air-Infiltration Barriers:
Amoco Foam Products Co.
Anthony Industries, Inc.; Simplex Products Division.
Celotex Corporation (The); Building Products Division.
DuPont Company; Fibers Department.
Parsec, Inc.
Raven Industries, Inc. Reemay, Inc.
Sto-Cote Products, Inc.
- h. Metal Framing Anchors:
Simpson Strong-Tie Company, Inc.

2.02 LUMBER, GENERAL

- A. Lumber Standards: Comply with DOC PS 20, "American Softwood Lumber Standard," and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.
- B. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
- C. For exposed lumber, furnish pieces with grade stamps applied to ends or back of each piece, or omit grade stamps and provide grade-compliance certificates issued by inspection agency.
- D. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
- E. Provide dressed lumber, S4S, unless otherwise indicated.

- F. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal (38-mm actual) thickness or less, unless otherwise indicated.

2.03 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. General: Where lumber or plywood is indicated as preservative treated or is specified to be treated, comply with applicable requirements of AWPAC2 (lumber) and AWPAC9 (plywood). Mark each treated item with the Quality Mark Requirements of an inspection agency approved by ALSC's Board of Review.
- B. Do not use chemicals containing chromium or arsenic.
- C. Pressure treat aboveground items with waterborne preservatives to a minimum retention of 0.25 lb/cu. ft. (4.0 kg/cu. m). After treatment, kiln-dry lumber and plywood to a maximum moisture content of 19 and 15 percent, respectively. Treat indicated items and the following:
- D. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
- E. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
- F. Wood framing members less than 18 inches (460 mm) above grade.
- G. Wood floor plates installed over concrete slabs directly in contact with earth.
- H. Pressure treat wood members in contact with ground or freshwater with waterborne preservatives to a minimum retention of 0.40 lb/cu. ft. (6.4 kg/cu. m).
- I. Complete fabrication of treated items before treatment, where possible. If cut after treatment, apply field treatment complying with AWPAM4 to cut surfaces. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.

2.04 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated wood is indicated, comply with applicable requirements of AWPAC20 (lumber) and AWPAC27 (plywood). Identify fire-retardant-treated wood with appropriate classification marking of UL; U.S. Testing; Timber Products Inspection, Inc.; or another testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Research or Evaluation Reports: Provide fire-retardant-treated wood acceptable to authorities having jurisdiction and for which a current model code research or evaluation report exists that evidences compliance of fire-retardant-treated wood for application indicated.

- C. Interior Type A: For interior locations, use chemical formulation that produces treated lumber and plywood with the following properties under conditions present after installation:
- D. Bending strength, stiffness, and fastener-holding capacities are not reduced below values published by manufacturer of chemical formulation under elevated temperature and humidity conditions simulating installed conditions when tested by a qualified independent testing agency.
- E. No form of degradation occurs due to acid hydrolysis or other causes related to treatment. Contact with treated wood does not promote corrosion of metal fasteners.
- F. Exterior Type: Use for exterior locations and where indicated.
- G. Inspect each piece of treated lumber or plywood after drying and discard damaged or defective pieces.

2.05 DIMENSION LUMBER

- A. General: Provide dimension lumber of grades indicated according to the ALSC National Grading Rule (NGR) provisions of the inspection agency indicated.
- B. Non-Load-Bearing Interior Partitions. Provide framing of the following grade and species:
 - Grade: Construction, Stud, or No. 3.
 - Species: Mixed southern pine; SPIB.
 - Species: Spruce-pine-fir south; WCLIB or WWPB.
- D. Exterior and Load-Bearing Walls. Provide framing of the following grade and species:
 - Grade: Construction or No. 2.
 - Species: Spruce-pine-fir south; NELMA.
 - Species: Southern pine; SPIB.
- F. Other Framing Not Listed Above: Provide the following grades and species:
 - Grade: Construction, Stud, or No. 3.
 - Species: Southern pine; SPIB.

2.06 MISCELLANEOUS LUMBER

- A. General: Provide lumber for support or attachment of other construction, including rooftop equipment curbs and support bases, cant strips, bucks, nailers, blocking, furring, grounds, stripping, and similar members.

- B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.
- C. Moisture Content: 19 percent maximum for lumber items not specified to receive wood preservative treatment.
- D. Grade: For dimension lumber sizes, provide No. 3 or Standard grade lumber per ALSC's NGRs of any species. For board-size lumber, provide No. 3 Common grade per NELMA, NLGA, or WWP; No. 2 grade per SPIB; or Standard grade per NLGA, WCLIB or WWP of any species.

2.07 ENGINEERED WOOD PRODUCTS

- A. General: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that evidence compliance with building code in effect for Project.
- B. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated on drawings. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis, and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- C. Wall Sheathing: APA-rated Structural I sheathing.
- D. Exposure Durability Classification: Exposure 1.
- E. Span Rating: As required to suit stud spacing indicated.
- F. Roof Sheathing: APA-rated Structural I sheathing.
- G. Exposure Durability Classification: Exposure 1.
- H. Span Rating: As required to suit rafter spacing indicated.

2.08 STRUCTURAL-USE PANELS FOR BACKING

- A. Plywood Backing Panels: For mounting electrical or telephone equipment, provide fire-retardant- treated plywood panels with grade, C-D Plugged Exposure 1, in thickness indicated or, if not otherwise indicated, not less than 15/32 inch (11.9 mm) thick.

2.09 AIR-INFILTRATION BARRIER

- A. Asphalt-saturated organic felt complying with ASTM D 226, Type I (No. 15 asphalt felt), unperforated.
- B. Air retarder complying with ASTM E 1677; made from polyolefins; either cross-laminated films, woven strands, or spunbonded fibers; coated or uncoated; with or without perforations to transmit water vapor but not liquid water; and as follows:

1. Minimum Thickness: 3 mils (0.08 mm).
2. Minimum Water-Vapor Transmission: 10 perms (575 ng/Pa x s x sq. m) when tested according to ASTM E 96, Procedure A.
3. Maximum Flame Spread: 25 per ASTM E 84.
4. Minimum Allowable Exposure Time: 3 months.

2.10 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
- B. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of Type 304 stainless steel.
- C. Nails, Wire, Brads, and Staples: FS FF-N-105.
- D. Power-Driven Fasteners: CABO NER-272.
- E. Wood Screws: ASME B18.6.1.
- F. Lag Bolts: ASME B18.2.1. (ASME B18.2.3.8M)
- G. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

2.11 METAL FRAMING ANCHORS

- A. General: Provide galvanized steel framing anchors of structural capacity, type, and size indicated and as follows
 1. Research or Evaluation Reports: Provide products for which model code research or evaluation reports exist that are acceptable to authorities having jurisdiction and that evidence compliance of metal framing anchors for application indicated with building code in effect for Project.
 2. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis, and demonstrated by comprehensive testing performed by a qualified independent testing agency.
 3. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 (ASTM A 653M, Z180) coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type of anchor indicated.

2.12 MISCELLANEOUS MATERIALS

- A. Sill-Sealer Gaskets: Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch (25-mm) nominal thickness, compressible to 1/32 inch (0.8 mm); selected from manufacturer's standard widths to suit width of sill members indicated.
- B. Adhesives for Field Gluing Panels to Framing: Formulation complying with APA AFG-01 that is approved for use with type of construction panel indicated by both adhesive and panel manufacturers.
- C. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbonate (IPBC) as its active ingredient.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.
- C. Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.
- D. Apply field treatment complying with AWPAC M4 to cut surfaces of preservative-treated lumber and plywood.
- E. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. CABO NER-272 for power-driven staples, P-nails, and allied fasteners.
 - 2. Published requirements of metal framing anchor manufacturer.
 - 3. "Table 2304.9.1 -- Fastening Schedule," of the International Building Code.
- F. Use common wire nails, unless otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; predrill as required.
- G. Use hot-dip galvanized or stainless-steel nails where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity.
- H. Countersink nail heads on exposed carpentry work and fill holes with wood filler.

3.02 WOOD GROUNDS, NAILERS, BLOCKING, AND SLEEPERS

- A. Install wood grounds, nailers, blocking, and sleepers where shown and where required for screeding or attaching other work. Form to shapes shown and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.

3.03 WOOD FURRING

- A. Install plumb and level with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Firestop furred spaces of walls at each floor level and at ceiling with wood blocking or noncombustible materials, accurately fitted to close furred spaces.
- C. Furring to Receive Plywood Paneling: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring at 24 inches (610 mm) o.c., horizontally and vertically. Select furring with no knots capable of producing bent-over nails and damage to paneling.
- D. Furring to Receive Gypsum Board: Install 1-by-3-inch nominal- (19-by-63-mm actual-) size furring at 16 inches (406 mm) o.c., vertically.

3.04 WOOD FRAMING, GENERAL

- A. Framing Standard: Comply with AFPA's "Manual for Wood Frame Construction," unless otherwise indicated.
- B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
- C. Install framing members of size and at spacing indicated.

Do not splice structural members between supports.

Firestop concealed spaces of wood-framed walls and partitions at each floor level and at ceiling line of top story. Where firestopping is not inherent in framing system used, provide closely fitted wood blocks of 2-inch nominal- (38-mm actual-) thickness lumber of same width as framing members.

3.05 WALL AND PARTITION FRAMING

- A. General: Arrange studs so that wide face of stud is perpendicular to direction of wall or partition and narrow face is parallel. Provide single bottom plate and double top plates using members of 2-inch nominal (38-mm actual) thickness whose widths equal that of studs; except single top plate may be used for non-load-bearing partitions. Nail or anchor plates to supporting construction, unless otherwise indicated.
- B. For exterior walls, provide wood studs at the size and spacing indicated.

- C. For interior partitions and walls, provide 2-by-4-inch nominal- (38-by-89-mm actual-) size wood studs spaced 16 inches (406 mm) o.c., except where otherwise indicated or required.
- D. Construct corners and intersections with 3 or more studs. Provide miscellaneous blocking and framing as shown and as required to support facing materials, fixtures, specialty items, and trim.
- E. Provide continuous horizontal blocking at midheight of single-story partitions over 96 inches (2438 mm) high and multistory partitions, using members of 2-inch nominal (38-mm actual) thickness and of same width as wall or partitions.
- F. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Set headers on edge and support on jamb studs.
- G. For non-load-bearing partitions, provide double-jamb studs with headers not less than 4-inch nominal (89-mm actual) depth for openings 36 inches (900 mm) and less in width, and not less than 6-inch nominal (140-mm actual) depth for wider openings.
- H. For load-bearing walls, provide double-jamb studs for openings 72 inches (1800 mm) and less in width, and triple-jamb studs for wider openings. Provide headers of depth shown or, if not shown, as recommended by AFPA's "Manual for Wood Frame Construction."
- I. Provide bracing in walls, at locations indicated, full-story height, unless otherwise indicated. Provide one of the following:
- J. Performance-rated structural-use panels, not less than 48 by 96 inches (1219 by 2438 mm) applied vertically.

3.06 INSTALLATION OF STRUCTURAL-USE PANELS

- A. General: Comply with applicable recommendations contained in APA Form No. E30, "APA Design/Construction Guide: Residential & Commercial," for types of structural-use panels and applications indicated.
- B. Sheathing: Nail to framing.
- C. Space panels 1/8 inch (3 mm) at edges and ends.
- D. Plywood Backing Panels: Nail or screw to supports.

END OF SECTION

SECTION 06192
METAL-PLATE-CONNECTED WOOD TRUSSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

- a. Triangular-pitched roof trusses.
- b. Girder trusses.
- c. Truss accessories.

B. Related Sections: The following Sections contain requirements that relate to this Section:

- a. Division 5 Section "Metal Fabrications" for rough hardware anchoring trusses to concrete or masonry structures.
- b. Division 6 Section "Rough Carpentry" for roof and floor sheathing of structural-use panels and dimension lumber for supplementary framing and permanent bracing.

1.03 DEFINITIONS

Metal-plate-connected wood trusses include planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.

1.04 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Engineer, fabricate, and erect metal-plate-connected wood trusses to
- B. withstand design loads within limits and under conditions required.
- C. Design Loads: As indicated.

- D. Design trusses to withstand design loads without deflections greater than the following:
- E. Roof Trusses: Vertical deflection of $1/180$ of span due to total load.
- F. Engineering Responsibility: Engage a fabricator who uses a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for metal-plate-connected wood trusses.

1.05 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and
- B. Division 1 Specification Sections.
- C. Product Data for lumber, metal-plate connectors, metal framing connectors, bolts, and fasteners.
- D. Shop Drawings detailing location, pitch, span, camber, configuration, and spacing for each type of truss required; species, sizes, and stress grades of lumber to be used; splice details; type, size, material, finish, design values, and orientation and location of metal connector plates; and bearing details.
 - a. To the extent truss design considerations are indicated as fabricator's responsibility, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - b. Include truss Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Research or evaluation reports of the model code organization acceptable to authorities having jurisdiction that evidence the following products' compliance with building code in effect for Project.
 - a. Metal-plate connectors.
 - b. Metal framing connectors.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed wood truss installation similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Fabricator's Qualifications:

Engage a firm that complies with the following requirements for quality control and is experienced in fabricating metal-plate-connected wood trusses similar to those indicated for this Project and with a record of successful in-service performance:

- a. Fabricator participates in a recognized quality-assurance program that involves inspection by SPIB; Timber Products Inspection, Inc.; Truss Plate Institute (TPI); or other independent inspecting and testing agency acceptable to Architect and authorities having jurisdiction.

C. Comply with applicable requirements and recommendations of the following publications:

- a. ANSI/TP1 1, "National Design Standard for Metal-Plate-Connected Wood Truss Construction."
- b. TPI HIB "Commentary and Recommendations for Handling Installing & Bracing Metal Plate Connected Wood Trusses."
- c. TPI DSB "Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses."

D. Metal-Plate Connector Manufacturer's Qualifications:

A manufacturer that is a member of TPI and that complies with TPI quality-control procedures for manufacture of connector plates published in ANSI/TP1 1.

E. Single-Source Responsibility for Connector Plates:

Provide metal connector plates from one source and by a single manufacturer.

F. Wood Structural Design Standard:

Comply with applicable requirements of AFPA's "National Design Specification for Wood Construction" and its "Supplement."

G. Professional Engineer Qualifications:

A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated that have resulted in installing metal-plate-connected wood trusses similar to those indicated for this Project and with a record of successful in service performance.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handle and store trusses with care and comply with manufacturer's written instructions and TPI recommendations to avoid damage and lateral bending.

- B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

1.08 SEQUENCING AND SCHEDULING

Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying progress of other trades whose work must follow erection of trusses.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers:
 - a. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - i. Metal Connector Plates:
Alpine Engineered Products, Inc.
Computrus, Inc.
Mitek Industries, Inc.
Robbins Manufacturing Company.
Tee-Lok Corporation.
Truswal Systems Corporation.
 - ii. Metal Framing Anchors:
Simpson Strong-Tie Company, Inc.

2.02 DIMENSION LUMBER

- A. Lumber Standards:
 - a. Comply with DOC PS 20, "American Softwood Lumber Standard," and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.
- B. Grade Stamps:
 - a. Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
- C. Provide dressed lumber, S4S, manufactured to actual sizes required by DOC PS 20 for moisture content specified, to comply with requirements indicated below:

- D. Provide dry lumber with 19 percent maximum moisture content at time of dressing.
- E. Grade and Species: Provide dimension lumber of any species for truss chord and web members, graded visually or mechanically, and capable of supporting required loads without exceeding allowable design values according to AFPA's "National Design Specification for Wood Construction" and its "Supplement."

2.03 METAL CONNECTOR PLATES

- A. General:
 - a. Fabricate connector plates from metal complying with requirements indicated below.
- B. Hot-Dip Galvanized Steel Sheet:
 - a. Structural-quality steel sheet, zinc coated by hot-dip process complying with ASTM A 653, G60 (ASTM A 653M, Z180) coating designation; Grade 33 and not less than 0.0359 inch (0.91 mm) thick.

2.04 FASTENERS

- A. General:
 - a. Provide fasteners of size and type indicated that comply with requirements specified below for material and manufacture.
 - b. Where truss members are exposed to weather or to high relative humidities, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of stainless steel, Type 304 or 316.
- B. Nails, Wire, Brads, and Staples: FS FF-N-105.
- C. Power-Driven Fasteners: CABO NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts and Screws: ASME B18.2.1 (ASME B18.2.3.8M).
- F. Bolts:
 - a. Steel bolts complying with ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

2.05 METAL FRAMING ANCHORS

A. General:

- a. Provide metal framing anchors of structural capacity, type, size, metal, and finish indicated that comply with requirements specified, including the following:
- b. Research or Evaluation Reports: Provide products for which model code research or evaluation reports exist that are acceptable to authorities having jurisdiction and that evidence compliance of metal framing anchors for application indicated with building code in effect for this Project.
- c. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis, and demonstrated by comprehensive testing performed by a qualified independent testing agency.

B. Galvanized Steel Sheet:

- a. Hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 (ASTM A 653M, Z180) coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type of anchor indicated.

2.06 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint:

- a. SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

2.07 FABRICATION

- B. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.
- C. Fabricate metal connector plates to size, configuration, thickness, and anchorage details required to withstand design loadings for types of joint designs indicated.
- D. Assemble truss members in design configuration indicated using jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances of ANSI/TPI 1. Position members to produce design camber indicated.

Fabricate wood trusses within manufacturing tolerances of ANSI/TPI 1.

- E. Connect truss members by metal connector plates located and securely embedded simultaneously into both sides of wood members by air or hydraulic press.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Do not install wood trusses until supporting construction is in place and is braced and secured.
- B. Before installing, splice trusses delivered to Project site in more than one piece.
- C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.
- D. Install and brace trusses according to recommendations of TPI and as indicated.
- E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.
- F. Space, adjust, and align trusses in location before permanently fastening and as follows:
 - a. Truss Spacing: As indicated.
- G. Anchor trusses securely at all bearing points using metal framing anchors. Install fasteners through each fastener hole in metal framing anchor according to manufacturer's fastening schedules and written instructions.
- H. Securely connect each truss ply required for forming built-up girder trusses.
 - a. Anchor trusses to girder trusses as indicated.
- I. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
- J. Install wood trusses within installation tolerances of ANSI/TPI 1.
 - a. Do not cut or remove truss members.

- K. Return wood trusses that are damaged or do not meet requirements to fabricator and replace with trusses that do meet requirements.
 - a. Do not alter trusses in the field.

3.02 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Protective Coating:
 - a. Clean and prepare exposed surfaces of embedded-metal connector plates. Brush apply primer, when part of coating system, and one coat of protective coating.
 - b. Apply materials to provide minimum dry film thickness recommended by manufacturer of coating system.

END OF SECTION

SECTION 07150 DAMPPROOFING

PART 1- GENERAL

1.01 SCOPE

- A. The work under this Section includes, but is not necessarily limited to, the furnishing and installation of all dampproofing as indicated on the Drawings, herein specified and as necessary for the proper and complete performance of this work.
- B. The bituminous dampproofing materials specified herein shall be surface applied as follows:
 - 1. Do not apply to the outside of concrete tanks which contain water.
 - 2. Apply to wall behind exterior wythe as indicated on the Drawings.
- C. Provide all labor, materials, equipment, and appliances as required for the proper installation of dampproofing as follows:
 - 1. Prepare all surfaces as specified herein to receive dampproofing.
 - 2. Provide dampproofing at all vertical and horizontal surfaces shown on the Drawings.
 - 3. The manufacturer shall provide all certifications, test data, affidavits or samples requested by the Engineer.
 - 4. Perform all installations to comply with local rules, ordinances and regulations, OSHA Requirements and EPA Statutes complying with environmental protection.
 - 5. Perform all installations in accordance with the approved construction progress schedule or at such times necessary for the orderly and expeditious completion of the Project.
 - 6. Upon completion of dampproofing, remove all waste or rubbish resulting from dampproofing operations and all equipment used for same.

1.02 SUBMITTALS

Submit approved manufacturer's product literature for dampproofing materials including all special details and recommended application procedures in accordance with the requirements of Section 01340 of these Specifications.

1.03 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect dampproofing materials before, during and after installation and to protect the installed work and materials of all

other trades, contiguous to the dampproofed surfaces. Packaged containers shall be stored on wood skids, 6-inches off the ground and covered with heavy plastic sheeting which shall remain in place at all times.

- B. Replacement: All broken containers and their contents shall be removed from the premises, discarded in a legal fashion, and replaced with new materials at no additional cost to the Owner.

1.04 COORDINATION

- A. Review all Drawings and details of installations of other adjoining materials and cooperate with the respective trades.
- B. The applicator's particular attention is directed to the requirement to properly prepare surfaces for the attachment of other materials and to chip out and repack surfaces at all attachments.

1.05 QUALITY ASSURANCE

- A. Qualifications of Installers
 - 1. The applicators performing this work must have a minimum of five years experience in this type of dampproofing and be able to show that they have successfully carried out contracts of a similar nature, size, and scope.
 - 2. Provide at least one person who shall be present during execution of this portion of the work and who shall be thoroughly experienced in installation of the specified products and shall direct all work performed under this Section.
- B. Manufacturer's Certification: Prior to start of installation of the work of this Section, arrange a visit to the job site by a representative of the manufacturer of the dampproofing materials used, who shall inspect and certify:
 - 1. That the surfaces to which dampproofing is to be applied are in condition suitable to receive dampproofing.
 - 2. That the materials to be installed comply in all respects with the requirements of this Section.
 - 3. That the applicator has the experience to install said materials in complete accordance with the manufacturer's current recommendations.

1.06 WARRANTY

Furnish a written warranty, warranting materials and workmanship for a period of five years after acceptance of the work of this Section and binding the Contractor to repair and make good, at no additional cost to the Owner, all defects which appear during this period.

PART 2- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Cold-applied, asphalt emulsion dampproofing shall be equal to Chem Rex, Inc., Sonneborn, or W.R. Meadows.

2.02 BITUMINOUS DAMPPROOFING

- A. General: Provide products recommended by manufacturer for designated application.
- B. Cold-Applied, Asphalt Emulsion Dampproofing: Asphalt-based emulsions recommended by the manufacturer for dampproofing use when applied according to the manufacturer's instructions. Trowel grade shall be emulsified asphalt mastic, prepared with mineral-colloid emulsifying agents suitable for application in a relatively thick film, complying with ASTM D 1187, Type I.

2.03 PRIMER

Asphalt primer complying with ASTM D 41, for asphalt-based dampproofing.

PART 3- EXECUTION

3.01 INSTALLATION

- A. Apply all dampproofing materials in strict accordance with manufacturer's instructions and recommendations and this Section.
- B. Before backfilling against dampproofing, repair all damaged surfaces.

3.02 PREPARATION

- A. Clean substrate of projections and substances detrimental to work; comply with recommendations of prime materials manufacturer.
- B. Install accessories as recommended by prime materials manufacturer even though not shown.
- C. Fill voids, seal joints, and apply bond breakers, if any, as recommended by prime materials manufacturer, with particular attention at construction joints.
- D. Install separate flashings and corner protection stripping, as recommended by prime materials manufacturer, where indicated to precede application of dampproofing. Comply with details shown and with manufacturer's recommendations. Pay particular attention to requirements at building expansion joints, if any.
- E. Prime substrate as recommended by prime materials manufacturer.

- F. Protection of Other Work: Do not allow liquid and mastic compounds to enter and clog drains and conductors. Prevent spillage and migration onto other surfaces of work by masking or otherwise protecting adjoining work.

3.03 INSTALLATION, GENERAL

- A. Comply with manufacturer's recommendations except where more stringent requirements are indicated and where Project conditions require extra precautions to ensure satisfactory performance of work.
- B. Application: Apply dampproofing to the following surfaces:
 - 1. Exterior surface of inside wythe of double-wythe, exterior masonry walls above grade, to prevent water-vapor penetration through the wall.
 - 2. Where indicated on the drawings.

3.04 COLD-APPLIED, ASPHALT EMULSION DAMPPROOFING

Trowel-Grade: Trowel apply a coat of mastic asphalt emulsion dampproofing onto substrate at a minimum rate of 7 gallons per 100 square feet, to produce an average, dry-film thickness of 60 mils but not less than 30 mils at any point.

3.05 PROTECTION AND CLEANING

Remove overspray and spilled materials from surfaces not intended to receive dampproofing.

END OF SECTION

SECTION 07210 BUILDING INSULATION

PART 1 GENERAL

1.01 SCOPE

The work covered by this Section includes furnishing all labor, materials and equipment required to furnish and install all building insulation as specified herein and/or shown on the Drawings.

1.02 SUBMITTALS

- A. Complete product data shall be submitted to the Engineer.
- B. Certified Test Reports: With product data, submit copies of certified test reports showing compliance with specified performance values, including R-values, fire performance and sound abatement characteristics.

1.03 STORAGE AND PROTECTION

Insulation shall be stored indoors in a dry location in accordance with the manufacturer's instructions.

1.04 QUALITY ASSURANCE

- A. All insulation shall be delivered to the site in unopened packages. Packages shall be clearly marked with the manufacturer's name, type, quantity of insulation and "R" value (where applicable).
- B. Installer Qualifications for Foamed-In-Place Masonry Insulation: Engage an experienced dealer/applicator who has been trained and licensed by the product manufacturer and which has not less than three years direct experience in the installation of the product used.

PART 2 PRODUCTS

2.01 FOAMED-IN-PLACE MASONRY INSULATION

- A. Foamed-In-Place Masonry Insulation: Two component thermal insulation produced by combining a plastic resin and catalyst foaming agent surfactant which, when properly ratioed and mixed, together with compressed air produce a cold-setting foam insulation in the hollow cores of hollow unit masonry walls.
 - 1. Fire-Resistance Ratings: Minimum four (4) hour fire resistance wall rating (ASTM E-119) for 8-inch and 12-inch concrete masonry units when used in standard two (2) hour rated CMUs.
 - 2. Surface Burning Characteristics: Maximum flame spread, smoke developed and fuel contributed of 0, 5 and 0 respectively.

3. Combustion Characteristics: Must be noncombustible, Class A building material.
4. Thermal Values: "R" Value of 4.91/inch at 32 degrees F mean; ASTM C-177.
5. Sound Abatement: Minimum Sound Transmission Class ("STC") rating of 53 and a minimum Outdoor Indoor Transmission Class ("OITC") rating of 44 for 8- inch wall assembly (ASTM E 90-90).

2.02 BATT INSULATION

Batt insulation shall be nominal 24-inch wide Kraft paper faced fiberglass Batts with a thickness as shown on the Drawings.

2.03 VAPOR BARRIER

Vapor barrier shall be 0.006-inch thick polyethylene film membrane in a width as wide as practical.

PART 3 EXECUTION

3.01 INSTALLATION OF FOAMED-IN-PLACE INSULATION

- A. General: Install foamed-in-place insulation from interior, or as specified, prior to installation of interior finish work and after all masonry and structural concrete work is in place; comply with manufacturer's instructions.
- B. Installation: Fill all open cells and voids in hollow concrete masonry walls where shown on Drawings. The foam insulation shall be pressure injected through a series of 5/8-inch to 7/8-inch holes drilled into every vertical column of block cells (every 8 inches on center) beginning at an approximate height of four (4) feet from finished floor level. Repeat this procedure at an approximate height of ten (10) feet above the first horizontal row of holes (or as needed) until the void is completely filled. Patch holes with mortar and score to resemble existing surface.

3.02 INSTALLATION OF VAPOR BARRIER

Install vapor barrier directly over fill and perimeter insulation. Where joints in membrane occur, lap a minimum of 18-inches. Exercise care not to puncture the membrane. Where punctures occur, patch so as to maintain a continuous membrane. Install concrete slab floor directly over the vapor barrier.

3.03 CLEANING

Prior to acceptance of the work of this Section, thoroughly clean all installed materials and related areas.

END OF SECTION

**SECTION 07600
FLASHING AND SHEET METAL**

PART 1 GENERAL

1.01 SCOPE

The work covered by this Section consists of furnishing all labor, equipment and material required to install all sheet metal work, including metal flashing and counterflashing, flashing transitions, wall flashing, gutters, downspouts, scuppers, copings, and related work as described herein and/or shown on the Drawings.

1.02 SUBMITTALS

- A. Submittals shall be made to the owner for approval via ME Sack Engineering.
- B. Submit written information regarding material proposed and installation instructions for the use substantiating compliance with Specification requirements. Submit two samples, 8-inches long, of each type of flashing or sheet metal fabrication and each accessory specified.
- C. Samples for Verification of each type of exposed finish indicated in manufacturer's standard sizes. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
- D. Submit shop drawings, showing manner of forming, jointing and securing flashings, guttering and accessories. Detail waterproof connections to adjoining work and at obstructions and penetrations. Shop drawings shall indicate thickness and dimensions of all parts, fastening and anchoring methods, details and locations of all seams, joints and other provisions necessary for thermal expansion and contraction.

1.03 STORAGE AND PROTECTION

- A. Sheet metal materials and accessories shall be stored and protected in accordance with the requirements of these Specifications.
- B. The Contractor shall protect all stainless steel materials from exposure to chlorides and muriatic acids. Wash affected areas immediately with five percent soda solution and rinse with clear water.
- C. Sheet metal work shall be handled with sufficient care to prevent damage to surfaces, edges and ends. All material at site shall be stored above ground in a covered, dry location. Damaged material that cannot be restored to its original condition will be rejected and shall be replaced at no additional cost to the Owner.

1.04 QUALITY ASSURANCE

The manufacturer shall provide written certification to the Engineer that all products furnished comply with all applicable requirements of these Specifications.

1.05 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Finish Warranty: Submit a written warranty, signed by manufacturer, covering failure of the factory-applied finish within the specified warranty period and agreeing to repair finish or replace components that show evidence of finish deterioration. Deterioration of finish includes, but is not limited to, color fade, chalking, cracking, peeling, and loss of film integrity.
- C. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 METALS

- A. Aluminum Extrusions: ASTM B 221, 6063-T5 alloy and temper, or as recommended by the manufacturer for use intended and as required for proper application of finish indicated.
- B. Aluminum Sheet: ASTM B 209, alloy and temper as recommended by the aluminum producer and finisher for use intended and finish indicated, with not less than the strength and durability of alloy and temper designated below.
 - 1. Alloy 3003-H14, with a minimum thickness of 0.040-inch, unless otherwise indicated, for aluminum sheet with mill finish.
 - 2. Alloy 5005-H14, with a minimum thickness of 0.050-inch for aluminum sheet with other than mill finish.
- C. Galvanized Steel Sheet: ASTM A 653, G90 coating designation; commercial quality; at least 0.034-inch thick, unless otherwise indicated.
- D. Stainless Steel Sheet: ASTM A 666, Type 304, soft annealed, with No. 2D finish, unless harder temper is required for forming or performance; at least 0.0187-inch thick, unless otherwise indicated.

2.02 GUTTER AND DOWNSPOUTS

- A. Provide gutters and downspouts in shapes and sizes indicated, with mitered and welded corners. Install steel straps formed from at least 0.028-inch thick, galvanized steel sheet; hangers, or other attachment devices; screens; end

plates; and trim and other accessories indicated or required for a complete installation.

- B. Provide gutters and downspout components fabricated from formed aluminum sheet in thickness indicated, but not less than the following:
 - 1. Gutter Thickness: 0.050-inch.
 - 2. Downspout Thickness: 0.025-inch.

2.03 COPINGS

Provide copings in shapes and sizes indicated, with shop-fabricated corners. Coping shall be Petersen Aluminum TITE-LOC Coping System UL-I90, fabricated from formed aluminum sheet, not less than 0.050-inch thick. Color as indicated on Drawings.

2.04 PARAPET SCUPPER AND CONDUCTOR HEADS

Provide parapet scuppers and conductor heads as indicated on Drawings. Fabricate scuppers of dimensions required with closure flange trim to exterior, 4-inch wide wall flanges to interior and base extending 4-inches beyond cant or tapered strip into field of roof. Fabricate conductor heads with flanged back, stiffened top edge, and built-in overflows. Fabricate conductor heads and scuppers from 0.0320 aluminum. Finish to match metal coping.

2.05 ACCESSORIES

- A. General: Provide manufacturer's standard accessories designed and manufactured to match and fit roof edge treatment system indicated.
- B. Exposed Fasteners: Stainless steel, non-magnetic, of manufacturer's standard type and size for product and application indicated. Match finish of exposed heads with material being fastened.
- C. Concealed Fasteners: Same metal as item fast or other non-corrosive metal as recommended by the manufacturer.
- D. Galvanizing Repair Paint: High-zinc-dust content paint for reglazing weld in steel, complying with SSPC-Paint 20.
- E. Asphalt Mastic: SSPC-Paint 12, solvent-type asphalt mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15 mil dry film thickness per coat.
- F. Mastic Sealant: Polyisobutylene; non-hardening, non-skinning, non-drying, non-immigrating sealant.
- G. Foam-Rubber Seal: Manufacturer's standard foam.
- H. Adhesives: Type recommended by the manufacturer for substrate and Project conditions, and formulated to withstand a minimum of 60 pounds per square foot wind up-lift force.

- I. Splash Blocks: Splash blocks shall be reinforced precast concrete, 3,000 psi, 30 x 16 x 4-inches thick.
- J. Bituminous Plastic Cement: Where bituminous plastic cement is specified or shown on the Drawings, use cement conforming to Federal Specification SS-C-153, Type I.
- K. Solder: Solder shall be ASTM B 32, Alloy grade 58, composed of 50 percent tin and 50 percent lead.
- L. Flux: Flux used on stainless steel shall be a phosphoric acid base flux equal to "MicroFlex Soldering Flux" by Washington Steel Corporation or Type "MA" by Lake Chemical Co.

2.06 FINISHES - GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective coating before shipment.
- C. Finish manufactured roof specialties after fabrication and assembly if products are not fabricated from pre-finished metals.
- D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved samples. Noticeable variations in the same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

2.07 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.
- C. Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.

2.08 METAL FINISHES

- A. General: Apply coating either before or after forming and fabricating flashing and sheet metal as required by coating process and as required for maximum coating performance capability. Protect coating promptly after application and

cure by application of strippable film or removable adhesive cover, and retain until installation has been completed.

- B. Fluoropolymer Coating: Full-strength, 70 percent "Kynar 500" coating baked-on for 15 minutes at 450 degrees F in a dry film thickness of 1.0 mil, 30 percent reflective gloss (ASTM D 523), over minimum 0.2 mil baked-on modified epoxy primer.
- C. Durability: Provide coating which has been field tested under normal range of weathering conditions for a minimum of 20 years without significant peel, blister, flake, chip, crack, or check in finish, and without chalking in excess of 8 (ASTM D 659), and without fading in excess of 5 NBS units.
- D. Color: As selected from manufacturer's standard colors, and as indicated on the Drawings.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that substrates are smooth and clean to extent needed for sheet metal work.
- B. Verify that reglets, nails, cants and blocking to receive sheet metal are installed and free of concrete and soil.
- C. Do not start sheet metal work until conditions are satisfactory.

3.02 PREPARATION

- A. Before installing sheet metal, verify shapes and dimensions of surface to be covered.
- B. Promptly remove protective film, if any, from exposed surfaces of finished metals. Strip with care to avoid damage to finish.
- C. Prepare concrete, concrete masonry block, cement plaster, and similar surfaces to receive roof edge system specified. Install blocking, cleats, water dams, and other anchoring and attachment accessories and devices required.

3.03 INSTALLATION

- A. General
 - 1. Install all flashing and sheet metal work in accordance with the "Architectural Sheet Metal Manual" by SMACNA.
 - 2. Install work watertight, without waves, warps, buckles, fastening stresses or distortion, allowing for expansion and contraction.

3. Hem exposed edges except edges forming drip lips.
- B. Seams
1. Common Lock Seams: 5/8-inch finished width; four-ply loose lock.
 2. Flat Lock Seams: 3/4-inch finished width; four-ply flat lock, malleted tight; sweated full with solder.
 3. Drive Lock Seams: Fold back abutting edges; cover joint with 1/8-inch wide loose drive cap.
 4. Single Corner Seams: 5/8-inch finished width; three-ply loose lock; corners lapped and soldered.
 5. Double Corner Seams: 5/8-inch finished width; four-ply double lock
 6. Lap Seams: 7/8-inch finished width.
 7. Soldered Lap Seams: 1-inch finished width; sweated full with solder.
- C. Gutters
1. Install inside straps at 30-inches on center, riveted to rear of gutter and locked into beaded front edge.
 2. Support lower edge of gutter with heavy duty support brackets at 30-inches on center. Alternate with inside straps.
- D. Downspouts
1. Hangers shall conform with SMACNA, minimum 0.028 x 1-inch flat stock galvanized steel.
 2. Downspout shall be securely fastened to the wall with aluminum bands located not more than five feet apart. Anchorage shall be made with 1/4-inch stainless steel machine bolts into noncorrosion anchors.
- E. Conductor Heads and Scuppers: Conform design and installation with SMACNA.
- F. Soldering
1. Other Materials: Clean and flux metals prior to soldering. Sweat solder completely through seam width.

3.04 PAINTING

All exposed galvanized items shall be factory-painted in accordance with the requirements of Section 09900 of these Specifications. After installation, the galvanized items shall be touched up with identical paint supplied from the factory.

3.05 INSPECTION

Damaged work shall be repaired or replaced. The Contractor shall make, at Contractor's own expense, all necessary changes, modifications and/or alterations required to ensure a satisfactory installation.

3.06 CLEANING

- A. As work progresses, neutralize excess flux with 5 to 10 percent washing soda solution, and thoroughly rinse.
- B. Prior to acceptance of the work of this Section, clean all installed materials and affected work areas in accordance with the requirements of Section 01710 of these Specifications.

END OF SECTION

**SECTION 07610
METAL ROOF PANELS**

PART 1 GENERAL

1.01 SUMMARY

This Section includes factory-formed and field-assembled, metal roof panels.

1.02 DEFINITIONS

- A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight roofing system.
- B. Solar Flux: Direct and diffuse radiation from the sun received at ground level over the solar spectrum, expressed in watts per square meter.
- C. Solar Reflectance: Fraction of solar flux reflected by a surface, expressed as a percent or within the range of 0.00 and 1.00.

1.03 PERFORMANCE REQUIREMENTS

- A. General: Provide metal roof panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by a qualified testing and inspecting agency.
- B. FMG Listing: Provide metal roof panels and component materials that comply with requirements in FGM 4471 as part of a panel roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FGM markings.
 - 1. Fire/Windstorm Classification: Class 1 A-120.
- C. Thermal Movements: Provide metal roof panel assemblies that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.04 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profile, and finishes for each type of metal roof panel and accessory.

- B. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.
 - 1. Accessories: Include details of the following items, at a scale of not less than 1- 1/2 inches per 12 inches (1:10):
 - a. Flashing and trim.
- C. Warranties: Special warranties specified in this Section.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
 - 1. Installer's responsibilities include fabricating and installing metal roof panel assemblies and providing professional engineering services needed to assume engineering responsibility.
 - 2. Engineering Responsibility: Preparation of data for metal roof panels, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Source Limitations: Obtain each type of metal roof panels through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of metal roof panels and are based on the specific system indicated. Do not modify intended aesthetic effects, as judged solely by Engineer, except with Engineer's approval. If modifications are proposed, submit comprehensive explanatory data to Engineer for review.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver components, sheets, metal roof panels, and other manufacturer items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.
- B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.

- D. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

1.07 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal roof panels to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify locations of roof framing and roof opening dimensions by field measurements before metal roof panel fabrication and indicate measurements on Shop Drawings.
- C. Established Dimensions: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal roof panels without field measurements, or allow for field- trimming of panels. Coordinate roof construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.08 COORDINATION

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations, which are specified elsewhere.
- B. Coordinate metal panel roof assemblies with rain drainage work, flashing, trim, and construction of decks, parapets, walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.09 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal roof panel assemblies that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including rupturing, cracking, or puncturing.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: One year from date of Final Acceptance.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturer: Subject to compliance with requirements, provide products by the manufacturer specified.

2.02 PANEL MATERIALS

- A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the soil-coating process to comply with ASTM A 775/A 755M.
 - 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
 - 2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792, Class AZ50 coating designation, Grade 40; structural quality.
 - 3. Surface: Smooth, flat finish.
 - 4. Exposed Finishes: Apply the following coil coating, as specified, or indicated on Drawings.
 - 5. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
- B. Panel Sealants:
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
 - 2. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.
 - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.03 UNDERLAYMENT MATERIALS

- A. Felts: ASTM D 226, Type I (No. 15) asphalt-saturated organic felts.
- B. Slip Sheet: Building paper, minimum 5 lb/100 sq. ft., rosin sized.

2.04 MISCELLANEOUS METAL FRAMING

- A. General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with manufacturer's standard corrosion-resistant zinc coating.
- B. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base Metal Thickness: 0.0179 inch.
 - 2. Depth: 7/8 inch.
- C. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.05 MISCELLANEOUS MATERIALS

- A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating.
 - 1. Fasteners for Roof Panels: Self-drilling or self-tapping 410 stainless or zinc- alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal roof panels.
 - 2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
 - 3. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
- B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.06 METAL ROOF PANELS

- A. General: Provide factory-formed metal roof panel assembly designed to be field assembled by covering vertical side edges of adjacent panels with a continuous interlocking leg and mechanically attaching panels to supports using concealed clips.
- B. Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.
 - 1. Manufacturer: Berridge Manufacturing Company.

2. Panel System: Snap-Clad, 24-gauge steel.
3. Clips: One piece.
 - a. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
4. Sealant: Factory applied sealant bead.
5. Panel Coverage: 18 inches nominal.
6. Batten Height: 1.75 inches.
7. Uplift Rating: UL 120.
8. Color: As indicated on Drawings.

2.07 ACCESSORIES

- A. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including trim, copings, fascia, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels, unless otherwise indicated.
 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch thick, flexible closure strips; cut or premolded to match roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- B. Flashing and Trim: Formed from 0.0179-inch thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fascia, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.
- C. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

2.08 FABRICATION

- A. General: Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by

laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Where indicated, fabricate metal roof panel joints with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will minimize noise from movements within panel assembly.
- D. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 - 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 4. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
 - 5. Conceal Fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal roof panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal roof panel manufacturer for application but no less than thickness of metal being secured.

2.09 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of work.
 - 1. Examine metal deck and mailable insulation so that installation is within flatness tolerances required by metal roof panel manufacturer.
 - 2. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
- B. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
- B. Install flashings and other sheet metal to comply with requirements specified elsewhere.
- C. Miscellaneous Framing: Install sub purlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written recommendations.

3.03 UNDERLAYMENT INSTALLATION

- A. Felt Underlayment: Install felt underlayment and building-paper slip sheet on roof sheathing under metal roof panels, unless otherwise recommended by metal roof panel manufacturer. Use adhesive for temporary anchorage, where possible, to minimize use of mechanical fasteners under metal roof panels. Apply at locations indicated on Drawings, in shingle fashion to shed water, with lapped joints of not less than two inches.
- B. Install flashings to cover underlayment to comply with requirements specified elsewhere.
- C. Apply slip sheet over underlayment before installing metal roof panels.

3.04 METAL ROOF PANEL INSTALLATION, GENERAL

- A. General: Provide metal roof panels of full length from eave to ridge, unless otherwise indicated or restricted by shipping limitations. Anchor metal roof panels and other components of the Work securely in place, with provisions for thermal and structural movement.
1. Field cutting of metal roof panels by torch is not permitted.
 2. Install panels perpendicular to purlins.
 3. Rigidly fasten eave end of metal roof panels and allow ridge end free movement due to thermal expansion and contraction. Predrill panels.
 4. Provide metal closures at peaks, rake edges, rake walls and each side of ridge and hip caps.
 5. Flash and seal metal roof panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.
 6. Locate and space fastenings in uniform vertical and horizontal alignment.
 7. Install ridge and hip caps as metal roof panel work proceeds.
 8. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 9. Lap metal flashing over metal roof panels to allow moisture to run over and off the material.
- B. Fasteners:
1. Steel Roof Panels: Use stainless-steel fasteners for surfaces exposed to the exterior and galvanized steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
- D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.
1. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.

2. Prepare joints and apply sealants to comply with requirements specified elsewhere.

3.05 FIELD-ASSEMBLED METAL ROOF PANEL INSTALLATION

- A. Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each interlocking joint at location, spacing, and with fasteners recommended by manufacturer.
 1. Install clips to supports with self-drilling fastener.
 2. Interlock metal roof panel at seams, fully engaged to provide weathertight joints.

3.06 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
 1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual". Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
 1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of ten feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than one inch deep, filled with mastic sealant (concealed within joints).
- C. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.07 ERECTION TOLERANCES

Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8- inch offset of adjoining faces and of alignment of matching profiles.

3.08 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.
- B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07900 SEALANTS

PART 1 GENERAL

1.01 SCOPE

The work covered by this Section consists of furnishing all labor, equipment and material required to apply all sealants and related work as described herein and/or shown on the Drawings.

1.02 SUBMITTALS

Complete engineering and product data shall be submitted to ME Sack Engineering in accordance with the requirements of these Specifications. Color samples shall be submitted for approval by the Owner.

1.03 STORAGE AND DELIVERY

- A. Materials shall be stored in strict conformance with the manufacturer's instructions and in accordance with the requirements of these Specifications.
- B. Materials shall be delivered to the job site in sealed containers, with the manufacturer's original labels attached and accompanied by written certification indicating compliance with the requirements of these Specifications.

1.04 QUALITY ASSURANCE

The manufacturer shall provide ME Sack Engineering with written certification that all products furnished comply with all applicable requirements of these Specifications.

1.05 WARRANTY

- A. Provide a warranty against defective materials and workmanship in accordance with the requirements of these Specifications.
- B. The following types of failures will be considered defective work requiring replacement: leakage, hardening, cracking, crumbling, melting, shrinking or running of caulking compound or staining of adjacent work by caulking compound.

PART 2 PRODUCTS

2.01 SILICONE SEALANT

- A. Acceptable Products: Dow Corning Corporation (#790), or General Electric Company (Silpruf).
- B. Type: One-part low modulus silicone rubber.

- C. Colors: To be selected from manufacturer's standard.

2.02 ONE-PART, NON-SAG POLYURETHANE SEALANT

- A. Acceptable Products: Mameco International, Vulken (#116), Sonneborn Building Products, Sonolastic (NP-1), or Tremco, Inc. (Dymeric).
- B. Colors: To be selected from manufacturer's standard.

2.03 TWO-PART, POURABLE POLYURETHANE SEALANT

- A. Acceptable Products: A.C. Horn, Inc. (Daraseal-U), Memeco International, Vulkem (#245), Tremco, Inc. (THC-900), or W.R. Meadows, Inc. (Pourthane).
- B. Colors: To be selected from manufacturer's standard.

2.04 ACRYLIC SEALANT

- A. Acceptable Products: A.C. Horn, Inc. (Daraseal A.R.), DAP, Inc. (DAP Acrylic), Protective Treatments, Inc. (#737), Tremco, Inc. (Mono), or W.R. Meadows, Inc. (Solaply).
- B. Type: One part acrylic polymer sealant.
- C. Colors: To be selected from manufacturer's standard.

2.05 JOINT BACKING

Joint backing, where indicated or required, shall be equal to "Tremco Joint Backing" by Tremco Mfg. Company or "Ethafoam SB" backer rod by Dow Chemical Company. Application shall be in accordance with sizes listed below:

Joint Size, inches	Rod Diameter, inches
3/16	1/4
1/4	3/8
3/8	1/2
1/2	5/8
5/8	3/4
3/4	1

2.06 COLORS AND DURABILITY

- A. Color of sealant or caulking shall be as selected by ME Sack Engineering.
- B. Caulking shall have a minimum life expectancy of 20 years and shall be resistant to the effects of sunlight, abrasion, oils, mild chemicals, cleaning agents and immersion in water.

PART 3 EXECUTION

3.01 PREPARATION

- A. All joints or channels shall be cleaned and free of dirt, oil, grease, moisture, old paint, loose mortar, and other foreign matter.
- B. Metal surfaces shall be wiped with material equal to Zylol or Mek and then dried.
- C. Masonry surfaces shall be cleaned with a wire brush and then blown clean. Any waterproofing treatments contaminating the joint must be completely removed.
- D. Where joints are 1/2-inch wide, they should be backed to 1/2-inch of the surface. All 3/4-inch-wide joints shall be backed to 1/4-inch of the surface. Size of joint backing shall be large enough so that it can be compressed by at least 30 percent before inserting into the joint.
- E. Surface of concrete or masonry shall be primed in accordance with the manufacturer's printed instructions.

3.02 CAULKING SCHEDULE

- A. Silicone Sealant: All exterior joints and interior expansion and control joints, except horizontal floor joints.
- B. One-Part, Non-Sag Polyurethane Sealant: Interior joints, except as otherwise scheduled.
- C. Two-Part, Pourable Polyurethane Sealant: Horizontal floor and pavement joints.
- D. Acrylic Sealant: Interior sealant joints to be painted, except joints in drywall construction of less than 1/8-inch in width.

3.03 APPLICATION

- A. The Contractor shall caulk all joints (both inside and outside of jambs, heads, and sills) between the metal doors, windows, louvers, etc. and masonry throughout the buildings, as indicated on the Drawings, or otherwise required, so as to leave the building weathertight.
- B. Apply sealant with hand or air gun under sufficient pressure and through nozzle openings of such a diameter so that a full bead of sealant is run into the joint and fills the opening completely.
- C. Apply joint backer with a blunt rounded tool in accordance with manufacturer's instructions so it will not stain the sealant.
- D. All beads should be tooled immediately after application to insure firm and full contact with the interface of the joint.

- E. Work shall be of highest quality and in accordance with the manufacturer's current printed instructions.

3.04 CLEANING

Remove all excess material and smears adjacent to joint as work progresses.

END OF SECTION

SECTION 08100
STEEL DOORS AND FRAMES

PART 1 – GENERAL

1.01 Provide all labor, materials, and services required for complete installation of steel door and frames.

1.02 DELIVERY AND STORAGE

- A. To provide protection during shipment, welded unit type frames shall be strapped together in pairs with heads at opposite ends or provided with temporary steel spreaders at the bottom of each frame; and knockdown type frames shall be securely strapped in bundles.
- B. Materials shall be delivered to the site in undamaged condition, stored out of contact with the ground and under a weather tight covering, permitting good air circulation.
- C. Whenever they become evident, abraded, scarred or rusty areas shall be cleaned and touched up with the paint used for the shop painting.

1.03 QUALITY ASSURANCE:

Steel doors and frames shall be fabricated in accordance with the applicable standards of:

- A. Steel Door Institute (SDI).
- B. American National Standards Institute (ANSI).
- C. American Society for Testing and Materials (ASTM).

PART 2 – PRODUCTS

2.01 GENERAL REQUIREMENTS FOR FRAMES:

- A. Steel: Frames shall be factory fabricated from steel conforming to ASTM A 366 or A 569, stretcher level degree of flatness, pickled and oiled if of hot rolled material, and Manufacturer's Standard Gages specified hereinafter for the various uses.

B. Shop Painting: After fabrication, frames shall be thoroughly cleaned, pretreated to provide a strong bond between metal and paint, and shop painted with a rust inhibiting primer paint.

C. Workmanship:

1. The finish items shall be rigid, neat in appearance, and free from defects warp, or buckle.
2. Welded members shall be sharp in detail, straight, and true.
3. Corner joints shall be coped or mitered, well formed, and in true alignment.
4. Exposed welded joints shall be dressed smooth.

D. Preparation for Hardware:

1. Frames shall be prepared for hardware in conformance with the templates provided under Section 08700, Finish Hardware; the requirements of ANSI A115.1, A115.2, A115.3, A115.4, and A123.1.
2. Cutting, reinforcing, drilling, and tapping of frames shall be done at the factory, except drilling and tapping for surface applied hardware will be done in the field when the hardware is applied.
3. In addition to the plaster guards required for strike reinforcement in the referenced American National Standards, plaster guards shall be provided on the doorframes for the hinge reinforcement.
4. Frames shall be prepared for silencers, and rubber silencers shall be provided with the frames.

E. Sound Deadening:

Doors shall be prepared with a sound deadening material standard with the manufacturer to eliminate metallic sound incident to the normal operation of the door.

2.02 CONSTRUCTION OF FRAMES:

A. Pressed steel frames for doors and other openings shall be of the combination buck, frame, and trim type of the sizes and details shown.

1. Gages of metal shall be not lighter than 16 gauge.
2. Frames shall be welded type.
3. Knockdown frames shall not be permitted.
4. Frames shall have headers and jambs secured at the corners either by internal welding of faces or by welded splice plates and shall be further secured at the rabbet either by welding or by mechanical interlock.
5. As an alternate, the headers and jambs shall be secured at the corners by external welding of faces and grinding smooth.
6. Faces of frames at junction of head and jamb shall present neat line joints. Mullions and transom bars shall member with heads or jambs, as applicable, and shall be butt welded thereto.

B. Anchors:

1. Frames shall be provided with a minimum of 3 wall anchors per jamb spaced not over 24 inches apart as required for the adjoining wall construction, ceiling strut anchors as required for the adjoining wall construction, ceiling strut anchors as required by the drawings, and anchors for attachments of frame to the floor.
2. The bottom of frames shall be at the finish floor level shown and supported by an 18 gauge adjustable or extended clip angle.
3. Jamb anchors shall be of not less than 18 gage steel or 3/16" diameter wire.

2.03 CONSTRUCTION OF DOORS

- A. Doors shall be SDI, Grade II, Heavy Duty, the type, size, and design shown.
- B. Door clearance shall not exceed the following: 1/8" at jambs and heads; 1/4" at meeting stiles of pair of doors; and 3/4" at bottom measured from finished floor line.
- C. Exterior doors shall have top edges closed flush and sealed against water penetration.
- D. Flush Doors shall be of full flush construction. Doors shall be internally reinforced to resist impact and to insure flatness of finished surfaces by steel members welded in place, water resistant honeycomb core glued in place or rigid insulation core glued or foamed in place. Doors with metal reinforcing shall have sound deadening material

applied to the interior of the door to eliminate metallic sound incident to normal door operation.

1. Honeycomb core material shall have a crushing strength of not less than 4,000 psf. and the lamination shall with stand not less than 1,500 psf. surface shear.
2. Foam insulation core material shall have a compressive strength of not less than 1,500 psf. and a shear strength not less than 18 psi. shall have an insulation to steel strength at least equal to the strength of the insulation, shall be dimensionally stable within plus or minus 5% of volume after 24 hour exposure to temperature ranging from minus 15 degree F to 165 degree F., shall have no voids exceeding 1/2" in any direction and shall have a density of not less than 1.0 pound per cubic foot. Foam insulation shall be rated as self extinguishing when tested in accordance with ASTM D 1692.
3. Solid mineral insulation core material shall have a density of not less than 20 pounds per cubic foot.

E. Face sheets shall not be less than 18 gage steel, shall have no seams or joints on door faces, and shall have top and bottom closed with a recessed channel or a flush end closure treatment.

F. Doors shall be galvanized.

2.04 APPROVED MANUFACTURERS: Steel craft, Amweld, Fenestra

PART 3 – EXECUTION

- 3.01 Each item specified in this section shall be installed plumb and level with all moving parts working, complete with all trim, filler panels, and hardware for installation.
- 3.02 Temporary spreaders shall be installed until the wall at the frame is completed and the frame is securely anchored in its position.
- 3.03 Wall anchors on door frames shall be installed approximately at the hinge and strike levels.
- 3.04 Doors shall be installed in conjunction with the application of hardware.
- 3.05 Weather stripping and thresholds shall be installed at exterior door openings to provide a weather tight installation.

- 3.06 Finished work shall be strong and rigid, neat in appearance and free from defects. Fabricate molded members straight and true with corner jambs well formed, in true alignment and fastenings concealed where practicable.

END OF SECTIONS

SECTION 08301 FLOOR DOORS

PART 1 GENERAL

1.01 SCOPE

The work covered by this Section consists of furnishing all labor, equipment and materials required to furnish and install aluminum floor doors as shown on the Drawings and/or specified herein.

1.02 DESIGN REQUIREMENTS

Exterior floor doors shall be designed for a live load of not less than 300 pounds per square foot at an extreme fiber stress in bending of not more than 33 percent of the minimum yield strength of the material.

1.03 SUBMITTALS

Complete shop drawings and engineering data shall be submitted in accordance with the requirements of Section 01340 of these Specifications.

1.04 STORAGE AND PROTECTION

Floor doors shall be stored and protected in accordance with the requirements of Section 01640 of these Specifications.

PART 2 PRODUCTS

2.01 EXTERIOR FLOOR DOORS

- A. Exterior floor doors shall be constructed of aluminum with a diamond pattern tread or other acceptable raised non-slip surface. Doors shall be watertight and of the sizes shown on the Drawings.
- B. Frames shall be 1/4-inch extruded aluminum formed to a channel gutter approximately 3-inches wide, with an anchor flange around the perimeter. Containing frames shall be neatly made. Sufficient anchors shall be attached to the frames for proper anchoring into the concrete. Clear opening must not be reduced. A 1-1/2-inch drainage coupling for plumber's connection shall be provided in the low corner of the channel frame located as indicated on the Drawings.
- C. Doors shall be provided with a minimum of two heavy forged bronze hinges with stainless steel pins. Doors shall be equipped with an outside flush lifting handle, hold back safety chains, spring operators for easy operation and an automatic hold-open arm with vinyl grip release handle.
- D. Factory finish for exterior floor doors shall be mill finish with bituminous coating applied to all surfaces in contact with concrete.

- E. Floor doors shall be furnished with all stainless steel hardware.
- F. Exterior floor doors shall be single-leaf or double-leaf as shown on the Drawings and shall be Bilco Type J or JD.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All floor doors shall be completely assembled in the containing frames prior to their delivery to the Project. The exterior of the frames and anchors, or those portions coming in contact with the concrete shall be painted with a heavy coating of asphalt or other bituminous material prior to their installation.
- B. All sidewalk door frames shall be installed so they will project slightly above the elevation of the surrounding concrete. No door shall be at an elevation lower than the adjacent concrete construction. They shall present a uniform, level surface with no indentations or projections. All hinged sidewalk doors shall operate freely and without binding.
- C. Gutters shall be connected to plant drain piping as shown on the Drawings.

END OF SECTION

**SECTION 08330
OVERHEAD ROLLING SERVICE DOOR (HEAVY DUTY)**

PART 1 GENERAL

1.01 SCOPE

The Work under this Section consists of furnishing all labor, materials, equipment and services necessary for the complete and satisfactory installation of manually operated overhead heavy duty rolling service door.

1.02 DEFINITIONS

- A. Operation Cycle: One cycle of a door is complete when it is moved from the closed position to the fully open position and returned to the closed position.

1.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide overhead rolling service doors capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation of door components:
1. Wind Load: Uniform pressure (velocity pressure) of 30lbf/sq. ft., acting inward and outward.
 2. Impact Test for Flying Debris: Comply with ASTM E 1996, tested according to ASTM E 1886.
 - a. Level of Protection: Basic Protection.
 - b. Wind Zone: 110 mph, pressure test to $\frac{1}{2}$ and 1-1/2 x design pressure (positive and negative).
- B. Operation-Cycle Requirements: Provide overhead rolling service door components and operators capable of operating for not less than 20,000 cycles and for 10 cycles per day.

1.04 SUBMITTALS

- A. Provide all submittals to ME Sack Engineering.
- B. Product Data: Manufacturer's printed product data indicating characteristics of products specified in this Section.
1. For each type and size of overhead rolling service door and accessory. Include summary of forces and loads on walls and jambs.
- C. Samples for Initial Selection: At contractor's option provide manufacturer's color charts showing full range of colors available for units with factory-applied finishes for selection by ME Sack Engineering or prime finish and field paint in accordance with Division 9 painting requirements.

D. Shop Drawings:

1. Elevations: Dimensioned elevation of each type of door opening assembly in project, indicate sizes and locations of door hardware, lites and louvers, if specified.
2. For special components and installations not dimensioned or detailed in manufacturer's product data.
3. Details: Installation details of each type installation condition in Work, indicate installation details of glazing, if specified.

D. Manufacturer's Instructions: Printed installation instructions for door opening assemblies.

E. Warranty Documents: Manufacturer's standard warranty of documents, executed by manufacturer's representative, countersigned by the Contractor.

F. Qualification Data: For Installer.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required in this Project.

B. Source Limitations: Obtain overhead rolling service doors through one source from a single manufacturer.

1. Obtain operators and controls from overhead rolling service door manufacturer.

1.06 WARRANTY

Manufacturer's Warranty: Manufacturer's 10-year warranty against failure due to corrosion from specified environment.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers of products that may be incorporated into the Work include but are not limited to, the following:

1. Alpine Overhead Doors, Inc.
2. Cookson Company
3. Cornell Iron Works Inc.
4. Overhead Door Corp.
5. Raynor
6. Wayne Dalton Corp.

2.02 DOOR CURTAIN MATERIALS AND CONSTRUCTION

- A. Door Curtains: fabricate overhead rolling service door curtain of interlocking slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated as follows:
 - 1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel (SS) sheet; complying with ASTM A 653/A, G90 (Z275) coating designation.
 - a. Minimum Base-Metal (Uncoated) Thickness 0.0209 inch.
 - 2. Insulation: Fill slat with manufacturer's standard rigid cellular polystyrene or polyurethane-foam-type thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within metal slat faces.
 - 3. Inside Curtain Slat Face: To match material of outside metal curtain slat.
- B. Endlocks and Windlocks for Service Doors: Malleable-iron casings galvanized after fabrication, secured to curtain slats with galvanized rivets or high-strength nylon. Provide locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.
- C. Bottom Bar for Service Doors: Consisting of 2 angles, each not less than 1-1/2 by 1- 1/2 by 1/8 inch (38 by 38 by 3 mm) thick; galvanized, stainless-steel, or aluminum extrusions to suit type of curtain slats.
 - 1. Astragal: Provide a replaceable, adjustable, continuous, compressible gasket of flexible vinyl, rubber, or neoprene; for placement between angles or fitted to shape, as a cushion bumper for interior door.
- D. Curtain Jamb Guides for Service Doors: Fabricate curtain jamb guides of steel angles or channels and angles, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Build up units with not less than 3/16-inch thick galvanized steel sections complying with ASTM A 36/A 36M and ASTM A 123/A 123M. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain, and a continuous bar for holding windlocks.

2.03 HOODS AND ACCESSORIES

- A. Hood: Form to act as weatherseal and entirely enclose rolled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods and provide fascia for any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sagging.

1. Fabricate hoods for steel doors of minimum 0.028-inch thick, hot-dip galvanized steel sheet with G90 zinc coating, complying with ASTM A 653/A 653M.
 2. Shape: Round or Square.
- B. Weatherseals: provide replaceable, adjustable, continuous, compressible weather- stripping gaskets fitted to bottom and top of exterior doors, unless otherwise indicated. At door head, use 1/8-inch thick, replaceable continuous sheet secured to inside of hood.
1. In addition, provide replaceable, adjustable, continuous, flexible, 1/8 inch thick seals of flexible vinyl, rubber, or neoprene at door jambs for a weather tight installation.
- C. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jambs for weather tight installation.
- D. Fabricate locking device assembly with lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bar to engage through slots in tracks.
1. Locking Bars: Single-jamb side operable from inside only.
 2. Lock cylinder is specified in Division 8 Section " Door Hardware".
- E. Chain Lock Keeper: Suitable for padlock.

2.04 COUNTERBALANCING MECHANISM

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

2.05 MANUAL DOOR OPERATORS

- A. Provide manual chain-hoist or manual or manual push up operators based on performance requirements listed below and manufacturer's standard offerings.
- B. Push-up Operation: Design counterbalance mechanism so required lift or pull for door operation does not exceed 25 lbf.
- C. Chain-Hoist Operator: Provide manual chain-hoist operator consisting of endless steel hand chain, chain pocket wheel and guard, and gear-reduction unit with a maximum 35-lbf. Force for door operation. Provide alloy steel hand chain with chain holder secured to operator guide.

2.06 FINISHES GENERAL

- A. General: Comply with NAAMM's "Metal Finishes manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.07 STEEL AND GALVANIZED STEEL FINISHES

- A. Factory primer for Field Finish: Manufacturer's standard primer, compatible with field-applied finish according to coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.
 - 1. Apply to ferrous surfaces except zinc-coated metal.
- B. Powder-Coat Finish: Manufacturer's standard powder-coat finish consisting of primer and topcoat according to coating, manufacturer's written instructions for cleaning, pretreatment, application, thermosetting, and minimum dry film thickness.
 - 1. Color and Gloss: As selected by ME Sack Engineering from manufacturer's full range.
- C. At contractor's option provide either a primer finish with field applied finish or Manufacturer's standard finish.

PART 3 EXECUTION

3.01 GENERAL

- A. Verification of conditions:
 - 1. Openings are correctly prepared to receive doors and frames.
 - 2. Openings are correct size and depth in accordance with shop drawings.

B. Installer's Examination:

1. Have installer examine conditions under which construction activities of this section are to be performed and submit written report if conditions are unacceptable.
2. Transmit two copies of installer's report to architect within 24 hours of receipt.
3. Beginning construction activities of this section before acceptable conditions have been corrected is prohibited.

3.02 INSTALLATION

- A. Install rolling service doors and operating equipment complete with necessary hardware, jamb and head molding strips, anchors, inserts, hangers, and equipment supports in accordance with shop drawings and manufacturer's printed installation instructions, using installation methods and materials specified in installation instructions.
- B. Field alteration of doors to accommodate field conditions is strictly prohibited.
- C. Site tolerances: Maintain plumb and level tolerance specified in manufacturer's printed installation instructions.

3.03 ADJUSTING

- A. Lubricate bearings and sliding parts: adjust doors to operate easily, free of warp, twist, or distortion and with weather tight fit around entire perimeter.

3.04 DEMONSTRATION

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

3.05 CLEANING

Clean surfaces of door opening assemblies and sight exposed door hardware in accordance with respective manufacturer's maintenance instructions.

3.06 PROTECTION OF INSTALLED PRODUCTS

Protect door opening assemblies and door hardware from damage by subsequent construction activities until final inspection.

END OF SECTION

SECTION 08342
FIBERGLASS REINFORCED PLASTIC DOORS
AND FIBERGLASS RESIN TRANSFER MOLDED DOOR FRAMES

PART 1 GENERAL

1.01 SCOPE

The Work under this Section consists of furnishing all labor, materials, equipment, and services necessary for the complete and satisfactory installation of fiberglass reinforced plastic doors and fiberglass resin transfer molded door frames.

1.02 SUBMITTALS

- A. Provide all submittals to ME Sack Engineering.
- B. Product Data: Manufacturer's printed product data indicating characteristics of products specified in this Section.
- C. Shop Drawings:
 - 1. Elevations: Dimensioned elevation of each type of door opening assembly in project, indicate sizes and locations of door hardware, lites and louvers, if specified.
 - 2. Details: Installation details of each type installation condition in project, indicate installation details of glazing, if specified.
 - 3. Schedule: Indicate each door opening assembly in project, cross-reference to plans, elevations, and details.
- D. Manufacturer's Instructions: Printed installation instructions for door opening assemblies.
- E. Warranty Documents: Manufacturer's standard warranty of documents, executed by manufacturer's representative, countersigned by the Contractor.

1.03 QUALITY ASSURANCE

Manufacturer Qualifications: Manufacturer: Minimum twenty (20) years documented experience producing products specified in this Section.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Packing, shipping, Handling, and Unloading:
 - 1. Deliver single doors, up to 4' x 8', and frames factory-assembled and pre-hung, with hardware. Double doors shipped knocked down.
 - 2. Package door opening assemblies in wood crates having wood perimeters, label crates with the following information:

- a. Manufacturer's name
 - b. Architect/Engineer-designated Project Number
 - c. Tag location in accordance with door schedule
 - d. Door type, color, and weight
- B. Acceptance at Site: Accept only sealed, crated, and labeled door opening assemblies at site.
- C. Storage and Protection: Store door assemblies in factory packaging in dry area, store on edge and protect from damage.

1.05 WARRANTY

Manufacturer's Warranty: Manufacturer's 10-year warranty against failure due to corrosion from specified environment.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All material used and consumed by Chem-Pruf in the manufacture of our products are of the highest quality to assure the end product meets Chem-Pruf's specifications.
- B. Fiberglass Mat: Random glass fiber mat, minimum 4.5 ounces per square foot weight of glass material.
- C. Polyurethane Foam: Minimum density 4 pounds per cubic foot, maximum flame spread 25 in accordance with ASTM E 84.
- D. Roving: Unidirectional glass fiber mat, minimum 16 ounces per square yard weight.
- E. Resins: Formulated for specified environment, maximum flame spread 25 in accordance with ASTM E 84, self-extinguishing in accordance with ASTM D 635.
- F. Anchors: Manufacturer's standard stainless steel anchors.
- G. Bonding Materials: Manufacturer's standard frame-to-opening bonding system.
- H. Glazing: Type specified in Section 08800, factory installed, if requested.
- I. Joint Sealer: Silicone sealant.

2.02 MANUFACTURED UNITS

A. Fiberglass Reinforced Plastic (FRP) doors:

1. Thickness 1- $\frac{3}{4}$ -inches
2. Thermal Insulating Value: 'R' factor 12
3. Construction:
 - a. Site and Rail Structure: One-piece molded U-shaped cross-section, minimum 15 mil gel coat, minimum three (3) layers random-fiberglass mat, saturated with resins.
 - b. Core: Polyurethane foam.
 - c. Face sheets: Minimum 15 mil gel coat, with minimum two (2) layers random-fiberglass mat and on (1) layer roving, saturated with resins.
4. Sizes: Indicated on the drawings.
5. Finish: Semi-Gloss Surface.
6. Color: shall be submitted to the owner (via ME Sack Engineering) for approval.

B. Fiberglass RTM Door Frames:

1. Construction: One-piece molded cross-section with molded stop, minimum 15 mil gel coat, minimum two (2) layers random-fiberglass mat, saturated with resins.
2. Sizes: For door sizes and frame depths indicated on the Drawings.
3. Finish: Smooth semi-gloss surface
4. Color: shall be submitted to the owner (via ME Sack Engineering) for approval.

C. Fiberglass RTM Door Windows:

1. Construction: RTM molded solid window frame with profile that drains away from glazing. 15-mil gel coat, minimum two (2) layers random fiberglass mat saturated with resin. Frame is molded into doorplate during door fabrication and becomes an integral part of the door. Glazing held in place by RTM retainer that matches opposite frame profile.
2. Sizes: Indicated on the Drawings.
3. Finish: Match fiberglass door finish.

D. Door Hardware:

1. Specified Section 08710.
2. Due to the special nature of the material in this section, all related hardware as specified must be furnished and installed by the door and frame manufacturer.

2.03 FABRICATION

A. Fiberglass Reinforced Plastic (FRP) Doors: All Chem-Pruf's workmanship is to be of the highest quality in order to meet Chem-Pruf's quality control requirements.

1. Stile and Rail Structure:

- a. Form in mold of exact door size, with gel coat layer to form, glass mat layers to a U-shaped channel interior.
- b. Formulate gel coat for environment and integral color specified.
- c. Form structure as single component, jointed construction at intersections of stiles and rails is prohibited.
- d. Form mortise for lockset, and recess for strike plate in lock stile, at time of molding.
- e. Embed compression members at the time of molding in locations where thru bolting of hardware is required.

2. Core:

- a. Foam polyurethane in place within stile/rail structure, allow no voids within structure.
- b. Mold openings for lites or louvers, if specified, form mold to sizes and locations indicated.

3. Face Sheets:

- a. Formulate gel coat with integral color specified, embed glass materials.
- b. Chemically bond face sheets to stile/rail structure and core material.

B. Fiberglass RTM door Frames

1. Resin transfer in mold of exact wall opening size, with gel coat. Glass mat layers to form solid fiberglass outer surface.

2. Formulate gel coat for environment and integral color specified.
 3. Form structure of fiberglass components.
 4. Form mortise for lock strike, and recess for strike plate in lock jamb, at time of molding.
 5. Embed reinforcement for hinges and other indicated hardware in fiberglass matrix, provide for hinge leaf recesses in hinge jamb at time of molding.
- C. Fiberglass RTM Door Windows
1. Form in mold of exact window frame size with 15-mil gel coat, minimum two (2) layers random fiberglass mat. Saturate mat with resin by RTM. Retainer fabricated in same way.
 2. Formulate gel coat for environment and color specified.
 3. Laminate frame onto exterior doorplate as plate is fabricated to make window frame an integral part of doorplate.
 4. FRP retainer held in place with silicone caulk factory applied.
 5. Fabricate retainer as a replaceable part so glazing may be replaced in field.
- D. Assemble doors and frames with louvers and transoms, if specified, install specified hardware, using through bolts or sex screw with compression members to resist screw torque and to prevent compressing door construction.

PART 3 EXECUTION

3.01 GENERAL

- A. Verification of conditions:
1. Openings are correctly prepared to received doors and frames.
 2. Openings are correct size and depth in accordance with shop drawings.
- B. Installer's Examination:
1. Have installer examine conditions under which construction activities of this section are to be performed and submit written report if conditions are unacceptable.
 2. Transmit two copies of installer's report to architect within 24 hours of receipt.

3. Beginning construction activities of this section before acceptable conditions have been corrected is prohibited.

C. Verify that door glazing has been factory-installed, if requested.

3.02 INSTALLATION

- A. Install door-opening assemblies in accordance with shop drawings and manufacturer's printed installation instructions, using installation methods and materials specified in installation instructions.
- B. Field alteration of doors or frames to accommodate field conditions is strictly prohibited.
- C. Site tolerances: Maintain plumb and level tolerance specified in manufacturer's printed installation instructions.

3.03 ADJUSTING

- A. Adjust doors in accordance with door manufacturer's maintenance instructions to swing open and shut without binding and to remain in place at any angle without being moved by gravitational influence.
- B. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instructions.

3.04 CLEANING

Clean surfaces of door opening assemblies and sight exposed door hardware in accordance with respective manufacturer's maintenance instructions.

3.05 PROTECTION OF INSTALLED PRODUCTS

Protect door opening assemblies and door hardware from damage by subsequent construction activities until final inspection.

END OF SECTION

SECTION 08710 DOOR HARDWARE

PART 1 GENERAL

1.01 SCOPE

- A. This Section includes items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed.
- B. This Section includes the following:
 - 1. Hinges
 - 2. Lock cylinders and keys
 - 3. Lock and latch sets
 - 4. Bolts
 - 5. Closures
 - 6. Overhead holders
 - 7. Door trim units
 - 8. Weatherstripping for exterior doors
 - 9. Astragals or meeting seals on pairs of doors
 - 10. Thresholds
 - 11. Panic exit device

1.02 REFERENCES

- A. Standards of the following as referenced:
 - 1. American National Standards Institute (ANSI)
 - 2. Door and Hardware Institute (DHI)
 - 3. Factory Mutual (FM)
 - 4. National Fire Protection Association (NFPA)
 - 5. Underwriters' Laboratories, Inc. (UL) UL 10C - Fire Tests Door Assemblies

6. Warnock Hersey
- B. Regulatory standards of the following as referenced:
 1. Department of Justice, Office of the Attorney General, Americans with Disabilities Act, Public Law 101-336 (ADA).
 2. CABO/ANSI A117.1: Providing Accessibility and Usability for Physically Handicap People, 1992 edition.

1.03 SUBMITTALS

- A. Submittals shall be made to ME Sack Engineering.
- B. Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements. For items other than those scheduled in the "Headings" of Section 3, provide catalog information for the specified items and for those submitted.
- C. Final hardware schedule coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 1. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into vertical format "hardware sets" indicating complete designations of every item required for each door or opening. Use specification Heading numbers with any variations suffixed a, b, etc. Include the following information:
 - a. Type, style, function, size, and finish of each hardware item.
 - b. Name and manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of each hardware set cross referenced to indications on Drawings both on floor plans and in door and frame schedule.
 - e. Explanation of all abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for hardware.
 - g. Door and frame sizes and materials.
 - h. Keying information.
 - i. Cross-reference numbers used within schedule deviating from those specified.
 - i. Column 1: State specified item and manufacturer.

- ii. Column 2: State prior approved substituted item and its manufacturer.
- 2. Submittal Sequence: Submit final schedule at earliest possible date particularly where acceptance of hardware schedule must precede fabrication of other work that is critical in the Project construction schedule. Include with schedule the product data, samples, shop drawings of other work affected by door hardware, and other information essential to the coordinated review of schedule.
- 3. Keying Schedule: Submit separate detailed schedule indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.
- C. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- D. Contract closeout submittals:
 - 1. Operation and maintenance data: Complete information for installed door hardware.
 - 2. Warranty: Completed and executed warranty forms.

1.04 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain each type of hardware (latch and lock sets, hinges, closers, etc.) from a single manufacturer.
- B. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware consultant (AHC) who is available to Owner, Architect, and Contractor, at reasonable times during the course of the Work, for consultation.
 - 1. Require supplier to meet with Owner to finalize keying requirements and to obtain final instructions in writing.
 - 2. Required supplier to meet with installer prior to beginning of installation of door hardware.
- C. Fire-Rated Openings: Provide door hardware for fire-rated openings that complies with NFPA Standard No. 80 requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and tested by UL or Warnock Hersey for given type/size opening and degree of label. Provide proper latching hardware, door closers, approved-bearing hinges and seals whether listed in the Hardware Schedule or not. All hardware shall comply with

standards UBC 702 (1997) and UL 10C. Where emergency exit devices are required on fire-rated doors, (with supplementary marking on doors' UL labels indicating "Fire Door to be equipped with Fire Exit Hardware") provide UL label on exit devices indicating "Fire Exit Hardware".

1.05 PRODUCT HANDLING

- A. Tag each item or package separately with identification related to final hardware schedule, and include basic installation instructions with each item or package.
- B. Packaging of door hardware is responsibility of supplier. As material is received by hardware supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in same container.
- C. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.
- D. Deliver individually packaged door hardware items promptly to place of installation (shop or Project site).
- E. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.06 WARRANTY

Door closers shall have a ten-year warranty period.

1.07 MAINTENANCE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Parts kits: Furnish manufacturers' standard parts kits for locksets, exit devices, and door closers.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

(* Denotes manufacturer referenced in the Hardware Headings)

A. Hinges

1. Acceptable manufacturers: Equal to Hager Hinge Company, Stanley Works, Mont Hard*.
2. Characteristics
 - a. Templates: Provide only template-produced units.
 - b. Screws: Provide Phillips flat-head screws complying with the following requirements:
 - i. For metal doors and frames install machine screws into drilled and tapped holes.
 - ii. Finish screw heads to match surface of hinges or pivots.
 - c. Hinge pins: Except as otherwise indicated, provide hinge pins as follows:
 - i. Out-Swing Exterior Doors: Non-removable pins.
 - ii. Out-Swing Corridor Doors with Locks: Non-removable pins.
 - iii. Interior Doors: Non-rising pins.
 - iv. Tips: Flat button and matching plug. Finished to match leafs.
 - d. Size: Size hinges in accordance with specified manufacturer's published recommendations.
 - e. Quantity: Furnish one pair of hinges for all doors up to 5'0" high. Furnish one hinge for each additional 2-1/2 feet or fraction thereof.

B. Cylinders

1. Acceptable Manufacturers: Equal to Schlage Lock, Division of Ingersoll-Rand*.
2. Characteristics
 - a. Multiple-Building System: Except as otherwise indicated, provide new grand master key system for Project.

- b. Equip locks with high-security cylinders that comply with performance requirements for Grade 1 cylinders as listed in ANSI/BHMA A156.5 and that have been tested for pick and drill resistance requirements of UL 437 and are UL listed.
- c. Metals: Construct lock cylinder parts from brass or bronze, stainless steel, or nickel silver.
- d. Comply with Owner's instructions for masterkeying and, except as otherwise indicated, provide individual change key for each lock that is not designated to be keyed alike with a group of related locks. Permanently inscribe each key with number of lock that identifies cylinder manufacturer's key symbol, and notation, "DO NOT DUPLICATE."
- e. Key Material: Provide keys of nickel silver only.
- f. Key Quantity: Furnish 3 change keys for each lock, 5 master keys for each master system, and 5 grandmaster keys for each grandmaster system. Furnish one extra blank for each lock. Deliver keys to Owner.

C. Locksets, Latchsets, Deadbolts

- 1. Acceptable Manufacturers: Equal to Schlage, Division of Ingersoll-Rand*.
- 2. Mortise Locksets and Latchsets: as scheduled.
 - a. Chassis: cold-rolled steel, handing field-changeable without disassembly.
 - b. Latchbolts: 3/4-inch throw stainless steel anti-friction type.
 - c. Lever Trim: through-bolted, accessible design, cast or solid rod lever as scheduled. Spindles: independent break-away.
 - d. Thumbturns: accessible design not requiring pinching or twisting motions to operate.
 - e. Deadbolts: stainless steel 1-inch throw.
 - f. Electric operation: Manufacturer-installed continuous duty solenoid.
 - g. Strikes: 16 gage curved stainless steel, bronze, or brass with 1" deep box construction, lips of sufficient length to clear trim and protect clothing.
 - h. Scheduled Lock Series and Design: Schlage L series, 07A design.
 - i. Certifications:

- ii. ANSI A156.13, 1994, Grade 1 Operational, Grade 1 Security.
- ii. ANSI/ASTM F476-84 Grade 30 UL Listed.

D. Closers and Door Control Devices

1. Acceptable Manufacturers: Equal to LCN Closers, Division of Ingersoll-Rand*.
2. Characteristics
 - a. Door closers shall have fully hydraulic, full rack and pinion action with a high strength cast iron cylinder.
 - b. All closers shall utilize a stable fluid withstanding temperature range of 120°F to -30°F without seasonal adjustment of closer speed to properly close the door. Closers for fire-rated doors shall be provided with temperature stabilizing fluid that complies with standards UBC 7-2 (1997) and UL 10C.
 - c. Spring power shall be continuously adjustable over the full range of closer sizes, and allow for reduced opening force for the physically handicapped. Hydraulic regulation shall be by tamper-proof, non-critical valves. Closers shall have separate adjustment for latch speed, general speed, and back check.
 - d. All closers shall have solid forged steel main arms (and forearms for parallel arm closers) and where specified shall have a cast-in solid stop on the closer shoe ("CNS"). Where door travel on out-swing doors must be limited, use "CNS" or "S-CNS" type closers. Auxiliary stops are not required when cushion type closers are used.
 - e. Overhead concealed closers shall have spring power adjustable for 50% increase in closing power and fully mortised door tracks.
 - f. All surface closers shall be certified to exceed ten million (10,000,000) full load cycles by a recognized independent testing laboratory. All closers (overhead, surface and concealed) shall be of one manufacturer and carry manufacturer's ten-year warranty (electric closers to have two year warranty).
 - g. Access-Free Manual Closers: Where manual closers are indicated for doors required to be accessible to the physically handicapped provide adjustable units complying with ADA and ANSI A-117.1 provisions for door opening force.
 - h. Closers to be installed to allow door swing as shown on plans. Doors swinging into exit corridors shall provide for corridor clear width as required by code. Where possible, mount closers inside rooms.

- i. Powder coating finish to be certified to exceed 100 hours salt spray testing by ETL, an independent testing laboratory used by BHMA for ANSI certification.

E. Overhead Door Holders

1. Acceptable Manufacturers: Equal to Glynn Johnson*, Division of Ingersoll- Rand, Rixson Firemark.
2. Characteristics: Provide heavy duty door holders surface mounted stainless steel.

F. Floor Stops and Wall Bumpers

1. Acceptable Manufacturers: Equal to Glynn Johnson, Division of Ingersoll- Rand*, Ives, Rockwood Manufacturing.
2. Characteristics: Refer to Hardware Headings.

G. Door Bolts/Coordinators

1. Acceptable Manufacturers: Equal to Glynn Johnson, Division of Ingersoll- Rand*, Ives, Rockwood Manufacturing.
2. Characteristics: Flush bolts to be forged brass 6-3/4" x 1", with 1/2" diameter bolts. Plunger to be supplied with milled surface one side which fits into a matching guide.

H. Thresholds

1. Acceptable Manufacturers: Equal to National Guard Products, Inc.*, Reese Industries, Zero Weatherstripping Co., Inc.
2. Types: Indicated in Hardware Headings.

I. Door Seals/Gasketing

1. Acceptable Manufacturers: Equal to National Guard Products, Inc.*, Reese Industries, Zero Weatherstripping Co., Inc.
2. Types: Indicated in Hardware Headings.

J. Silencers

1. Acceptable Manufacturers: Equal to Glynn Johnson, Division of Ingersoll- Rand*, Ives, Rockwood Manufacturing.
2. Three for each single doors; four for pairs of doors.

2.02 MATERIALS AND FABRICATION

- A. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to Architect. Manufacturer's identification will be permitted on rim of lock cylinders only.
- B. Base Metals: Produce hardware units of basic metal and forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units by applicable ANSI/BHMA A156 series standards for each type of hardware item and with ANSI/BHMA A156.18 for finish designations indicated. Do not furnish "optional" materials or forming methods for those indicated, except as otherwise specified.
- C. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
 - 1. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.
 - 2. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.
 - 3. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners.
 - 4. Do not use thru-bolts or sex bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of adequately fastening the hardware, or otherwise found in Headings. Coordinate with wood doors and metal doors and frames where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.

2.03 HARDWARE FINISHES

- A. Match items to the manufacturer's standard color and texture finish for the latch and lock sets (or push-pull units if no latch or lock sets).
- B. Provide finishes that match those established by ANSI or, if none established, match the Architect's sample.
- C. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

- D. The designations used to indicate hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.
1. Hinges: 630 (US32D) Satin Stainless Steel
 2. Flush Bolts: 626 (US26D) Satin Chrome Plated Brass/Bronze
 3. Locks: 630 (US32D) Satin Stainless Steel
 4. Door Closers: 689 Powder Coat Aluminum
 5. Push Plates: 630 (US32D) Satin Stainless Steel
 6. Pull Plates: 630 (US32D) Satin Stainless Steel
 7. Protective Plates: 630 (US32D) Satin Stainless Steel
 8. Door Stops: 630 (US32D) Satin Stainless Steel
 9. Overhead Holders: 630 Satin Stainless Steel
 10. Thresholds/Weatherstripping: 627/628 (US27/US28) Aluminum
 11. Continuous Hinges: Anodized to match Aluminum Frames

PART 3 EXECUTION

3.01 INSTALLATION

- A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by Architect. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
- B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.
- C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- D. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

- E. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant.
- F. Weatherstripping and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

3.02 ADJUSTING, CLEANING, AND DEMONSTRATING

Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to function properly with final operation of heating and ventilating equipment.

3.03 HARDWARE SCHEDULE

HEADING #AA

Door #: 101

Each Pair to Have:

3 Pair	Hinges STS BB991
1	Lockset L9070 x 07A
1	Exit device 9975L x 07A Von Duprin
1	Closer 4111-Cush SRI primer
1	Set of weatherstripping 2525C
1	Threshold 425E
1	Door bottom seal 19VA
1	Astragal 125 NA
1	Overhead door holder 79H series
1	Set of flushbolts FB6A x DP2

HEADING #BB

Door #: 102

Each Door to Have:

1-1/2 Pair	Hinges STS BB991
1	Set of weatherstripping 2525C
1	Threshold 425E
1	Door bottom seal 19VA
1	Closer 4111-Cush SRI primer Lockset L9070 x 07A

END OF SECTION

**SECTION 08711
FINISH HARDWARE**

PART I – GENERAL

1.01 DESCRIPTION

- A. Work included: Furnish and deliver to the job site all finish hardware required to complete the work as indicated on the drawings and specified herein. Provide all trim attachments, and fastenings specified or required for proper and complete

1.02 QUALITY ASSURANCE

- A. Qualifications of Manufacturers:

Products used in the work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production acceptable to the Architect.

1.03 TEMPLATES

In a timely manner to ensure orderly progress of the work, deliver templates or physical samples of the approved finish hardware items to pertinent manufacturers of interfacing items such as doors and frames.

1.04 PRODUCT HANDLING

- A. Packing and Marking:

Individual package each unit of finish hardware, complete with proper fastenings and appurtenances, clearly marked on the outside to indicate the contents and specific locations in the work.
- B. Protection:

Use all means necessary to protect materials of this Section before, during and after delivery to the job site and to protect the work and materials of all other trades.
- C. Replacement:

In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

PART 2 – PRODUCTS

2.01 PROPRIETARY PRODUCTS

References to specific proprietary products are used to establish minimum standards of utility and quality. Unless otherwise approved by the Architect provide only the specific products. Design is based on the materials specified.

2.02 APPROVED MANUFACTURERS

- A. Butts: Stanley, McKinney, Russwin.
- B. Locks: Sargent, Yale, Russwin.
- C. Door closers: LCN, Yale, Sargent.
- D. Kick Plates: Rockwood, Russwin, Sargent.
- E. Stops: Rockwood, Bladwin, Ives.
- F. Thresholds: Pemlo, Zero, May.

2.03 KEYING

- A. All locksets shall be keyed alike as noted on the door schedule. Furnish two (2) change keys for each lock.
- B. Tag all keys to identify which door they operate.

2.04 FASTENERS

- A. Furnish all finish hardware with all necessary screws, bolts, and other fasteners of suitable size and type to anchor the hardware in position for long life under hard use.
- B. Furnish fastenings where necessary with expansion shields, toggle bolts, sex bolts, and other anchors approved by the Architect, according to the material to which the hardware is to be applied and the recommendations of the hardware manufacturer.
- C. All fastenings shall harmonize with the hardware as to material and finish.

2.05 FINISHES

Finishes of all hardware shall match the finish of the locksets. Take special care to coordinate all of the various manufactured items furnished under this section, to ensure acceptably uniform finish.

2.06 TOOLS AND MANUALS

- A. For hardware items that require special adjustment tools, deliver to the Owner one complete set of such tools.
- B. Deliver to the Owner one set of maintenance manuals for locksets.

PART 3 – EXECUTION

- 3.01 Install hardware accurately fitted, securely applied, and carefully adjusted. Install in accordance with manufacturer's instructions. Use care not to injure other work when installing.
- 3.02 Provide and use boring jigs, mortising tools, and other special equipment and appliances as required for proper installation of hardware items.
- 3.03 Remove all visible hardware before painting is begun and replace afterwards.

3.04 INSPECTION

Upon completion of the installation, and as a condition of its acceptance, visually inspect all finish hardware furnished under this Section and place in optimum working condition.

END OF SECTION

**SECTION 09260
METAL STUD AND GYPSUM WALLBOARD**

PART 1 GENERAL

1.01 SCOPE

The work under this Section consists of furnishing all labor, materials, equipment and services necessary for the complete and satisfactory installation of metal stud and gypsum wallboard partitions as called for on the Drawings or in these Specifications.

1.02 Submittals

- A. Manufacturer's Literature: Prior to beginning installation operations, the Contractor shall submit to the Engineer the manufacturer's instructions for the proper installation of all materials furnished under this item.
- B. Samples for Verification: Of each type of exposed finish in manufacturer's standard sizes. Where finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.

1.03 JOB CONDITIONS

- A. Environmental Conditions: During and subsequent to gypsum panel application and joint finishing, temperatures within the building shall be maintained within the range of 55 to 90 degrees F. Adequate ventilation shall be provided to carry off excess moisture.
- B. Job Coordination: Coordinate wallboard installation with work of other trades to minimize cutting and patching. If patching is required, it shall be unnoticeable in the finished work.

1.04 STORAGE AND PROTECTION

Deliver and store materials in manufacturer's original, unopened packaging. Protect materials from moisture, freezing and improper handling.

1.05 QUALITY ASSURANCE

Prior to commencing installation of any materials required under this Section, the Contractor shall provide the Engineer with the manufacturer's certification that the materials meet or exceed all requirements of these Specifications.

PART 2 PRODUCTS

2.01 SHAFT WALL ASSEMBLY MATERIALS

- A. General: Provide materials and components complying with requirements of fire- resistance-rated assemblies indicated.

1. Provide panels in maximum lengths available to eliminate or minimize end-to-end butt joints.
 2. Provide auxiliary materials complying with gypsum board shaft-wall assembly manufacturer's written recommendations.
- B. Steel Framing: ASTM C 645.
1. Protective Coating: ASTM A 653/A, G40, hot-dip galvanized coating.
 2. Deflection Limit: L/240.
- C. Gypsum Liner Panels: Manufacturer's proprietary liner panels in 1-inch (25.4-mm) thickness and with moisture-resistant paper faces.
- D. Gypsum Wallboard: ASTM C 36, core type as required by fire-resistance-rated assembly indicated.
1. Edges: Tapered.
- E. Track (Runner) Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft-wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
1. Powder-Actuated Fasteners: Provide powder-actuated fasteners with capability to sustain, without failure, a load equal to 10 times that imposed by shaft-wall assemblies, as determined by testing conducted by a qualified independent testing agency according to ASTM E 1190.

2.02 WALLBOARD

- A. Regular and Type X gypsum wallboard shall be 5/8-inch thick, tapered edge, 48-inches wide, in lengths as long as practical, conforming to ASTM C 36.
- B. Gypsum panels for ceilings shall be 1/2-inch, abuse resistant, glass-mat, mold, and mildew resistant, gypsum sheathing board conforming to ASTM C630 and ASTM C1177. Provide products equal to "DENS-ARMOR PLUS" by G-P Gypsum Corp.

2.03 WALLBOARD ACCESSORIES

- A. Corner Bead: Corner bead shall be formed from heavy-gauge, hot dipped galvanized steel with flange widths of at least 1-inch.
- B. Dry Wall Screws: Dry wall screws shall be corrosion resistant Type S-12 Bugle Head, not less than 1-inch long for single layer and 1-1/2-inches long for double layer.

- C. Joint Compound: Joint compound and finishing or topping compound shall conform with all requirements of ASTM C 475 and panel manufacturer.
- D. Joint Tape
 - 1. Interior Gypsum Wallboard: Paper.
 - 2. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.

PART 3 EXECUTION

3.01 INSTALLING SHAFT WALL ASSEMBLY

- A. General: Install gypsum board shaft-wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and the following:
 - 1. ASTM C 754 for installing steel framing.
- B. Install supplementary framing in gypsum board shaft-wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, and similar items that cannot be supported directly by shaft-wall assembly framing.
- C. At penetrations in shaft wall, maintain fire-resistance rating of shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.
- D. Isolate gypsum finish panels from building structure to prevent cracking of finish panels while maintaining continuity of fire-rated construction.
- E. Install control joints to maintain fire-resistance rating of assemblies.
- F. Seal gypsum board shaft walls with acoustical sealant at perimeter of each assembly where it abuts other work and at joints and penetrations within each assembly. Install acoustical sealant to withstand dislocation by air-pressure differential between shaft and external spaces; maintain an airtight and smoke-tight seal; and comply with manufacturer's written instructions or ASTM C 919, whichever is more stringent.

3.02 GYPSUM PANEL ERECTION

- A. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member. Fasten with corrosion resistant screws.
- B. Attachment

1. Space fasteners not less than 3/8-inch nor more than 1/2-inch from edges and ends of wallboard. While fasteners are being driven, hold the wallboard in firm contact with the underlying support. Proceed from the central portion of the wallboard to the ends and edges. If the paper surface is broken by fastener in attachment, drive another fastener approximately 2-inches from the faulty fastener.
2. Drive screws with a mechanical tool, using a special bit to provide screwhead penetration just below wallboard surface, without breaking surface paper or stripping the framing member around the screw.
3. Space screws 12-inches on center in field of panel and 6-inches on center staggered along vertical abutting edges.

3.03 JOINT AND FASTENER TREATMENT

- A. Joint Finishing Materials: Mix and use joint finishing materials in accordance with manufacturer's recommendations. Allow a minimum drying time of 24 hours between coats. Sand as necessary after each application without scuffing paper surface of board.
- B. Inside Corners: Reinforce inside vertical corner angles with tape folded to conform to the adjoining surfaces and to form a straight, true angle. Provide metal trim as required.
- C. Exterior Corners: Conceal flanges of corner beads and trim members with a minimum of two coats of compound, applied in accordance with manufacturer's directions.
- D. Embedment Coat: Apply a thin, uniform layer of joint compound (embedding type) approximately 3-inches wide over the joint to be reinforced. Center tape over the joint and seat into the compound, leaving sufficient compound under the tape to provide proper bond. Apply a skim coat of compound immediately after embedding tape.
- E. Fill Coat: After drying, apply fill coat over embedding coat by evenly spreading compound over and slightly beyond the tapered edge area of the board; feather at the edges. Sand all feathering after drying.
- F. Topping: Cover fill coat with topping compound, spread evenly over and slightly beyond the edge of the preceding coat, and feather to a smooth, uniform finish. Sand all feathering after drying.
- G. Fastener Concealment: Treat fastener dimples and holes as described above for joint treatment.
- H. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as soffit board.

3.04 CLEANING

- A. Maintain the work area in accordance with the requirements of Section 01710 of these Specifications.
- B. At the completion of the work, remove all excess materials and debris from the site. The gypsum wallboard shall be left ready to receive painting, vinyl wall covering or paneling as scheduled on the Drawings. The entire work area shall be left in a neat and workmanlike condition, ready for the Engineer's inspection.

END OF SECTION

SECTION 09900 PAINTING

PART 1 GENERAL

1.01 SCOPE

This Section includes, but is not necessarily limited to, standards for cleaning and painting structures and equipment described in the Drawings and Specifications. Furnish all materials, equipment, and labor necessary to complete the work.

1.02 SUBSTITUTIONS

To the maximum extent possible, all coatings shall be the products of a single manufacturer. Guidelines for determination of acceptability of product substitutions shall be obtained from ME Sack Engineering. Contractors intending to furnish substitute materials or equipment shall contact ME Sack Engineering for further instructions.

1.03 SUBMITTALS

- A. All submittals shall be made to ME Sack Engineering.
- B. The Contractor shall submit to the Engineer, for review, the following information concerning the materials the Contractor proposes to use in work covered by this Section:
 - 1. A list of all components (paints or other materials) to be used in each painting system required herein.
 - 2. A complete descriptive specification, including manufacturer's data sheet, of each component.
 - 3. Prior to completing the purchase and delivery of the coating material selected by the Contractor, the Contractor shall obtain a letter from the material supplier stating that the selected material is suitable and compatible for application and use as directed under these Specifications, and that if properly applied will provide metal protection and a pleasing appearance for five years or longer.
 - 4. A color chart for each product to be applied.

1.04 PAINTING REQUIREMENTS

- A. Finish paint all exposed surfaces except prefinished items, anodized or lacquered aluminum, stainless steel and copper surfaces. Exposures and surfaces are defined in 3.07 of this Section. Items to be left unfinished or to receive other types of finishes, such as tile, are specifically shown on the Drawings or specified.

1. Unpainted Products: Full field cleaning and priming will be performed in accordance with specification requirements for unpainted products. Maintain adequate equipment on the site to assure proper cleaning.
2. Shop Primed Products
 - a. Manufactured products may be shop cleaned and primed. Shop cleaning must equal or exceed cleaning specified in the Painting Schedule. Clean as specified and reprime all abrasions, weld splatter, excessive weathering, and other defects in the shop prime coating.
 - b. Manufacturers furnishing shop primed products shall certify that cleaning was performed in accordance with specification requirements and that the specified primer was used.
 - c. Fully field clean and prime any shop primed products which the Engineer determines that were not cleaned in accordance with the Specifications prior to priming, that the wrong primer was applied, that the primer was applied improperly, or has excessively weathered, or that the product is otherwise unacceptable.
3. Finish Painted Products: Certain products such as electrical control panels and similar items may, with the approval of the Engineer, be furnished finish painted. Properly protect these products throughout the Project to maintain a bright and new appearance. If the finish surfaces are defaced, weathered or not of the selected color, repaint as necessary.
4. Existing Surfaces
 - a. Properly protect existing finish painted items and surfaces from damage throughout the Project.
 - b. Repair any damage to existing coatings repaired in accordance with the requirements of this Section, at no expense to the Owner.
5. Hardware: Remove all electrical plates, surface hardware, fittings, and fastenings prior to painting operations. These items are to be carefully stored, cleaned, and replaced upon completion of work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

1.05 QUALITY ASSURANCE

- A. Only those systems and components which are judged acceptable by the Engineer shall be utilized in the work covered by this item. No materials shall be delivered to the job site until the Engineer has evaluated their acceptability.

- B. The following information shall be included on the label of all containers of materials supplied under this item:
 - 1. Manufacturer's name.
 - 2. Type of paint or other generic identification.
 - 3. Manufacturer's stock number.
 - 4. Color (if any).
 - 5. Instructions for mixing, thinning, or reducing (as applicable).
 - 6. Manufacturer's application recommendations.
 - 7. Safety and storage information.
- C. All coating material used on this Project shall be purchased specifically for this Project and furnished in new, unopened containers.
- D. The Contractor shall obtain the Engineer's review of the first finished room, space, area, item, or portion of work of each surface type and color specified. The first room, space, area, item, or portion of work which is acceptable to the Engineer shall serve as the Project standard for all surfaces of similar type and color. Where spray application is utilized, the area to be reviewed shall not be smaller than 100 square feet.

1.06 TESTING EQUIPMENT

- A. The Contractor shall furnish and make available to the Engineer the following items of testing equipment for use in determining if the requirements of this Section are being satisfied. The specified items of equipment shall be available for the Engineer's use at all times when field painting or surface preparation is in progress:
 - 1. Wet film gauge.
 - 2. Surface thermometer.
 - 3. "Surface Profile Comparator" as published by The Society for Protective Coatings (SSPC) (with magnifier and three discs).
 - 4. "Visual Standard for Abrasive Blast Cleaned Steel", as published by SSPC (SSPC-VIS 1-89).
 - 5. "Visual Standard for Power- and Hand-Tool Cleaned Steel", as published by SSPC (SSPC-VIS 3).
 - 6. Holiday (pin hole) detector (low voltage).

7. Sling-psychrometer or other on-site device used to calculate relative humidity and ambient air temperature.
8. Magnetic dry film gauge, meeting the requirements of SSPC-PA2, Type I or Type II, including calibration.

1.07 PRODUCT HANDLING

A. Delivery

1. Deliver materials in original, sealed containers of the manufacturer with labels legible and intact.
2. Each container shall be clearly marked or labeled to show paint identification, date of manufacture, batch number, analysis or contents, and special instructions. At all times a copy of every component's MSDS shall be available.

B. Storage

1. Store only acceptable Project materials on the Project site.
2. Store material in a suitable location and in such a manner as to comply with all safety requirements including any applicable federal, state, and local rules and requirements. Storage shall also be in accordance with the instructions of the paint manufacturer and the requirements of the insurance underwriters.
3. Restrict storage area to paint materials and related equipment.
4. Place any material, which may constitute a fire hazard, in closed metal containers and remove daily from the Project site.

- C. Material Safety Data Sheets: A copy of every component's MSDS shall be available at all times on the Project site.

1.08 MATERIAL SCHEDULES

Material Schedules at the end of this Section list prime coats, intermediate coats, finish coats and cover coats that comprise a complete and compatible system of surface protection for the particular substrate. Maintain the unity of these systems, making sure all coats applied to any surface are from the same system and same manufacturer. Verify with the manufacturer the compatibility of the materials used.

PART 2 PRODUCTS

2.01 COATING MATERIALS

- A. Acceptable Manufacturers: The only acceptable manufacturers and products shall be those listed in the Material Schedules at the end of this Section.

- B. All applicable data currently published by the paint manufacturer relating to surface preparation, coverages, film thickness, application technique, drying and overcoating times is included by reference as a part of this Section. It is the responsibility of the Contractor to obtain and fully understand the appropriate data sheets for the coatings specified.
- C. Products
 - 1. Paints shall be factory mixed and delivered to the site in unbroken original packages bearing the manufacturer's name and brand designation and shall be applied in strict accordance with the manufacturer's printed specifications. Two-component coatings shall be mixed in accordance with manufacturer's instructions. All two-component coatings, once mixed, shall be applied within the pot-life recommended by the manufacturer.
 - 2. Unless otherwise specified, paints shall be of the best grade. All thinners, driers, varnish, etc., shall be of the best grade and shall be furnished by the coating manufacturer for use with the specified paints.
- D. Colors: The Owner will select the colors to be used on the various portions of the work. Provide color cards for the coatings proposed. Where more than one coat of paint is required, job tint off-shade the paint for each undercoat to show complete coverage.

2.02 MIXING AND TINTING

- A. When possible, all paints and other materials shall be mixed and tinted by the paint manufacturer prior to delivery to the job site.
- B. When job site mixing and/or tinting is required, the manufacturer's recommendations shall be strictly adhered to. The Contractor shall be solely responsible for the proper conduct of all on-site mixing and/or tinting.

2.03 PIPE AND EQUIPMENT IDENTIFICATION

Different colors will be used on pumps, motors, valves, piping systems and other surfaces as shown in Table 1.

2.04 OSHA SAFETY COLOR USAGE GUIDE

- A. OSHA Safety colors, in accordance with ANSI Z3.1, shall be used for marking physical hazards and safety equipment and locations. The following OSHA Safety Color Usage Guide will be used in determining the coating color and type of marking required.

Safety Red	Safety Orange	Safety Yellow	Safety Green
		Physical Hazard <u>CAUTION</u> (Generally used with Black in checks or stripes)	Safety Equipment and Locations
Fire protection equipment	Exposed box housings	Unguarded edges of platforms	First aid kits and stretchers
Fire boxes	Exposed edges of pulleys, gears, etc.	Elevator door edges	First aid signs, dispensaries and drinking water stations
Extinguishers	Exposed box housings	Bollards	
Exit signs	Safety starting buttons	Pulley Blocks	
Sprinkler piping		Material handling equipment	
Portable containers of flammable liquids			
Emergency stop bars			

PART 3 EXECUTION

3.01 GENERAL

- A. Protect other surfaces from paint and damage. Furnish sufficient shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted. Repair damage as a result of inadequate or unsuitable protection.
- B. The Contractor's on-site representative shall keep a record of work performed each day and shall submit it to the Engineer weekly. The forms for this record will be furnished by the Engineer.
- C. No coat of paint shall be applied until the surface has been inspected and accepted by the Engineer. The Contractor shall give at least 24 hours notice to the Engineer when cleaning is to be performed to prevent inspection delays. The Contractor shall provide the necessary access for inspection by the Engineer.
- D. Shop applied prime coatings which are damaged during transportation, construction or installation shall be thoroughly cleaned and touched-up in the field as directed by the Engineer. The Contractor shall use repair procedures which insure the complete protection of all adjacent primer. The specified repair method and equipment may include wire brushing, hand or power tool cleaning, or dry air blast cleaning. In order to prevent injury to surrounding painted areas, blast cleaning may require use of lower air pressure, small nozzle and abrasive particle sizes, short blast nozzle, distance from surface, shielding and masking. If

damage is too extensive or uneconomical to touch-up, then the item shall be re-cleaned and coated or painted as directed by the Engineer.

3.02 ENVIRONMENTAL CONDITIONS

- A. Environmental conditions which affect coating application include, but are not necessarily limited to, ambient air temperature, surface temperature, humidity, dew point and environmental cleanliness. Comply with the manufacturer's recommendations regarding environmental conditions under which coatings may be applied.
- B. Surface preparation and cleaning of the exterior surfaces must be performed during periods of still air or only a slight breeze so that fallout of the dust produced does not drift onto adjacent property. The Owner reserves the right to temporarily stop the Contractor from exterior blasting (or painting) when by observation it is apparent that the wind direction or velocity prevents compliance with this requirement. Any clean-up of fall-out on adjacent property shall be the responsibility of the Contractor.
- C. No paint shall be applied upon damp or frosty surfaces, or in wet or foggy weather. No paint shall be applied in temperatures below 40 degrees F, when freezing (32 degrees F) is predicted within 24 hours of application, or under temperature or humidity conditions not recommended by the manufacturer. However, in no case shall coatings be applied when the surface temperature is within 5 degrees F of dew point, and in no cases shall coating be applied over a damp surface.

3.03 SAFETY

A. GENERAL

- 1. The Contractor is responsible for the safety of all workers and subcontractors and suppliers performing work on this Project.
- 2. The Contractor shall protect the Owner, their agents, and the General Public from harm attributable to the Contractor's performance, or non-performance, of the work on this Project. The protection shall include, but not be limited to, providing the necessary safety equipment and instructions for its use by the Owner, and their agents.
- 3. The Contractor shall protect the existing structures and environment from damage attributable to the Contractor's performance, or non-performance, of the work on this Project.
- 4. The Contractor shall comply with the applicable standards of 29 CFR Part 1910 and 29 CFR Part 1926.
- 5. The listing of the following potential hazards shall in no way relieve the Contractor's responsibility for safety on this Project.

3.04 SURFACE PREPARATION

- A. General: All surfaces shall be thoroughly clean, dry, and free from oil, grease, or dust. All concrete shall have cured a minimum of 21 days before painting. All fabricated metal products shall have all weld flux and weld spatter removed and sharp peaks in welds ground smooth. The Engineer will inspect the surface preparation prior to the application of coatings. If the preparation is found to be satisfactory, a written order will be given to proceed with coatings.
- B. Ferrous Metals: Standards for the surface preparation of ferrous metals required in the Material Schedules are the standards of the SSPC – The Society for Protective Coatings (SSPC, SP-1 through SP-10). Inspection of these surfaces will be evaluated by field comparison with visual comparator panels. These panels shall be securely wrapped in clear plastic and sealed to protect them from deterioration and marring.
- C. Concrete Surfaces: For all concrete surfaces, the following surface preparation shall be employed:
 - 1. CC-1 - Wash: Wash and scrub all surfaces with a solution of 1-1/2 ounces of soap chips and 1-1/2 ounces of trisodium phosphate in each gallon of water used. Flush away all soap and dirt with clean water. After this washing the surface will be re-checked and any rough areas not suitable for painting shall be sandblasted smooth.
 - 2. CC-2 - Acid Etch: Surface preparation for painting shall not commence until 7 days after the concrete has been pronounced cured. Wash and scrub all surfaces with a solution of 1-1/2 ounces of soap chips and 1-1/2 ounces of trisodium phosphate in each gallon of water used. Flush away all soap and dirt with clean water and then etch the surface with a 15 percent or stronger solution of muriatic acid until an open-faced granular texture, similar to fine sandpaper, is obtained. Any areas that remain smooth are to be re-etched until the desired texture is achieved. Flush and scrub away with clear water all acid and loosened particles.
 - 3. CC-3 - Blast Cleaning: Remove all form oil and dirt by washing the surface with a solution of 1-1/2 ounces of soap chips and 1-1/2 ounces of trisodium phosphate in each gallon of water used. Blast clean all laitance and other foreign material from the surface of the concrete until an openfaced granular texture similar to fine sandpaper is achieved. These results should be accomplished with blast cleaning similar to "brush blasting" steel surfaces.
- D. Wood Surfaces: All wood surfaces shall be clean, dry, and adequately protected from dampness. Sandpaper to a smooth, even surface, then dust off. After priming coat has dried, apply shellac to all knots, pitch, and resinous sapwood. Putty all nail holes, cracks, open joints, and other defects; color putty to match finish paint or stain.

3.05 APPLICATION

- A. Surface Preparation: After specified surface preparation, all surfaces shall be brushed free of dust or foreign matter. Surfaces shall be completely dry before any paint is applied. All voids, open or hollow places in masonry shall be repaired with an epoxy patching compound.
- B. Application: Paint shall be evenly spread in the proper thickness, so that there shall be no drops, runs or saggings of the coating. Where runs and drops do occur, they shall be removed and the surface re-coated to the satisfaction of the Engineer. Sufficient time, as directed by the manufacturer, shall be allowed for the paint to dry before the application of succeeding coats.
- C. Protection of Work Area: Use drop cloths or other suitable means to protect other surfaces of the structure or equipment in place. Upon completion of the work, remove all paint spots from surfaces as directed by the Engineer.
- D. Inspection: The Engineer will inspect each coat prior to the application of subsequent coats. If the work is found to be satisfactory, a written order will be given to proceed.
- E. Defective Work: Remove and replace, at the direction of the Engineer, any painting work found to be defective or applied under adverse conditions.

3.06 PAINTING SCHEDULE

- A. General: The Painting Schedule summarizes the painting systems to be applied to the various surfaces. Items which appear in the Painting Schedule are defined in following paragraphs.
- B. Exposure terms refer to the environmental conditions to which different surfaces may be exposed. A surface may exist in more than one exposure, e.g., an exterior wall can be categorized not only as "above grade", but also as "below grade", where the exposure is delimited by the grade line.
 - 1. Interior: All surfaces within the confines of a building or other enclosure not constantly exposed to weather, including concealed surfaces subject to trapped moisture, heat or other deteriorating conditions and all surfaces exposed to view.
 - 2. Exterior
 - a. Above Grade: All surfaces above finished grade and exposed to weather.
 - b. Below Grade: All surfaces below the finished grade line. Building surfaces with this exposure shall only be painted when they are structurally common with an interior surface, e.g., exterior walls of a dry pit, not the exterior wall of a below grade tank.

3. Submerged: All surfaces below a water surface or exposed to spray. Surfaces exposed to spray includes all areas within 6-inches of maximum water surface in quiescent tanks and within 18-inches of maximum water surface in mixed or agitated tanks. Building surfaces with this exposure shall only be painted when surfaces above water level have an interior exposure.

C. Surfaces

1. Floors: Interior surfaces subject to foot or roller traffic.
2. Building Surfaces: All structural and architectural surfaces except floors. Building surfaces include, but are not limited to, doors and frames, windows and frames, floor doors and walls.
3. Piping: All plumbing and process piping and accessories including valves, fittings, pipe supports, electrical conduit and similar related items.
4. Equipment: All mechanical, electrical, and architectural equipment, items, and accessories installed in the work and not defined above. Equipment includes, but is not limited to: pumps, motors, cabinets, ducts, tanks, and process equipment.

3.07 MATERIAL SCHEDULES

Material Schedules list pretreatment coats, wash coats, seal coats, prime coats, intermediate coats, finish coats and cover coats that comprise a complete and compatible system of surface protection for the particular substrate. Maintain the unity of these systems, making sure all coats applied to any surface are from the same system and same manufacturer. Verify with the manufacturer the compatibility of the materials used.

3.08 MAINTENANCE MATERIALS

Furnish the Owner at least one gallon of each type and color of paint used for finish coats and one gallon of each type of thinner required. Containers shall be tightly sealed and clearly labeled.

3.09 COATING REPAIR

Where coatings have been damaged, the surfaces shall be cleaned and repainted. Surface preparation shall conform to SSPC-SP 11, and feathered into undamaged areas. Painting shall be performed as specified for the damaged surface.

END OF SECTION

**SECTION 12360
LABORATORY CASEWORK**

PART 1 GENERAL

1.01 GENERAL

- A. Laboratory equipment and facilities shall be compatible with the raw water source, intended design of the treatment plant, daily monitoring and the complexity of the treatment process involved.
- B. Recognized laboratory procedures must be utilized, and the testing equipment shall be acceptable to the Division.
- C. Laboratory facilities and any other part of the water treatment plant should not be used for activities and/or purposes that are not pertinent to the operation of the plant or in the execution of the duties of the operator and/or the laboratory analyst.
- D. Sufficient bench space, adequate ventilation, adequate lighting, storage room, laboratory sink, and auxiliary facilities shall be provided.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. Section Includes:

- 1. Wood laboratory casework.
- 2. Filler and closure panels.
- 3. Laboratory countertops.
- 4. Shelves.
- 5. Laboratory sinks.
- 6. Water, laboratory gas, and electrical service fittings.

B. Related Sections:

- 1. Division 11 Section "Laboratory Fume Hoods" for fume hoods, including base cabinets and countertops under fume hoods.

2. Divisions 15 and 16 Sections for installing service fittings specified in this Section, including connecting service utilities.

1.04 DEFINITIONS

- A. Exposed Surfaces of Casework: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 48 inches above floor, and visible surfaces in open cabinets or behind glass doors.
 1. Ends of cabinets, including those installed directly against walls or other cabinets are defined as "exposed."
 2. Ends of cabinets indicated to be installed directly against and completely concealed by walls or other cabinets are defined as "concealed."
- B. Semi-exposed Surfaces of Casework: Surfaces behind opaque doors, such as cabinet interiors, shelves, and dividers; interiors and sides of drawers; interior faces of doors. Tops of cabinets 78 inches or more above floor are defined as "semi-exposed."
- C. Concealed Surfaces of Casework: Include sleepers, web frames, dust panels, and other surfaces not usually visible after installation.
- D. Hardwood Plywood: A panel product composed of layers or plies of veneer, or of veneers in combination with lumber core, hardboard core, MDF core, or particleboard core, joined with adhesive faced both front and back with hardwood veneers.

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For laboratory casework. Include plans, elevations, sections, details, and attachments to other work.
 1. Indicate locations of hardware and keying of locks.
 2. Indicate locations and types of service fittings.
 3. Indicate locations of blocking and reinforcements required for installing laboratory casework.
 4. Include details of exposed conduits, if required, for service fittings.
 5. Indicate locations of and clearances from adjacent walls, doors, windows, and other building components, and other laboratory equipment.
 6. Include coordinated dimensions for laboratory equipment specified in other Sections.

- C. Samples for Initial Selection: For factory-applied finishes and other materials requiring color selection.
- D. Qualification Data: For qualified manufacturer.
- E. Product Test Reports for Casework: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework with requirements of specified product.
- F. Product Test Reports for Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface materials with requirements specified for chemical and physical resistance.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that produces casework of types indicated for this Project that has been tested for compliance with SEFA 8.
- B. Source Limitations: Obtain laboratory casework from single source from single manufacturer unless otherwise indicated. Obtain countertop sink accessories and service fittings from casework manufacturer.
- C. Product Designations: Drawings indicate sizes and configurations of laboratory casework by referencing designated manufacturer's catalog numbers. Other manufacturers' laboratory casework of similar sizes and similar door and drawer configurations and complying with the Specifications may be considered. Refer to Division 1 Section "Product Requirements."
- D. Casework Product Standard: Comply with SEFA 8, "Laboratory Furniture – Casework, Shelving, and Tables – Recommended Practices."
- E. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.08 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install laboratory casework until building is enclosed, utility roughing-in and wet work are complete and dry, and temporary HVAC system is operation and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.09 COORDINATION

- A. Coordinate layout and installation of framing and reinforcements for support of laboratory casework.
- B. Coordinate installation of laboratory casework with installation of fume hoods and other laboratory equipment.

PART 2 – PRODUCTS

2.01 WOOD CABINET MATERIALS

A. General:

1. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
2. Hardwood Plywood: HPVA HP-1, either veneer core or particleboard core, unless otherwise indicated.
3. MDF: ANSI A208.2, Grade 130.
4. Particleboard: ANSI A208.1, Grade M-2.
5. Hardboard: AHA A135.4, Class 1 Tempered.
6. Edgebanding for Wood-Veneered Construction: Minimum 1/8-inch thick, solid wood of same species as face veneer.

B. Exposed Materials:

1. General: Provide materials that are selected and arranged for compatible grain and color. Do not use materials adjacent to one another that are noticeably dissimilar in color, grain, figure, or natural character markings.
2. Plywood: Hardwood Plywood with face veneer of species indicated, selected for compatible color and grain. Grade A exposed faces at least 1/50 inch thick, and Grade J crossbands. Provide backs of same species as faces.
 - a. Face Veneer Cut: Plain sliced.

3. Solid Wood: Clear hardwood lumber of species indicated and selected for grain and color compatible with exposed hardwood plywood.

C. Semi-exposed Materials:

1. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects, of any species similar in color and grain to exposed solid wood.
2. Plywood: Hardwood plywood of any species similar in color and grain to exposed plywood. Grade B faces and Grade J crossbands. Provide backs of same species as faces.
3. Provide solid wood or hardwood plywood for semi-exposed surfaces unless otherwise indicated.

D. Concealed Materials

1. Solid Wood: Any species, with no defects affecting strength or utility.
2. Plywood: Hardwood plywood. Provide backs of same species as faces.
3. Particleboard
4. MDF.
5. Hardboard.

2.02 COUNTERTOP SHELF and SINK MATERIALS

A. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3.

1. Colors, Patterns & Finishes: As selected by Architect from plastic-laminate manufacturer's full range.

B. Core Materials for Plastic Laminate: Particleboard, ANSI A208.1, Grade M-2.

C. Adhesive for Bonding Plastic Laminate: Manufacturer's standard waterproof adhesive.

D. Epoxy: Factory –molded, modified epoxy-resin formulation with smooth, nonspecular finish.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Durcon Company (The).
 - b. Epoxyn Products.

- c. Laboratory Tops, Inc.
 - d. Prime Industries, Inc.
2. Physical Properties:
- a. Flexural Strength: Not less than 10,000 psi.
 - b. Modulus of Elasticity: Not less than 2,000,000 psi.
 - c. Hardness (Rockwell M): Not less than 100.
 - d. Water Absorption (24 Hours): Not more than 0.02 percent.
 - e. Heat Distortion Point: Not less than 260 deg F.
3. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5.
- a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
 - b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).
4. Color: As selected by Architect from manufacturer's full range.

2.03 WOOD CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- 1. Advanced Lab Concepts, Inc.
 - 2. CampbellRhea.
 - 3. CiF Furniture Ltd.
 - 4. Collegedale Casework, LLC.
 - 5. Diversified Woodcrafts, Inc.
 - 6. Fisher Hamilton, L.L.C.
 - 7. Keur Industries, Inc.
 - 8. Kewaunee Scientific Corporation; Laboratory Products Group.
 - 9. Laboratory Design & Supply.
 - 10. Leonard Peterson & Company, Inc.
 - 11. Sheldon Laboratory Systems.
 - 12. South Texas Woodmill, Inc.
 - 13. Terrill Manufacturing Company.

- B. Design: Reveal overlay with radiused edges. Provide 1/8-inch reveals between doors and drawers that are adjacent.
- C. Grain Direction:
1. Vertical on both doors and drawer fronts, with continuous vertical matching.
 2. Lengthwise on face frame members.
 3. Vertical on end panels.
 4. Side to side on bottoms and tops of units.
 5. Vertical on knee-space panels.
 6. Horizontal on aprons and table frames.
- D. Veneer Matching:
1. Provide veneers for each cabinet from a single flitch, book and running matched. Provide continuous matching of adjacent drawer fronts within each cabinet.
- E. Construction: Provide wood-faced laboratory casework of the following minimum construction:
1. Bottoms of Base Cabinets and Tall Cabinets: ¾-inch thick veneer-core hardwood plywood.
 2. Tops and Bottoms of Wall Cabinets and Tops of Tall Cabinets: 1-inch thick veneer-core hardwood plywood.
 3. Ends of Cabinets: ¾-inch thick hardwood plywood.
 4. Shelves: 1-inch thick veneer-core hardwood plywood
 5. Base Cabinet Top Frames: ¾-by-2-inch solid wood with mortise and tenon or doweled connections, glued and pinned or screwed.
 6. Backs of Cabinets: ¾-inch thick, particleboard- or MDF-core hardwood plywood where exposed, ¼ -inch thick, hardwood plywood dadoed into sides, bottoms, and tops where not exposed.
 7. Drawer Fronts: ¾-inch thick, particleboard- or MDF-core hardwood plywood or solid hardwood.
 8. Drawer Sides and Backs: 1/2-inch thick, solid hardwood or veneer-core hardwood plywood, with glued dovetail or multiple-dowel joints.
 9. Drawer Bottoms: ¾-inch thick, veneer-core hardwood plywood glued and dadoed into front, back and sides of drawers. Use ½-inch thick material for drawers more than 24 inches wide.
 10. Doors 48 Inches High or Less: 3/4 inch thick, with particleboard or MDF cores, solid hardwood stiles and rails, and hardwood face veneers and crossbands.
 11. Doors More than 48 Inches High: 1-1/8 inches thick, with particleboard cores and hardwood face veneers and crossbands.

- F. Filler and Closure Panels: Provide where indicated and as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as adjacent exposed cabinet surfaces unless otherwise indicated.
 - 1. Provide utility-space closure panels at spaces between base cabinets where utility space would otherwise be exposed, including spaces below countertops.

2.04 WOOD FINISH

- A. Preparation: Sand lumber and plywood before assembling. Sand edges of doors, drawer fronts, and molded shapes with profile-edge sander. Sand after assembling for uniform smoothness at least equivalent to that produced by 220-grit sanding and without machine marks, cross sanding, or other surface blemishes.
- B. Staining: Remove fibers and dust and apply stain to exposed and semiexposed surfaces as necessary to match approved Samples. Apply stain in a manner that will produce a consistent appearance. Apply wash-coat sealer before applying stain to closed-grain wood species.
 - 1. Stain Color: As selected by Architect from manufacturer's full range.
- C. Chemical-Resistant Finish: Apply laboratory casework manufacturer's standard three-coat, chemical-resistant, transparent finish. Sand and wipe clean between coats. Topcoat(s) may be omitted on concealed surfaces.
 - 1. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8. Acceptance level for chemical spot test shall be no more than four Level 3 conditions.

2.05 HARDWARE

- A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.
- B. Hinges: Stainless-steel, 5-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide 2 for doors 48 inches high or less and 3 for doors more than 48 inches high.
- C. Hinges for Wood Cabinets: Frameless concealed hinges (European type) complying with A156.9, Type B01602, 170 degrees of opening, self-closing.

- D. Hinged Door and Drawer Pulls: Solid aluminum, stainless steel, or chrome-plated brass back-mounted pulls. Provide 2 pulls for drawers more than 24 inches wide.
 - 1. Design: Wire pulls.
 - 2. Overall size: 1-1/4 by 4-1/2 inches.
- E. Sliding Door Pulls: Stainless-steel or chrome-plated recessed flush pulls.
 - 1. Design and Size: As selected from manufacturer's full range.
- F. Pulls: Recessed aluminum pulls. Provide 2 pulls for drawers more than 24 inches wide.
- G. Pulls for Wood Cabinets: Full-width, recessed solid hardwood channels; matching exposed wood of cabinets.
- H. Door Catches: Dual, self-aligning, permanent magnet catches. Provide 2 catches on doors more than 48 inches high.
- I. Drawer Slides: Side mounted, epoxy-coated steel, self-closing; designed to prevent rebound when drawers are closed; complying with BHMA A156.9, Type B05091.
 - 1. Provide Grade 1HD-100; for drawers not more than 6 inches high and 24 inches wide.
 - 2. Provide Grade 1HD-200; for drawers more than 6 inches high or 24 inches wide.
 - 3. Standard Duty (Grade1): Full-extension type, with polymer rollers.
 - 4. Heavy Duty (Grade 1HD-100 and Grade 1 HD-200): Full-overtravel-extension, ball-bearing type.
- J. Drawer Slides for Wood Cabinets: Hardwood runners under centers of drawers with polymer guides fastened to backs of drawers.
- K. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cards approximately 1 by 2 inches, attached with screws or rivets. Provide on all drawers.
- L. Locks for Wood Cabinets: Cam type with 5-pin tumbler, brass with chrome-plated finish; complying with BHMA A156.11, Type E07281 or E07261.
 - 1. Provide a minimum of two keys per lock and two master keys.
 - 2. Provide on all drawers and doors.
 - 3. Keying: Key locks within each room alike, key each room separately.

- 4. Master Key System: Key all locks to be operable by master key.
- M. Sliding-Door Hardware Sets: Laboratory casework manufacturer's standard, to suit type and size of sliding-door units.
- N. Adjustable Shelf Supports for Wood Cabinets: Power-coated steel shelf rests complying with BHMA A156.9, Type B04013.
- O. Adjustable Shelf Supports for Wood Cabinets: Mortise-type, powder –coated steel standards and shelf rests complying with BHMA A156.9, Types B04071 and B04112.

2.06 COUNTERTOPS, SHELVES, TROUGHS, AND SINKS

- A. Countertops, General: Provide units with smooth surfaces in uniform plane free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch, with continuous drip groove on underside ½ inch from edge.
- B. Sinks, General: Provide sizes indicated or laboratory casework manufacturer's closest standard size of equal or greater volume, as approved by Architect.
 - 1. Outlets: Provide with strainer and tailpieces, NPS 1-1/2, unless otherwise indicated.
 - 2. Overflows: For each sink except cup sinks, provide overflow of standard beehive or open-top design with separate strainer. Height 2 inches less than sink depth. Provide in same material as strainer.
- C. Plastic-Laminate Shelves:
 - 1. Plastic-Laminate Shelves: Plastic laminate shop bonded to both faces and all edges of 1-inch thick core. Sand surfaces to which plastic laminate is to be bonded.
 - a. Shelf Core: Particle board Urea-formaldehyde-free particle board Exterior-glue particle board straw-based particle board or exterior plywood.
 - b. Plastic-Laminate Grade for Shelves: HGL.
- D. Epoxy Countertops and Sinks:
 - 1. Countertop Fabrication: Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and with butt joints assembled with epoxy adhesive and concealed metal splines.

- a. Countertop Configuration: Flat, $\frac{3}{4}$ inch thick, with beveled or rounded edge or corners, and with drip groove and integral coved or applied backsplash.
 - b. Countertop Construction: Uniform throughout full thickness.
- 2. Sink Fabrication: Molded in 1 piece with smooth surfaces, coved corners, and bottom sloped to outlet, $\frac{1}{2}$ -inch minimum thickness.
 - a. Provide with polypropylene strainers and tailpieces.
 - b. Provide integral sinks in epoxy countertops, bonded to countertops with invisible joint line.
 - c. Provide manufacturer's recommended adjustable support system for table- and cabinet-type installations.
- 3. Water settling will not be permitted in clay soils. It may be required at the option of the Engineer in sandy soils.

2.07 WATER AND LABORATORY GAS SERVICE FITTINGS

- A. Service Fittings: Provide units that comply with SEFA 7, "Laboratory and Hospital Fixtures – Recommended Practices." Provide fittings complete with washers, locknuts, nipples and other installation accessories. Include wall and deck flanges, escutcheons, handle extension rods, and similar items. Provide units that comply with "Vandal-Resistant Faucets and Fixtures" recommendations in SEFA 7.
- B. Materials: Fabricated from cast or forged red brass unless otherwise indicated. Reagent-Grade Water Service Fittings: Polypropylene, PVC, or PVDF for parts in contact with water.
- C. Finish: Acid- and solvent-resistant powder coating in laboratory casework manufacturer's standard metallic brown, aluminum, white or other color as approved by Architect.
- D. Water Valves and Faucets: Provide units complying with ASME A112.18.1, with renewable seats, designed for working pressure up to 80 psig.
 - 1. Vacuum Breakers: Provide ASSE 1035 vacuum breakers on water fittings with serrated outlets.
 - 2. Aerators: Provide aerators on water fittings that do not have serrated outlets.
 - 3. Self-Closing Valves: Provide self-closing valves where indicated.
- E. Hand of Fittings: Furnish right-hand fittings unless fitting designation is followed by "L."

PART 3- EXECUTION

3.01 INSTALLATION OF CABINETS

- A. Comply with installation requirements in SEFA 2.3. Install level, plumb, and true; shim as required, using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:
 - 1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet.
 - 2. Variation of Bottoms of Upper Cabinets from Level: 1/8 inch in 10 feet.
 - 3. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet.
 - 4. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch.
 - 5. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch.
- B. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions with fasteners spaced not more than 24 inches o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform. Where base cabinets are installed from walls, fasten to floor at toe space at not more than 24 inches o.c and at sides of cabinets not less than 2 fasteners per side.
- C. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 24 inches o.c.
- D. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.
- E. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.03 INSTALLATION OF COUNTERTOPS

- A. Comply with installation requirements in SEFA 2.3. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where shown on Shop Drawings.
- B. Field Jointing: Where possible, make in same manner as shop-made joints using dowels, splines, fasteners, adhesives, and sealants recommended by manufacturer. Prepare edges in shop for field-made joints.

- C. Fastening: Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48 inches. o.c. Where necessary to penetrate countertops with fasteners, countersink heads approximately 1/8 inch and plug hole flush with material equal to countertop in chemical resistance, hardness and appearance.
- D. Provide required hole and cutouts for service fittings.
- E. Provide scribe moldings for closures at junctures of countertop, curb and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.04 INSTALLATION OF SINKS

- A. Comply with installation requirements in SEFA 2.3.
- B. Underside Installation of Epoxy Sinks: Use laboratory casework manufacturer's recommended adjustable support system for table-and cabinet-type installations. Set top edge of sink unit in sink and countertop manufacturers' recommended chemical-resistant sealing compound or adhesive and firmly secure to produce a tight and fully leakproof joint. Adjust sink and securely support to prevent movement. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.

3.05 INSTALLATION OF SERVICE FITTINGS:

- A. Comply with installation requirements in Division 15 and 16 Sections for installing water and laboratory gas service fittings and electrical devices.
- B. Install fittings according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions. Set bases and flanges of sink- and countertop-mounted fittings in sealant recommended by manufacturer of sink and countertop material. Securely anchor fittings to laboratory casework unless otherwise indicated.

3.06 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

- B. Protect countertop surfaces during construction with 6-mil plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches o.c

END OF SECTION

**SECTION 13610
WALKWAYS AND WORK PLATFORMS**

PART 1 – GENERAL

1.01 SCOPE

- A. The work for this section involves the furnishing and installing of walkways and work platform structures necessary for a complete installation in corrosive environments (e.g., wastewater treatment plants, pump stations, etc.).

1.02 SUBMITTAL OF INFORMATION

- A. Submit manufacturers data showing:
 - 1. Dimensions of structure
 - 2. Materials of construction
 - 3. Calculations of expected deflections of structure
- B. Submit shop drawings showing the structure's installation, layout, and dimensions.
- C. Submit Operation and Maintenance Manuals, which include specific instructions for receiving and handling, disassembly, installation repair and service, and a full parts list.

PART 2 – PRODUCTS

2.01 FLAT CHANNEL COVERS

- A. The flat channel covers shall be at a minimum designed of 3/16" thick aluminum diamond tread plate. Fiberglass maybe used as an alternative with the project engineer's agreement. Alternate prefabricated aluminum cover systems such as the Thermancon Enviro Covertite system shall be acceptable.
- B. Acceptable covers shall be of airtight and watertight construction.
- C. Cover systems shall use gaskets between panels and channel edges to obtain a tight seal.
- D. No caulking or any type of secondary sealant may be used.
- E. Gaskets shall be Neoprene Mil R900 or equal.
- F. Covers shall fit into the existing channel with no modification of the channel itself. The top of the cover shall be flush with the top of the channel with no exposed ridges protruding.

- G. The covers shall be supported by a structural grid support system having the following properties:
 - 1. Shall be able to withstand concentrated loads of at least 350 lbs. and uniform loads of at least 25 psf.
 - 2. Shall have a deflection rate of $L/240$ or lower, where L is the overall cover length.
- H. Covers must meet all O.S.H.A. regulations for walkways and work platforms.
- I. Fiberglass covers must be able to resist the corrosion affects of UV lights.
- J. Covers shall be removable by plant personnel without special lifting equipment.
- K. All bolts and fasteners shall be type 316 stainless steel and comply with ASTM A167.
- L. No more than six (6) bolts shall need to be removed to remove any panel within the cover system.
- M. No more than two (2) other panels shall be disturbed when removing a single panel from any location.
- N. Multiple covers shall not be allowed for any given span.

2.02 STAIRS AND PLATFORMS

- A. Stairs and platforms shall be constructed of 1" minimum tubular aluminum frame.
- B. The walking surface shall be constructed of 3/16" minimum aluminum plate. The aluminum plate shall have a reverse stamped pattern covering the entire work surface.
- C. All joints and panels shall be welded in place according to the American Welding Society's standard for aluminum.
- D. The tubular frame and plate system shall be able to withstand concentrated loads of 500 lbs. and uniform loads of at least 30 psf. The system shall also have a minimum deflection rate of $L/240$, where L is the overall member or span length.
- E. All stairs and platforms shall strictly conform to all O.S.H.A. regulations for walkways and work platforms.

END OF SECTION

SECTION 14010
STAINLESS STEEL PROCESS PIPE

PART 1 – GENERAL

1.01 APPLICABLE STANDARDS

A. American Welding Society (AWS):

D1.1/D1.1M Structural Welding Code - Steel.

B. American Society of Mechanical Engineers (ASME):

B1.20.1 Pipe Threads, General Purpose, Inch.

B16.1 Cast Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, 250 and 800.

B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

B16.9 Factory-Made Wrought Butt welding Fittings.

B16.11 Forged Fittings, Socket-Welding and Threaded.

B16.20 Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed.

B16.21 Nonmetallic Flat Gaskets for Pipe Flanges.

B31.3 Process Piping.

Boiler and Pressure Vessel Code (BPVC), Section IX
Welding and Brazing Qualifications.

C. American Society of Testing Materials (ASTM):

A182/A182M Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.

A193/A193M Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.

A194/A194M	Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
A269/A269M	Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
A312/A312M	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

1.02 SUBMITTALS

- A. Materials used in process shall be submitted for approval to the Design Engineer. The Design Engineer shall review the drawings, provide a list of materials and certify compliance to the Owner.

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall be responsible for handling and storage of all materials and damaged materials shall not be used in the work. Materials delivered to the site shall be promptly inspected for damage upon arrival. Damaged or defective materials to be immediately removed from the site.
- B. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas. Protect piping and appurtenances by storing off ground. Provide additional protection according to manufacturer instructions.

PART 2 – PRODUCTS

2.01 STAINLESS STEEL PIPE AND FITTINGS

- A. General Service Piping:
 - 1. Type:
 - a. Welded; comply with ASTM A813/A813M.
 - b. Class: SW; comply with ASTM A814/A814M.
 - 2. Schedule: 80S.

3. Grade: Type 316L.
4. Dimensions: As indicated on shop Drawings.

B. Fittings:

1. Type:
 - a. Piping 2 Inches and Smaller: Socket welding.
 - b. Piping 2-1/2 Inches and Larger: Butt welding.
2. Dimensions: Comply with ASTM A312/A312M.
3. Threaded Fittings:
 - a. Comply with ASME B16.11 and ASTM A182.
 - b. Grade: Type 316L.
 - c. Threads: Comply with ASME B1.20.1.
4. Butt-Welding Fittings:
 - a. Comply with ASTM A403/A403M.
 - b. Grade: Type 316L
 - c. Class: CR; comply with ASME B16.9.
5. Socket-Welding Fittings:
 - a. Comply with ASTM A403/A403M.
 - b. Grade: Type 316L.
 - c. Class: WP; comply with ASME B16.11.
6. Flanged Fittings:
 - a. Type: Threaded.

- b. Class: 300.
 - c. Comply with ASTM A182/A182M.
 - d. Grade: Type 316L.
 - e. Facing and Drilling: Comply with ASME B16.5.
 - f. Backing Flanges:
 - 1) Material: Stainless steel.
 - 2) Class: 150.
 - 3) Comply with ASTM A351/A351M.
 - 4) Type: Van stone.
 - 5) Drilling: Comply with ASME B16.1.
7. Flanged Connections: as required to connect stainless-steel piping to fittings and equipment.

2.02 ACCESSORIES

- A. Pipe-Thread Tape:
 - 1. Material: PTFE.
 - 2. Comply with ASTM D3308.
- 3. B. O-Ring Seals: EPDM.
- 4. Flange Gaskets:
 - 1. Comply with ASME B16.5.
 - 2. Nonmetallic Gaskets:
 - a. Material: Chloroprene rubber.

- b. Comply with ASME B16.21.
- 3. Metallic Ring Joint Gaskets:
 - a. Comply with ASME B16.20.
- 4. Type:
 - a. Raised-Face Flanges: Flat ring.
 - b. Flat-Face Flanges: Full face.

2.03 SOURCE QUALITY CONTROL

- A. Provide shop inspection and testing of completed assembly.
- B. Owner Inspection:
 - 1. Make completed piping and tubing components available for inspection at manufacturer's factory prior to packaging for shipment.
 - 2. Notify Owner at least seven days before inspection is allowed.
- C. Owner Witnessing:
 - 1. Allow witnessing of factory inspections and test at manufacturer's test facility.
 - 2. Notify Owner at least seven days before inspections and tests are scheduled.
- D. Certificate of Compliance:
 - 1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
 - 2. Specified shop tests are not required for Work performed by the approved manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field dimensions are as indicated on shop Drawings.
- B. Inspect existing flanges for nonstandard bolt hole configurations or design, and verify that new pipe and flange mate properly.

3.02 PREPARATION

- A. Ream pipe and tube ends and remove burrs.
- B. Thoroughly clean pipe and fittings before installation.

3.03 INSTALLATION

- A. Comply with ASME B31.3.
- B. Run piping straight along alignment as indicated on shop Drawings, with minimum number of joints.
- C. Fittings:
 - 1. Clean gasket seats thoroughly, and wipe gaskets clean prior to installation.
 - 2. Install according to manufacturer instructions.
 - 3. Bolting:
 - c. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight.
 - d. Use torque wrench to tighten bolts to manufacturer instructions.
- D. Provide required upstream and downstream clearances from devices as indicated on shop Drawings.
- E. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.
- F. Support exposed piping as specified in the plans and specifications.

- G. Provide expansion joints, and pipe guides as specified in this specification book to compensate for pipe expansion due to temperature differences.
- H. Dielectric Fittings: Provide between dissimilar metals.
- I. Field Cuts: According to pipe manufacturer instructions.
- J. Field welding of stainless steel is not permitted.
- K. Provide cathodic protection where indicated on drawings for buried ferrous piping systems.

3.04 TOLERANCES

- A. Piping Laying Tolerance: 5/8 inch.

3.05 FIELD QUALITY CONTROL

A. Inspection:

1. Inspect for damage to piping or tubing that may be detrimental as determined by the Engineer.
2. Repair damaged piping, or provide new, undamaged pipe.
3. After installation, inspect for required supports and anchoring, interferences, and damage to pipe, tube, or fittings.

B. Pressure Testing:

1. Test Pressure: Not less than 200 psig or 50 psi in excess of maximum static pressure, whichever is greater.
2. Conduct hydrostatic test for minimum two hours.
3. Filling:
 - a. Fill section to be tested with water slowly and expel air from piping at high points.
 - b. Install corporation cocks at high points.

- c. Close air vents and corporation cocks after air is expelled.
 - d. Raise pressure to specified test pressure.
- 4. Observe joints, fittings, and valves under test.
- 5. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage and retest.
- 6. Leakage:
 - a. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
 - b. Maintain pressure within plus or minus 5 psi of test pressure.
 - c. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
 - d. Compute maximum allowable leakage by following formula:
 - 1) $L = SD \times \sqrt{P}/C$.
 - 2) L = testing allowance, in gallons per hour.
 - 3) S = length of pipe tested, in feet.
 - 4) D = nominal diameter of pipe, in inches.
 - 5) P = average test pressure during hydrostatic test, in psig.
 - 6) C = 148,000.
 - 7) When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.
 - e. If test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
 - f. Correct visible leaks regardless of quantity of leakage.
- C. Replace pipe or fittings with mortar cracks wider than 1/16 inch.

3.06 CLEANING

- A. Contractor to clean the completed system of any debris or obstructions prior to Final Inspection.

END OF SECTION

C. EQUIPMENT SPECIFICATIONS

SECTION 15100 VALVES

PART 1 - GENERAL

1.01 APPLICABLE STANDARDS

- A. American Waterworks Association (AWWA):
 - C-500 Gate Valves-3" through 48" for Water and Other Liquids
- B. American Society for Testing and Materials (ASTM):
 - A48 Gray Iron Casting
 - A240 Chromium and Chromium-Nickle Stainless Steel Plate Sheet, and Strip for Fusion-Welded Unfired Pressure Vessels
 - A307 Low Carbon Steel Externally and Internally Threaded Standard Fasteners
- C. American National Standards Institute (ANSI):
 - B18.2 Square and Hex-Head Bolts and Screws

1.02 DESCRIPTION

- A. All valves of the same type shall be from a single manufacturer. Parts for valves of the same type and size shall be interchangeable. Spare parts shall be furnished where required in the payment items. Special tools required for repacking or disassembling valves shall be provided.
- B. All valves shall open left (counter-clockwise)

1.03 SUBMITTALS

- A. The Contractor shall prepare and submit for approval, six (6) copies of complete detailed drawings of all valves.

PART 2 – PRODUCTS

2.01 VALVES

- A. All valves 2" in diameter and smaller shall be constructed of brass or bronze except that the hand wheel which shall be of malleable iron construction with screwed ends. All valves 2-1/2" in diameter and larger shall have flanged ends for interior service and mechanical joints for buried service unless otherwise approved. They shall be iron body, bronze mounted, except that in the smaller sizes the valves may be all bronze.
- B. Gate Valves:

1. Gate valves smaller than three inches shall meet the requirements of Fed. Spec. WW-V-54, Class A, 125 pounds.
2. Gate valves three inches and larger shall have nonrising stems and shall meet the requirements of AWWA Standard C-500. Valves for lighter pressures than the AWWA Standard shall meet the requirements of the above specifications except that the requirements for metal thickness and strengths and structural designs shall be adjusted as required to meet hydrostatic test pressures not less than 150 psi.
3. All gate valves shall have standard stuffing box seals. Bonnet bolts, studs and nuts shall be cadmium plated. Seating devices shall be bronze to iron or bronze to bronze. The glands shall be bronze or bronze bushed. Gland bolts and nuts shall be bronze.
4. All gate valves 2-1/2 inches in diameter and larger shall be of the double disc type. All gate valves two inches in diameter and smaller shall be of the double disc or the solid wedge type.
5. Valves to have two inches square operating nut, with the exception that gate valves in altitude valves pits shall have hand wheels.
6. Valves buried in ground or located in vaults or structures shall have suitable extensions for socket operation with top of operating nut located six blow finished grades.

C. Check Valves:

1. Check valves 2" through 24" shall be iron body, bronze mounted swing check valves meeting the requirements of AWWA Standard C508-76.
2. The check valve shall be metal to metal or composite to metal seat construction with flange ends or screw and coupled ends.

D. Altitude Valves:

1. Altitude valves shall have bodies and bonnets of cast iron, or semi-steel with Bronze trim unless otherwise noted on the drawings. They shall be of the differential single acting type as designated on the drawings, and in general shall perform the service of maintaining the liquid level of the storage facility(s) to which they are attached within a 3" to 12" variation.
2. The valve must be cushioned by air or water in opening and closing to prevent hammer and shock. A regulating device shall be provided to adjust the speed of valve closing.
3. All altitude valves furnished for use on this project shall be equipped for showing at all times the position of the valve. Said altitude valves shall be of the size specified on the drawings and suitable for the use intended.

4. The Contractor shall supply the services of a qualified manufacturer's representative to check and calibrate each altitude valve installation for proper working pressure and sequence.

E. Air Release Valves

1. Air release valve shall have all bronze body and bonnet. They shall be the direct acting type.
2. Valves shall be hydrostatically tested to at least 150 psi.
3. The valve shall have stainless steel floats and an internal coating with rust inhibitors.

F. Automatic Control Valves

1. Automatic control valves shall be diaphragm actuated. Valve seat design should readily handle low flow and high differential flow, without enhancement devices.
2. Stainless steel main valve body stem shall be guided top and bottom. The ductile iron valve body shall be rated at 250 psi for class 150 flanges; 640 psi for class 300 flanges; and 640 psi for threaded connections.
3. Ductile iron body and body parts shall be ASTM A536 – epoxy coated. Main valve stem and pilot stems shall be AISI 303 stainless. Diaphragm shall be nylon reinforced Buna – N. Pilot bodies, seat ring and Y-strainer shall be B62 cast bronze. Studs, nuts, plugs and stems should be non-rusting.
4. Speed controls and isolation cocks shall be standard and shall be brass. All tubing shall be stainless and fittings can be a combination of brass and stainless. All valves shall have visual indicators and shall have up-stream and down-stream isolated pressure gauge ports in pilot system.
5. Basic valve port shall be full-port (line size – same as flanges), unless otherwise designated in the written specification. Basic valve and pilot components shall be machined and assembled in the United States.
6. Electric solenoids, utilized as part of the pilot system, shall be commercially distributed throughout the United States, have manual overrides, and they shall be full ported, tube line size, and not piloted in series with accelerators.

PART 3 – EXECUTION

- A. All valves shall be carefully mounted in their respective positions free from distortion and strain. All valves shall be properly packed and left in satisfactory operating condition at the completion of the project.
- B. Valve box and cover shall be installed with each valve as shown in miscellaneous details.

- C. Valves shall be delivered to customer with O&M manual and accompanied with electrical application wiring schematic where applicable.

END OF SECTION

**SECTION 15205
REJECT PUMP STATION**

PART 1 - GENERAL

1.01 SCOPE

- A. The work of this section involves furnishing and installing submersible sewage pump station complete with controls, access covers and accessories necessary for a complete installation. Controls shall be as specified in paragraph 2.02, below.

1.02 SUBMITTAL OF INFORMATION

- A. Submit characteristic curves for pumps, showing total dynamic head, efficiency and brake horsepower plotted against capacity in gpm for all conditions of head and capacity.
- B. Submit manufacturers data showing dimensional information and materials of construction for pumps, discharge elbows, access covers, control panels, floats, and all other accessories. Control panel drawings shall include wiring diagrams.
- C. Submit shop drawings showing equipment installation, layout, and dimensions.
- D. Submit Operation and Maintenance Manuals, which include specific instructions for receiving and handling, disassembly, wiring, installation repair and service troubleshooting pumps and controls, and full parts list.

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- C. Submit shop drawings showing equipment installation, layout, and dimensions.
- D. Submit Operation and Maintenance Manuals, which include specific instructions for receiving and handling, disassembly, wiring, installation repair and service troubleshooting pumps and controls, and full parts list.

PART 2 - PRODUCTS

2.01 PUMPS (Effluent Pump Station)

- A. Quantity of Pumps: 2 Submersible Pumps
- B. Manufacturer: Flygt Concenter N100-3050 or approved equal
- C. Operating Conditions:

1. Capacity (GPM):	278 GPM
2. Min. Pump Efficiency:	70%
3. Max. Static Lift (ft):	15'
4. Total Dynamic Head (ft):	30'
5. Min. Motor Power (hp):	5.5 HP
6. Speed (RPM):	1750 RPM
7. Base Elbow Size (in):	4"
8. Liquid Type:	Wastewater

D. Impeller:

1. Semi open, non clog
2. Keyed to shaft
3. Dynamically balanced while pumping

All openings and passages shall be large enough to permit the passage of a sphere 3" in diameter. The pump motors shall not be overloaded beyond their nameplate rating at the design conditions nor at any head in the operating range.

E. Materials of Construction:

1. Casing: Cast Iron
2. Impeller: Cast Iron
3. Shaft: Stainless steel, integral pump and motor supported by upper and lower ball bearings.
4. All exposed fasteners: Stainless Steel

F. Welding:

All steel structural members shall be joined by electric arc welding with welds of adequate section for the joint involved.

2.02 CONTROL PANELS

A. Power Distribution:

1. The panel power distribution shall include all necessary components and be wired with stranded copper conductors rated at a minimum of 90 degrees C. All conductor terminations shall be as recommended by the device manufacturer.

B. Transformers:

1. Control transformers shall provide the 120 VAC and/or 24 VAC for control circuits. Transformers shall be fused on the primary and secondary circuits. One leg of the secondary shall be grounded. The

120V control transformer shall have additional 500VA capacity for owners 120V miscellaneous electrical loads.

C. Phase Monitor:

1. A line voltage rated, adjustable phase monitor shall be installed to sense low voltage, loss of power, reversed phasing and loss of a phase. Control circuits shall be de-energized upon sensing any of the faults and shall automatically restore service upon return to normal power.

D. Alarm System:

1. The alarm light shall be a weatherproof, shatterproof, red-light fixture with a 40 watt bulb to indicate alarm conditions. The alarm light shall be turned on by the alarm condition.
2. The alarm horn shall be mounted on the exterior of the cabinet. The alarm horn shall provide an aural signal of not less than 90db at 10 feet.
3. An alarm silence switch shall deactivate the alarm horn; however, the alarm light shall flash until the alarm condition ceases to exist. Provide a high-level alarm relay contact for Owner's remote alarm via telemetering system.

E. Control Wires

1. All control wiring shall be Tinned MTW or an equivalent tinned flexible multistrand conductor (tinned wires and components resist hydrogen sulfide corrosion).
2. Colors of wires shall be as follows – Blue for DC control circuits, Red for AC control circuits, Yellow for “powered by external AC or DC control sources”.
3. Control wires shall be routed in schedule 80 wire duct with removable covers and not stuffed to beyond 75% capacity.
4. Control cable shall be labeled on an individual basis, with the same number at both ends of the wire.
5. Control wire labels shall be Panduit clear/white with black ink, self-laminating laser inkjet type (the clear self-laminating process extends the lifespan of the label).

F. Terminal Strips

1. All terminal strips shall be installed using 35mm aluminum DIN rail.
2. All terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.

3. All terminal strips shall use a quality terminal block such as those manufactured by Phoenix Contact, Weidmuller or Allen-Bradley and sized to accommodate 26 – 10 AWG, be rated to 1000V and 30 amps, with a width of .250. These specifications are the minimum.
4. All terminal strip components shall be gray in color except for ground connections which shall be green and terminal strips for devices going into the well/sump shall be blue.
5. There shall be at least a 20% quantity of the total number of terminal blocks used for control in the panel available as spares.
6. AC and DC control wires shall be terminated on different terminal strips or isolated on the same DIN rail using raised terminal block end caps and terminal end blocks, with a six-inch gap between them.
7. Terminal blocks shall be labeled with plastic type press in labels, including spares.

G. Relays

1. All relays and relay bases shall be 8-pin octal or 12-pin octal.
2. All relays shall come with an integral LED type light to indicate when the relay is energized.
3. All relays and relay sockets shall have a protective coating to resist corrosion from hydrogen sulfides.
4. All relays shall come with an integral lever to manually close the relay.
5. Relays and socket bases shall be sourced from a common manufacturer such as Allen-Bradley, Omron, Schneider Electric, Finder.
6. Alternating relays shall be from Diversified Electronics, Macromatic, Eaton, Square- D or Time Mark. If a pump controller is not provided which including includes a pump alternator.
7. Time delay relays shall come from a common manufacturer such as Allen- Bradley, Omron, Schneider Electric, Finder.

H. Motor Starters

1. Motor starters shall be sourced from a common brand such as Square-D or Schneider Electric.
2. All terminal connections shall have a protective coating to resist
3. corrosion from hydrogen sulfides.
4. Motor starters shall use thermal overload or solid-state overload relays, both with auxiliary contacts to indicate overload is tripped and to remove neutral circuit from the associated contactor control coil.

5. Control coil voltages shall not exceed 120Vac.

I. Control Systems

1. All control systems shall be 24vdc, 120Vac is not preferred but acceptable for motor starter/contactors coils, and only if its necessary due to the size of the starter coil.
2. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. The control panel shall be of duplex or triplex design (depending on the number of pumps) to automatically alternate the pumps on each pump down cycle.
4. The alternator shall also have manual alternation mode to allow the operator to manually select the pump to operate.

J. Pump Controllers

1. Pump controllers shall be the Xylem/Flygt MTDPC, MT2PC, or MT3PC model, or approved equal.
2. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. Pump controllers for advanced PLC control systems shall be Allen-Bradley Micro800 series with PanelView HMI Display with a minimum screen size of five inches, or CompactLogix with PanelView Plus HMI display with a minimum 7-inch display or approved equal.
4. Floats shall be mercury free.
5. Other level controllers such as level transducers and probe must be compatible with approved controller.
6. Backup Float Controller - If primary level control is accomplished with a level/pressure transducer then a backup float control system (separate independent PLC or smart relay such as the Micro820) is required where the pumps will be turned ON and OFF using the HIGH- and Low-level floats, this system shall be automatically turned on when the HIGH float is activated, then the controls will require a manual reset to put the controls back to using the primary level transducer. In float mode, if VFDs are included they shall be commanded to 100% speed via digital input (bypassing the analog speed demand). Pumps shall be commanded to come on in a staggered fashion based on how long the High-level float remains active (Lead pump immediately on, lag pump 10 to 15 seconds after lead if high float still active and backup pump 10 to 15 seconds after lag if high float still active).

K. Variable Speed Drives and Motor Soft Starts

1. Variable Speed Drives and Motor Soft Starts shall be from either of these two common and reputable manufacturers, Schneider Electric and Allen-Bradley.
2. Remote panel mounted, program storing keypads with display shall be installed.
3. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.

L. Remote Termination Cabinet

1. A remote mounted termination cabinet shall be installed below the main control cabinet where floats, motor leads and other field mounted devices can be de-terminated and terminated for maintenance and repairs.
2. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. The remote mounted termination cabinet shall be sealed from the main control cabinet with grommet type reusable seals (not Chico or other permanent sealing mediums, if explosion proofing is not required).
4. The connections inside the remote termination cabinet shall be terminated like motor leads (bolted and taped together) and not to a termination strip.

M. Control Cabinet Standards

1. The control cabinet shall be completely made of stainless steel NEMA 4X (304 or 316 grades stainless minimum), no PVC or composite materials. The door gasket shall be rubber in composition to assure a waterproof seal.
2. Only control transformers shall be allowed inside the control cabinet.
3. All external conduits and connections of the control cabinet shall be sealed with grommet type reusable seals (not Chico or other permanent sealing mediums, if explosion proofing is not required).
4. All control panels mounted outside are required to have a heat shield.
5. The control panel shall have a door that opens easily, is lockable to prevent unauthorized intrusion and completely blocks out UV rays from the sun that damage equipment displays and have a removable hinged inner door constructed on minimum .090" 5052 H-32 marine alloy aluminum. Print pocket shall be provided on the inside of exterior door.

6. The control panel shall include toggle latches, drip shield, and a single handled three-point latch system with padlocking provisions.
7. Control panels, electrical enclosures, junction boxes, and remote termination cabinets shall be sourced from any of these common and reliable manufacturers, Hoffman, Hubbell-Wiegmann, Eaton or Appleton.
8. All control panels (even if a permanently mounted emergency standby generator/transfer switch is installed) shall have a portable generator connection manufactured by Crouse-Hinds, with part number AR-1041 Arktite heavy duty plugs, receptacles and connectors (NEMA 4 watertight, 4 wire, 100-amp, style 1, 600Vac/250Vdc, 50-400Hz). Include these options: back angled box, spring return cover, and 4 wire mating plugs.
9. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.

N. Mounting of field devices and equipment

1. All Unistrut material shall be made of grade 304 or 316 stainless steel.
2. All fasteners used in the construction of Lift station shall be 304 or 316 stainless steel (installed with anti-galling compound on fasteners 5/6 or 8mm and larger).
3. All field devices with a visible display shall be mounted in a NEMA 4X lockable enclosure (separate enclosures if the process or measuring medium requires it).
4. All field enclosures and junction boxes shall be sealed with grommet type reusable seals (not Chico or other permanent sealing mediums, if explosion proofing is not required).

O. Installation and Operation Instructions:

1. Installation of the pump chamber shall be done in accordance with the written instructions provided by the manufacturer. Operation and maintenance manuals shall be furnished which will include parts lists of components and complete service procedures and troubleshooting guide.

P. Startup:

1. The Manufacturer shall provide the services of a factory-trained representative for a maximum period of one day on-site to perform initial start-up of the pump station and to instruct the owner's operating personnel in the operation and maintenance of the equipment.
2. All AC inputs and outputs shall be protected against transients induced by inducted loads. The controller shall be UL listed as a control device

with an intrinsically safe output level of 630 microwatts at 5 VDC applied to the float regulators assuring adherence to UL913 Publication for Division 1, Class 1, Intrinsically Safe Apparatus.

Q. Miscellaneous:

1. Drawings: A final as built drawing encapsulated in mylar shall be attached to the inside of the front door. A list of all legends shall be included.
2. Panel Markings: All component parts in the control panel shall be permanently marked and identified as they are indicated on the drawing. Marking shall be on the back plate adjacent to the component. All control conductors shall be identified with wire markers as close as practical to each end of conductors.
3. Testing: All panels shall be tested to the power requirements as shown on the plans to ensure proper operation of all the components. Each control function shall be activated to check for proper operation and indication.
4. Guarantee: All equipment shall be guaranteed for a period of one (1) year from the date of acceptance. The guarantee shall be effective against all defects in workmanship or defective components. The warranty is limited to replacement or repair of defective equipment.
5. All cables shall be enclosed in electrical conduit from the control panel through the wet well wall. Conduit shall be sized to allow easy removal of the cables and shall be sealed at both ends.
6. Manufacturer: The manufacturer shall be a UL listed shop for industrial control systems and shall provide evidence of such on request from the Engineer or using authority.
7. All pump stations shall include a SCADA system provided by the developer to meet the requirements of the City's current system reporting to the treatment facility. The system shall be by radio communication. Any submittals shall be reviewed by the City and it's current supplier prior to the design of the system.

END OF SECTION

**SECTION 15213
UNDERDRAIN PUMP STATION**

PART 1 - GENERAL

1.01 SCOPE

- A. The work of this section involves furnishing and installing submersible sewage pump station complete with controls, access covers and accessories necessary for a complete installation. Controls shall be as specified in paragraph 2.02, below.

1.02 SUBMITTAL OF INFORMATION

- A. Submit characteristic curves for pumps, showing total dynamic head, efficiency and brake horsepower plotted against capacity in gpm for all conditions of head and capacity.
- B. Submit manufacturers data showing dimensional information and materials of construction for pumps, discharge elbows, access covers, control panels, floats, and all other accessories. Control panel drawings shall include wiring diagrams.
- C. Submit shop drawings showing equipment installation, layout, and dimensions.
- D. Submit Operation and Maintenance Manuals, which include specific instructions for receiving and handling, disassembly, wiring, installation repair and service troubleshooting pumps and controls, and full parts list.

1.03 SUBMITTAL OF INFORMATION

- A. Submit characteristic curves for pumps, showing total dynamic head, efficiency and brake horsepower plotted against capacity in gpm for all conditions of head and capacity.
- B. Submit manufacturers data showing dimensional information and materials of construction for pumps, discharge elbows, access covers, control panels, floats, and all other accessories. Control panel drawings shall include wiring diagrams.
- C. Submit shop drawings showing equipment installation, layout, and dimensions.
- D. Submit Operation and Maintenance Manuals, which include specific instructions for receiving and handling, disassembly, wiring, installation repair and service troubleshooting pumps and controls, and full parts list.

PART 2 - PRODUCTS

2.01 PUMPS (Effluent Pump Station)

- A. Quantity of Pumps: 2 Submersible Pumps
- B. Manufacturer: Flygt Concertor N100-4950 or approved equal

C. Operating Conditions:

1. Capacity (GPM):	208 GPM
2. Min. Pump Efficiency:	70%
3. Max. Static Lift (ft):	15'
4. Total Dynamic Head (ft):	47'
5. Min. Motor Power (hp):	7.5 HP
6. Speed (RPM):	1750 RPM
7. Base Elbow Size (in):	4"
8. Liquid Type:	Wastewater

D. Impeller:

1. Semi open, non clog
2. Keyed to shaft
3. Dynamically balanced while pumping

All openings and passages shall be large enough to permit the passage of a sphere 3" in diameter. The pump motors shall not be overloaded beyond their nameplate rating at the design conditions nor at any head in the operating range.

E. Materials of Construction:

1. Casing: Cast Iron
2. Impeller: Cast Iron
3. Shaft: Stainless steel, integral pump and motor supported by upper and lower ball bearings.
4. All exposed fasteners: Stainless Steel

F. Welding:

All steel structural members shall be joined by electric arc welding with welds of adequate section for the joint involved.

2.02 CONTROL PANELS

A. Power Distribution:

1. The panel power distribution shall include all necessary components and be wired with stranded copper conductors rated at a minimum of 90 degrees C. All conductor terminations shall be as recommended by the device manufacturer.

B. Transformers:

1. Control transformers shall provide the 120 VAC and/or 24 VAC for control circuits. Transformers shall be fused on the primary and

secondary circuits. One leg of the secondary shall be grounded. The 120V control transformer shall have additional 500VA capacity for owners 120V miscellaneous electrical loads.

C. Phase Monitor:

1. A line voltage rated, adjustable phase monitor shall be installed to sense low voltage, loss of power, reversed phasing and loss of a phase. Control circuits shall be de-energized upon sensing any of the faults and shall automatically restore service upon return to normal power.

D. Alarm System:

1. The alarm light shall be a weatherproof, shatterproof, red-light fixture with a 40 watt bulb to indicate alarm conditions. The alarm light shall be turned on by the alarm condition.
2. The alarm horn shall be mounted on the exterior of the cabinet. The alarm horn shall provide an aural signal of not less than 90db at 10 feet.
3. An alarm silence switch shall deactivate the alarm horn; however, the alarm light shall flash until the alarm condition ceases to exist. Provide a high-level alarm relay contact for Owner's remote alarm via telemetering system.

E. Control Wires

1. All control wiring shall be Tinned MTW or an equivalent tinned flexible multistrand conductor (tinned wires and components resist hydrogen sulfide corrosion).
2. Colors of wires shall be as follows – Blue for DC control circuits, Red for AC control circuits, Yellow for “powered by external AC or DC control sources”.
3. Control wires shall be routed in schedule 80 wire duct with removable covers and not stuffed to beyond 75% capacity.
4. Control cable shall be labeled on an individual basis, with the same number at both ends of the wire.
5. Control wire labels shall be Panduit clear/white with black ink, self-laminating laser inkjet type (the clear self-laminating process extends the lifespan of the label).

F. Terminal Strips

1. All terminal strips shall be installed using 35mm aluminum DIN rail.
2. All terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.

3. All terminal strips shall use a quality terminal block such as those manufactured by Phoenix Contact, Weidmuller or Allen-Bradley and sized to accommodate 26 – 10 AWG, be rated to 1000V and 30 amps, with a width of .250. These specifications are the minimum.
4. All terminal strip components shall be gray in color except for ground connections which shall be green and terminal strips for devices going into the well/sump shall be blue.
5. There shall be at least a 20% quantity of the total number of terminal blocks used for control in the panel available as spares.
6. AC and DC control wires shall be terminated on different terminal strips or isolated on the same DIN rail using raised terminal block end caps and terminal end blocks, with a six-inch gap between them.
7. Terminal blocks shall be labeled with plastic type press in labels, including spares.

G. Relays

1. All relays and relay bases shall be 8-pin octal or 12-pin octal.
2. All relays shall come with an integral LED type light to indicate when the relay is energized.
3. All relays and relay sockets shall have a protective coating to resist corrosion from hydrogen sulfides.
4. All relays shall come with an integral lever to manually close the relay.
5. Relays and socket bases shall be sourced from a common manufacturer such as Allen-Bradley, Omron, Schneider Electric, Finder.
6. Alternating relays shall be from Diversified Electronics, Macromatic, Eaton, Square- D or Time Mark. If a pump controller is not provided which including includes a pump alternator.
7. Time delay relays shall come from a common manufacturer such as Allen- Bradley, Omron, Schneider Electric, Finder.

H. Motor Starters

1. Motor starters shall be sourced from a common brand such as Square-D or Schneider Electric.
2. All terminal connections shall have a protective coating to resist
3. corrosion from hydrogen sulfides.
4. Motor starters shall use thermal overload or solid-state overload relays, both with auxiliary contacts to indicate overload is tripped and to remove neutral circuit from the associated contactor control coil.

5. Control coil voltages shall not exceed 120Vac.

I. Control Systems

1. All control systems shall be 24vdc, 120Vac is not preferred but acceptable for motor starter/contactors coils, and only if its necessary due to the size of the starter coil.
2. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. The control panel shall be of duplex or triplex design (depending on the number of pumps) to automatically alternate the pumps on each pump down cycle.
4. The alternator shall also have manual alternation mode to allow the operator to manually select the pump to operate.

J. Pump Controllers

1. Pump controllers shall be the Xylem/Flygt or approved equal.
2. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. Pump controllers for advanced PLC control systems shall be Allen-Bradley Micro800 series with PanelView HMI Display with a minimum screen size of five inches, or CompactLogix with PanelView Plus HMI display with a minimum 7-inch display or approved equal.
4. Floats shall be mercury free.
5. Other level controllers such as level transducers and probe must be compatible with approved controller.
6. Backup Float Controller - If primary level control is accomplished with a level/pressure transducer then a backup float control system (separate independent PLC or smart relay such as the Micro820) is required where the pumps will be turned ON and OFF using the HIGH- and Low-level floats, this system shall be automatically turned on when the HIGH float is activated, then the controls will require a manual reset to put the controls back to using the primary level transducer. In float mode, if VFDs are included they shall be commanded to 100% speed via digital input (bypassing the analog speed demand). Pumps shall be commanded to come on in a staggered fashion based on how long the High-level float remains active (Lead pump immediately on, lag pump 10 to 15 seconds after lead if high float still active and backup pump 10 to 15 seconds after lag if high float still active).

K. Variable Speed Drives and Motor Soft Starts

1. Variable Speed Drives and Motor Soft Starts shall be from either of these two common and reputable manufacturers, Schneider Electric and Allen-Bradley.
2. Remote panel mounted, program storing keypads with display shall be installed.
3. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.

L. Remote Termination Cabinet

1. A remote mounted termination cabinet shall be installed below the main control cabinet where floats, motor leads and other field mounted devices can be de-terminated and terminated for maintenance and repairs.
2. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. The remote mounted termination cabinet shall be sealed from the main control cabinet with grommet type reusable seals (not Chico or other permanent sealing mediums, if explosion proofing is not required).
4. The connections inside the remote termination cabinet shall be terminated like motor leads (bolted and taped together) and not to a termination strip.

M. Control Cabinet Standards

1. The control cabinet shall be completely made of stainless steel NEMA 4X (304 or 316 grades stainless minimum), no PVC or composite materials. The door gasket shall be rubber in composition to assure a waterproof seal.
2. Only control transformers shall be allowed inside the control cabinet.
3. All external conduits and connections of the control cabinet shall be sealed with grommet type reusable seals (not Chico or other permanent sealing mediums, if explosion proofing is not required).
4. All control panels mounted outside are required to have a heat shield.
5. The control panel shall have a door that opens easily, is lockable to prevent unauthorized intrusion and completely blocks out UV rays from the sun that damage equipment displays and have a removable hinged inner door constructed on minimum .090" 5052 H-32 marine alloy aluminum. Print pocket shall be provided on the inside of exterior door.

6. The control panel shall include toggle latches, drip shield, and a single handled three-point latch system with padlocking provisions.
7. Control panels, electrical enclosures, junction boxes, and remote termination cabinets shall be sourced from any of these common and reliable manufacturers, Hoffman, Hubbell-Wiegmann, Eaton or Appleton.
8. All control panels (even if a permanently mounted emergency standby generator/transfer switch is installed) shall have a portable generator connection manufactured by Crouse-Hinds, with part number AR-1041 Arktite heavy duty plugs, receptacles and connectors (NEMA 4 watertight, 4 wire, 100-amp, style 1, 600Vac/250Vdc, 50-400Hz). Include these options: back angled box, spring return cover, and 4 wire mating plugs.
9. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.

N. Mounting of field devices and equipment

1. All Unistrut material shall be made of grade 304 or 316 stainless steel.
2. All fasteners used in the construction of Lift station shall be 304 or 316 stainless steel (installed with anti-galling compound on fasteners 5/6 or 8mm and larger).
3. All field devices with a visible display shall be mounted in a NEMA 4X lockable enclosure (separate enclosures if the process or measuring medium requires it).
4. All field enclosures and junction boxes shall be sealed with grommet type reusable seals (not Chico or other permanent sealing mediums, if explosion proofing is not required).

O. Installation and Operation Instructions:

1. Installation of the pump chamber shall be done in accordance with the written instructions provided by the manufacturer. Operation and maintenance manuals shall be furnished which will include parts lists of components and complete service procedures and troubleshooting guide.

P. Startup:

1. The Manufacturer shall provide the services of a factory-trained representative for a maximum period of one day on-site to perform initial start-up of the pump station and to instruct the owner's operating personnel in the operation and maintenance of the equipment.
2. All AC inputs and outputs shall be protected against transients induced by inducted loads. The controller shall be UL listed as a control device with an intrinsically safe output level of 630 microwatts at 5 VDC

applied to the float regulators assuring adherence to UL913 Publication for Division 1, Class 1, Intrinsically Safe Apparatus.

Q. Miscellaneous:

1. Drawings: A final as built drawing encapsulated in mylar shall be attached to the inside of the front door. A list of all legends shall be included.
2. Panel Markings: All component parts in the control panel shall be permanently marked and identified as they are indicated on the drawing. Marking shall be on the back plate adjacent to the component. All control conductors shall be identified with wire markers as close as practical to each end of conductors.
3. Testing: All panels shall be tested to the power requirements as shown on the plans to ensure proper operation of all the components. Each control function shall be activated to check for proper operation and indication.
4. Guarantee: All equipment shall be guaranteed for a period of one (1) year from the date of acceptance. The guarantee shall be effective against all defects in workmanship or defective components. The warranty is limited to replacement or repair of defective equipment.
5. All cables shall be enclosed in electrical conduit from the control panel through the wet well wall. Conduit shall be sized to allow easy removal of the cables and shall be sealed at both ends.
6. Manufacturer: The manufacturer shall be a UL listed shop for industrial control systems and shall provide evidence of such on request from the Engineer or using authority.
7. All pump stations shall include a SCADA system provided by the developer to meet the requirements of the City's current system reporting to the treatment facility. The system shall be by radio communication. Any submittals shall be reviewed by the City and it's current supplier prior to the design of the system.

END OF SECTION

**SECTION 15214
INFLUENT PUMP STATION**

PART 1 - GENERAL

1.01 SCOPE

- A. The work of this section involves furnishing and installing submersible sewage pump station complete with controls, access covers and accessories necessary for a complete installation. Controls shall be as specified in paragraph 2.03, below.

1.02 SUBMITTAL OF INFORMATION

- A. Submit characteristic curves for pumps, showing total dynamic head, efficiency and brake horsepower plotted against capacity in gpm for all conditions of head and capacity.
- B. Submit manufacturers data showing dimensional information and materials of construction for pumps, discharge elbows, access covers, control panels, floats, and all other accessories. Control panel drawings shall include wiring diagrams.
- C. Submit shop drawings showing equipment installation, layout, and dimensions.
- D. Submit Operation and Maintenance Manuals, which include specific instructions for receiving and handling, disassembly, wiring, installation repair and service troubleshooting pumps and controls, and full parts list.

1.03 SUBMITTAL OF INFORMATION

- A. Submit characteristic curves for pumps, showing total dynamic head, efficiency and brake horsepower plotted against capacity in gpm for all conditions of head and capacity.
- B. Submit manufacturers data showing dimensional information and materials of construction for pumps, discharge elbows, access covers, control panels, floats, and all other accessories. Control panel drawings shall include wiring diagrams.
- C. Submit shop drawings showing equipment installation, layout, and dimensions.
- D. Submit Operation and Maintenance Manuals, which include specific instructions for receiving and handling, disassembly, wiring, installation repair and service troubleshooting pumps and controls, and full parts list.

PART 2 - PRODUCTS

2.01 PUMPS (SBR Influent Pump Station)

- A. Quantity of Pumps: 2 Submersible Pumps
- B. Manufacturer: Flygt NP 3171 MT3-435 or approved equal
- C. Operating Conditions:

1. Capacity (GPM): 1,130 GPM
2. Min. Pump Efficiency: 70%
3. Max. Static Lift (ft): 39'
4. Total Dynamic Head (ft): 63'
5. Min. Motor Power (hp): 30 HP
6. Speed (RPM): 1750 RPM
7. Base Elbow Size (in): 8"
8. Liquid Type: Wastewater

2.02 PUMPS (Lagoon Influent Pump Station)

D. Quantity of Pumps: 2 Submersible Pumps

E. Manufacturer: Flygt NP 3171 MT3-455 or approved equal

F. Operating Conditions:

1. Capacity (GPM): 875 GPM
2. Min. Pump Efficiency: 70%
3. Max. Static Lift (ft): 39'
4. Total Dynamic Head (ft): 64'
5. Min. Motor Power (hp): 25 HP
6. Speed (RPM): 1750 RPM
7. Base Elbow Size (in): 6"
8. Liquid Type: Wastewater

G. Impeller:

1. Semi open, non clog
2. Keyed to shaft
3. Dynamically balanced while pumping

All openings and passages shall be large enough to permit the passage of a sphere 3" in diameter. The pump motors shall not be overloaded beyond their nameplate rating at the design conditions nor at any head in the operating range.

H. Materials of Construction:

1. Casing: Cast Iron
2. Impeller: Cast Iron
3. Shaft: Stainless steel, integral pump and motor supported by upper and lower ball bearings.
4. All exposed fasteners: Stainless Steel

I. Welding:

All steel structural members shall be joined by electric arc welding with welds of adequate section for the joint involved.

2.03 CONTROL PANELS

J. Power Distribution:

1. The panel power distribution shall include all necessary components and be wired with stranded copper conductors rated at a minimum of 90 degrees C. All conductor terminations shall be as recommended by the device manufacturer.

K. Transformers:

1. Control transformers shall provide the 120 VAC and/or 24 VAC for control circuits. Transformers shall be fused on the primary and secondary circuits. One leg of the secondary shall be grounded. The 120V control transformer shall have additional 500VA capacity for owners 120V miscellaneous electrical loads.

L. Phase Monitor:

1. A line voltage rated, adjustable phase monitor shall be installed to sense low voltage, loss of power, reversed phasing and loss of a phase. Control circuits shall be de-energized upon sensing any of the faults and shall automatically restore service upon return to normal power.

M. Alarm System:

1. The alarm light shall be a weatherproof, shatterproof, red-light fixture with a 40 watt bulb to indicate alarm conditions. The alarm light shall be turned on by the alarm condition.
2. The alarm horn shall be mounted on the exterior of the cabinet. The alarm horn shall provide an aural signal of not less than 90db at 10 feet.
3. An alarm silence switch shall deactivate the alarm horn; however, the alarm light shall flash until the alarm condition ceases to exist. Provide a high-level alarm relay contact for Owner's remote alarm via telemetering system.

N. Control Wires

1. All control wiring shall be Tinned MTW or an equivalent tinned flexible multistrand conductor (tinned wires and components resist hydrogen sulfide corrosion).

2. Colors of wires shall be as follows – Blue for DC control circuits, Red for AC control circuits, Yellow for “powered by external AC or DC control sources”.
3. Control wires shall be routed in schedule 80 wire duct with removable covers and not stuffed to beyond 75% capacity.
4. Control cable shall be labeled on an individual basis, with the same number at both ends of the wire.
5. Control wire labels shall be Panduit clear/white with black ink, self-laminating laser inkjet type (the clear self-laminating process extends the lifespan of the label).

O. Terminal Strips

1. All terminal strips shall be installed using 35mm aluminum DIN rail.
2. All terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. All terminal strips shall use a quality terminal block such as those manufactured by Phoenix Contact, Weidmuller or Allen-Bradley and sized to accommodate 26 – 10 AWG, be rated to 1000V and 30 amps, with a width of .250. These specifications are the minimum.
4. All terminal strip components shall be gray in color except for ground connections which shall be green and terminal strips for devices going into the well/sump shall be blue.
5. There shall be at least a 20% quantity of the total number of terminal blocks used for control in the panel available as spares.
6. AC and DC control wires shall be terminated on different terminal strips or isolated on the same DIN rail using raised terminal block end caps and terminal end blocks, with a six-inch gap between them.
7. Terminal blocks shall be labeled with plastic type press in labels, including spares.

P. Relays

1. All relays and relay bases shall be 8-pin octal or 12-pin octal.
2. All relays shall come with an integral LED type light to indicate when the relay is energized.
3. All relays and relay sockets shall have a protective coating to resist corrosion from hydrogen sulfides.
4. All relays shall come with an integral lever to manually close the relay.

5. Relays and socket bases shall be sourced from a common manufacturer such as Allen-Bradley, Omron, Schneider Electric, Finder.
6. Alternating relays shall be from Diversified Electronics, Macromatic, Eaton, Square- D or Time Mark. If a pump controller is not provided which including includes a pump alternator.
7. Time delay relays shall come from a common manufacturer such as Allen- Bradley, Omron, Schneider Electric, Finder.

Q. Motor Starters

1. Motor starters shall be sourced from a common brand such as Square-D or Schneider Electric.
2. All terminal connections shall have a protective coating to resist
3. corrosion from hydrogen sulfides.
4. Motor starters shall use thermal overload or solid-state overload relays, both with auxiliary contacts to indicate overload is tripped and to remove neutral circuit from the associated contactor control coil.
5. Control coil voltages shall not exceed 120Vac.

R. Control Systems

1. All control systems shall be 24vdc, 120Vac is not preferred but acceptable for motor starter/contactors coils, and only if its necessary due to the size of the starter coil.
2. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. The control panel shall be of duplex or triplex design (depending on the number of pumps) to automatically alternate the pumps on each pump down cycle.
4. The alternator shall also have manual alternation mode to allow the operator to manually select the pump to operate.

S. Pump Controllers

1. Pump controllers shall be the Xylem/Flygt or approved equal.
2. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. Pump controllers for advanced PLC control systems shall be Allen-Bradley Micro800 series with PanelView HMI Display with a minimum screen size of five inches, or CompactLogix with PanelView Plus HMI display with a minimum 7-inch display or approved equal.

4. Floats shall be mercury free.
5. Other level controllers such as level transducers and probe must be compatible with approved controller.
6. Backup Float Controller - If primary level control is accomplished with a level/pressure transducer then a backup float control system (separate independent PLC or smart relay such as the Micro820) is required where the pumps will be turned ON and OFF using the HIGH- and Low-level floats, this system shall be automatically turned on when the HIGH float is activated, then the controls will require a manual reset to put the controls back to using the primary level transducer. In float mode, if VFDs are included they shall be commanded to 100% speed via digital input (bypassing the analog speed demand). Pumps shall be commanded to come on in a staggered fashion based on how long the High-level float remains active (Lead pump immediately on, lag pump 10 to 15 seconds after lead if high float still active and backup pump 10 to 15 seconds after lag if high float still active).

T. Variable Speed Drives and Motor Soft Starts

1. Variable Speed Drives and Motor Soft Starts shall be from either of these two common and reputable manufacturers, Schneider Electric and Allen-Bradley.
2. Remote panel mounted, program storing keypads with display shall be installed.
3. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.

U. Remote Termination Cabinet

1. A remote mounted termination cabinet shall be installed below the main control cabinet where floats, motor leads and other field mounted devices can be de-terminated and terminated for maintenance and repairs.
2. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. The remote mounted termination cabinet shall be sealed from the main control cabinet with grommet type reusable seals (not Chico or other permanent sealing mediums, if explosion proofing is not required).
4. The connections inside the remote termination cabinet shall be terminated like motor leads (bolted and taped together) and not to a termination strip.

V. Control Cabinet Standards

1. The control cabinet shall be completely made of stainless steel NEMA 4X (304 or 316 grades stainless minimum), no PVC or composite materials. The door gasket shall be rubber in composition to assure a waterproof seal.
2. Only control transformers shall be allowed inside the control cabinet.
3. All external conduits and connections of the control cabinet shall be sealed with grommet type reusable seals (not Chico or other permanent sealing mediums, if explosion proofing is not required).
4. All control panels mounted outside are required to have a heat shield.
5. The control panel shall have a door that opens easily, is lockable to prevent unauthorized intrusion and completely blocks out UV rays from the sun that damage equipment displays and have a removable hinged inner door constructed on minimum .090" 5052 H-32 marine alloy aluminum. Print pocket shall be provided on the inside of exterior door.
6. The control panel shall include toggle latches, drip shield, and a single handled three-point latch system with padlocking provisions.
7. Control panels, electrical enclosures, junction boxes, and remote termination cabinets shall be sourced from any of these common and reliable manufacturers, Hoffman, Hubbell-Wiegmann, Eaton or Appleton.
8. All control panels (even if a permanently mounted emergency standby generator/transfer switch is installed) shall have a portable generator connection manufactured by Crouse-Hinds, with part number AR-1041 Arktite heavy duty plugs, receptacles and connectors (NEMA 4 watertight, 4 wire, 100-amp, style 1, 600Vac/250Vdc, 50-400Hz). Include these options: back angled box, spring return cover, and 4 wire mating plugs.
9. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.

W. Mounting of field devices and equipment

1. All Unistrut material shall be made of grade 304 or 316 stainless steel.
2. All fasteners used in the construction of Lift station shall be 304 or 316 stainless steel (installed with anti-galling compound on fasteners 5/6 or 8mm and larger).
3. All field devices with a visible display shall be mounted in a NEMA 4X lockable enclosure (separate enclosures if the process or measuring medium requires it).

4. All field enclosures and junction boxes shall be sealed with grommet type reusable seals (not Chico or other permanent sealing mediums, if explosion proofing is not required).

X. Installation and Operation Instructions:

1. Installation of the pump chamber shall be done in accordance with the written instructions provided by the manufacturer. Operation and maintenance manuals shall be furnished which will include parts lists of components and complete service procedures and troubleshooting guide.

Y. Startup:

1. The Manufacturer shall provide the services of a factory-trained representative for a maximum period of one day on-site to perform initial start-up of the pump station and to instruct the owner's operating personnel in the operation and maintenance of the equipment.
2. All AC inputs and outputs shall be protected against transients induced by inducted loads. The controller shall be UL listed as a control device with an intrinsically safe output level of 630 microwatts at 5 VDC applied to the float regulators assuring adherence to UL913 Publication for Division 1, Class 1, Intrinsically Safe Apparatus.

Z. Miscellaneous:

1. Drawings: A final as built drawing encapsulated in mylar shall be attached to the inside of the front door. A list of all legends shall be included.
2. Panel Markings: All component parts in the control panel shall be permanently marked and identified as they are indicated on the drawing. Marking shall be on the back plate adjacent to the component. All control conductors shall be identified with wire markers as close as practical to each end of conductors.
3. Testing: All panels shall be tested to the power requirements as shown on the plans to ensure proper operation of all the components. Each control function shall be activated to check for proper operation and indication.
4. Guarantee: All equipment shall be guaranteed for a period of one (1) year from the date of acceptance. The guarantee shall be effective against all defects in workmanship or defective components. The warranty is limited to replacement or repair of defective equipment.
5. All cables shall be enclosed in electrical conduit from the control panel through the wet well wall. Conduit shall be sized to allow easy removal of the cables and shall be sealed at both ends.

6. Manufacturer: The manufacturer shall be a UL listed shop for industrial control systems and shall provide evidence of such on request from the Engineer or using authority.
7. All pump stations shall include a SCADA system provided by the developer to meet the requirements of the City's current system reporting to the treatment facility. The system shall be by radio communication. Any submittals shall be reviewed by the City and it's current supplier prior to the design of the system.

END OF SECTION

**SECTION 15215
RECLAIMED WATER PUMP STATION**

PART 1 - GENERAL

1.01 SCOPE

- A. The work of this section involves furnishing and installing sewage pump station complete with controls using turbine pumps, hydropneumatics tank and accessories necessary for a complete installation. Controls shall be as specified in paragraph 2.03, below.

1.02 SUBMITTAL OF INFORMATION

- A. Submit characteristic curves for pumps, showing total dynamic head, efficiency and brake horsepower plotted against capacity in gpm for all conditions of head and capacity.
- B. Submit manufacturers data showing dimensional information and materials of construction for pumps, discharge elbows, access covers, control panels, floats, and all other accessories. Control panel drawings shall include wiring diagrams.
- C. Submit shop drawings showing equipment installation, layout, and dimensions.
- D. Submit Operation and Maintenance Manuals, which include specific instructions for receiving and handling, disassembly, wiring, installation repair and service troubleshooting pumps and controls, and full parts list.

1.03 SUBMITTAL OF INFORMATION

- A. Submit characteristic curves for pumps, showing total dynamic head, efficiency and brake horsepower plotted against capacity in gpm for all conditions of head and capacity.
- B. Submit manufacturers data showing dimensional information and materials of construction for pumps, fittings, wet well, control panels, floats, and all other accessories. Control panel drawings shall include wiring diagrams.
- C. Submit shop drawings showing equipment installation, layout, and dimensions.
- D. Submit Operation and Maintenance Manuals, which include specific instructions for receiving and handling, disassembly, wiring, installation repair and service troubleshooting pumps and controls, and full parts list.

PART 2 - PRODUCTS

2.01 PUMPS

- A. Quantity of Pumps: 2
- B. Manufacturer: Peerless Pump model 6LB/LC or approved equal

C. Operating Conditions:

1. Capacity (GPM):	60 GPM
2. Max. Static Lift (ft):	35'
3. Total Dynamic Head (ft):	240'
4. Min. Motor Power (hp):	7.5 HP
5. Speed (RPM):	1780 RPM
6. Liquid Type:	Clean Water

D. Impeller:

1. Semi open, non clog
2. Keyed to shaft
3. Dynamically balanced while pumping

All openings and passages shall be large enough to permit the passage of a sphere 3" in diameter. The pump motors shall not be overloaded beyond their nameplate rating at the design conditions nor at any head in the operating range.

E. Materials of Construction:

1. Casing: Cast Iron
2. Impeller: Cast Iron
3. Shaft: Stainless steel, integral pump and motor supported by upper and lower ball bearings.
4. All exposed fasteners: Stainless Steel

F. Welding:

All steel structural members shall be joined by electric arc welding with welds of adequate section for the joint involved.

G. Motors:

The pump motors shall be vertical, solid shaft, NEMA P-base, squirrel-cage induction type, suitable for 3 phase, 60 Hz cycle, 460 volt electric current. They shall have Class F insulation. Insulation temperature shall, however, be limited to Class B. The motors shall have normal starting torque and low-starting torque and low-starting current, as specified by NEMA Design B characteristics. They shall be open drip-proof design with forced air circulation by integral fan. Openings for ventilation shall be uniformly spaced around the motor frame. Leads shall be terminated in a cast connection box and shall be clearly identified.

The motors shall have 1.15 service factor. The service factor shall be reserved for the owner's protection. The motors shall not be overloaded beyond their

nameplate rating, at the design conditions, nor at any head in the operating range as specified under Operating Conditions.

The motor-pump shaft shall be centered, in relation to the motor base, within .005". The shaft runout shall not exceed .003".

The motor shaft shall equal or exceed the diameter specified under Main Pumps at all points from immediately below the top bearing to the top of the impeller hub.

A bearing cap shall be provided to hold the bottom motor bearing in a fixed position. Bearing housings shall be provided with fittings for lubrication as well as purging old lubricant.

The motor shall be fitted with heavy lifting eyes or lugs, each capable of supporting the entire weight of the pump and motor.

2.02 PNEUMATIC TANK

- A. Tank shall be a 600-gallon tank designed in accordance with ASME Boiler and Pressure Code.
- B. The tank shall be capable of operating on a 70-psi internal pressure.
- C. Tank shall be equipped with a pressure relief valve set at 65 psi, and a 6" dial, 0 to 80 psi pressure gauge.
- D. Tank shall have an integrated valve to maintain the proper charge of air in the tank.
- E. Tank shall bear a plate showing manufacturer, manufactured date, pressure rating, and capacity.
- F. All surfaces must be coated with epoxy, and shall applied by the manufacturer and certified to be in full compliance with applicable sections of AWWA D100.

2.03 CONTROL PANELS

A. Power Distribution:

The panel power distribution shall include all necessary components and be wired with stranded copper conductors rated at a minimum of 90 degrees C. All conductor terminations shall be as recommended by the device manufacturer.

B. Transformers:

Control transformers shall provide the 120 VAC and/or 24 VAC for control circuits. Transformers shall be fused on the primary and secondary circuits. One leg of the secondary shall be grounded. The 120V control transformer shall have additional 100VA capacity for owners 120V miscellaneous electrical loads.

C. Phase Monitor:

A line voltage rated, adjustable phase monitor shall be installed to sense low voltage, loss of power, reversed phasing and loss of a phase. Control circuits shall be de-energized upon sensing any of the faults and shall automatically restore service upon return to normal power.

D. Alarm System:

The alarm light shall be a weatherproof, shatterproof, red-light fixture with a 40 watt bulb to indicate alarm conditions. The alarm light shall be turned on by the alarm condition.

The alarm horn shall be mounted on the exterior of the cabinet. The alarm horn shall provide an aural signal of not less than 90db at 10 feet.

An alarm silence switch shall deactivate the alarm horn; however, the alarm light shall flash until the alarm condition ceases to exist. Provide a high-level alarm relay contact for Owner's remote alarm via telemetering system.

H. Control Wires

1. All control wiring shall be Tinned MTW or an equivalent tinned flexible multistrand conductor (tinned wires and components resist hydrogen sulfide corrosion).
2. Colors of wires shall be as follows – Blue for DC control circuits, Red for AC control circuits, Yellow for “powered by external AC or DC control sources”.
3. Control wires shall be routed in schedule 80 wire duct with removable covers and not stuffed to beyond 75% capacity.
4. Control cable shall be labeled on an individual basis, with the same number at both ends of the wire.
5. Control wire labels shall be Panduit clear/white with black ink, self-laminating laser inkjet type (the clear self-laminating process extends the lifespan of the label).

I. Terminal Strips

1. All terminal strips shall be installed using 35mm aluminum DIN rail.
2. All terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. All terminal strips shall use a quality terminal block such as those manufactured by Phoenix Contact, Weidmuller or Allen-Bradley and sized to accommodate 26 – 10 AWG, be rated to 1000V and 30 amps, with a width of .250. These specifications are the minimum.

4. All terminal strip components shall be gray in color except for ground connections which shall be green and terminal strips for devices going into the well/sump shall be blue.
5. There shall be at least a 20% quantity of the total number of terminal blocks used for control in the panel available as spares.
6. AC and DC control wires shall be terminated on different terminal strips or isolated on the same DIN rail using raised terminal block end caps and terminal end blocks, with a six-inch gap between them.
7. Terminal blocks shall be labeled with plastic type press in labels, including spares.

J. Relays

1. All relays and relay bases shall be 8-pin octal or 12-pin octal.
2. All relays shall come with an integral LED type light to indicate when the relay is energized.
3. All relays and relay sockets shall have a protective coating to resist corrosion from hydrogen sulfides.
4. All relays shall come with an integral lever to manually close the relay.
5. Relays and socket bases shall be sourced from a common manufacturer such as Allen-Bradley, Omron, Schneider Electric, Finder.
6. Alternating relays shall be from Diversified Electronics, Macromatic, Eaton, Square- D or Time Mark. If a pump controller is not provided which including includes a pump alternator.
7. Time delay relays shall come from a common manufacturer such as Allen- Bradley, Omron, Schneider Electric, Finder.

K. Motor Starters

1. Motor starters shall be sourced from a common brand such as Square-D or Schneider Electric.
2. All terminal connections shall have a protective coating to resist
3. corrosion from hydrogen sulfides.
4. Motor starters shall use thermal overload or solid-state overload relays, both with auxiliary contacts to indicate overload is tripped and to remove neutral circuit from the associated contactor control coil.
5. Control coil voltages shall not exceed 120Vac.

L. Control Systems

1. All control systems shall be 24vdc, 120Vac is not preferred but acceptable for motor starter/contactors coils, and only if its necessary due to the size of the starter coil.
2. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. The control panel shall be of duplex or triplex design (depending on the number of pumps) to automatically alternate the pumps on each pump down cycle.
4. The alternator shall also have manual alternation mode to allow the operator to manually select the pump to operate.

M. Pump Controllers

1. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
2. Pump controllers for advanced PLC control systems shall be Allen-Bradley Micro800 series with PanelView HMI Display with a minimum screen size of five inches, or CompactLogix with PanelView Plus HMI display with a minimum 7-inch display or approved equal.
3. Floats shall be mercury free.
4. Other level controllers such as level transducers and probe must be compatible with approved controller.
5. Backup Float Controller - If primary level control is accomplished with a level/pressure transducer then a backup float control system (separate independent PLC or smart relay such as the Micro820) is required where the pumps will be turned ON and OFF using the HIGH- and Low-level floats, this system shall be automatically turned on when the HIGH float is activated, then the controls will require a manual reset to put the controls back to using the primary level transducer. In float mode, if VFDs are included they shall be commanded to 100% speed via digital input (bypassing the analog speed demand). Pumps shall be commanded to come on in a staggered fashion based on how long the High-level float remains active (Lead pump immediately on, lag pump 10 to 15 seconds after lead if high float still active and backup pump 10 to 15 seconds after lag if high float still active).

N. Variable Speed Drives and Motor Soft Starts

1. Variable Speed Drives and Motor Soft Starts shall be from either of these two common and reputable manufacturers, Schneider Electric and Allen-Bradley.
2. Remote panel mounted, program storing keypads with display shall be installed.

3. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.

O. Remote Termination Cabinet

1. A remote mounted termination cabinet shall be installed below the main control cabinet where floats, motor leads and other field mounted devices can be de-terminated and terminated for maintenance and repairs.
2. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.
3. The remote mounted termination cabinet shall be sealed from the main control cabinet with grommet type reusable seals (not Chico or other permanent sealing mediums, if explosion proofing is not required).
4. The connections inside the remote termination cabinet shall be terminated like motor leads (bolted and taped together) and not to a termination strip.

P. Control Cabinet Standards

1. The control cabinet shall be completely made of stainless steel NEMA 4X (304 or 316 grades stainless minimum), no PVC or composite materials. The door gasket shall be rubber in composition to assure a waterproof seal.
2. Only control transformers shall be allowed inside the control cabinet.
3. All external conduits and connections of the control cabinet shall be sealed with grommet type reusable seals (not Chico or other permanent sealing mediums, if explosion proofing is not required).
4. All control panels mounted outside are required to have a heat shield.
5. The control panel shall have a door that opens easily, is lockable to prevent unauthorized intrusion and completely blocks out UV rays from the sun that damage equipment displays and have a removable hinged inner door constructed on minimum .090" 5052 H-32 marine alloy aluminum. Print pocket shall be provided on the inside of exterior door.
6. The control panel shall include toggle latches, drip shield, and a single handled three-point latch system with padlocking provisions.
7. Control panels, electrical enclosures, junction boxes, and remote termination cabinets shall be sourced from any of these common and reliable manufacturers, Hoffman, Hubbell-Wiegmann, Eaton or Appleton.
8. All control panels (even if a permanently mounted emergency standby generator/transfer switch is installed) shall have a portable

generator connection manufactured by Crouse-Hinds, with part number AR-1041 Arktite heavy duty plugs, receptacles and connectors (NEMA 4 watertight, 4 wire, 100-amp, style 1, 600Vac/250Vdc, 50-400Hz). Include these options: back angled box, spring return cover, and 4 wire mating plugs.

9. All hardware components and terminal connections shall have a protective coating to resist corrosion from hydrogen sulfides.

Q. Mounting of field devices and equipment

1. All Unistrut material shall be made of grade 304 or 316 stainless steel.
2. All fasteners used in the construction of Lift station shall be 304 or 316 stainless steel (installed with anti-galling compound on fasteners 5/6 or 8mm and larger).
3. All field devices with a visible display shall be mounted in a NEMA 4X lockable enclosure (separate enclosures if the process or measuring medium requires it).
4. All field enclosures and junction boxes shall be sealed with grommet type reusable seals (not Chico or other permanent sealing mediums, if explosion proofing is not required).

R. Installation and Operation Instructions:

1. Installation of the pump chamber shall be done in accordance with the written instructions provided by the manufacturer. Operation and maintenance manuals shall be furnished which will include parts lists of components and complete service procedures and troubleshooting guide.

S. Startup:

1. The Manufacturer shall provide the services of a factory-trained representative for a maximum period of one day on-site to perform initial start-up of the pump station and to instruct the owner's operating personnel in the operation and maintenance of the equipment.
2. All AC inputs and outputs shall be protected against transients induced by inducted loads. The controller shall be UL listed as a control device with an intrinsically safe output level of 630 microwatts at 5 VDC applied to the float regulators assuring adherence to UL913 Publication for Division 1, Class 1, Intrinsically Safe Apparatus.

T. Miscellaneous:

1. Drawings: A final as built drawing encapsulated in mylar shall be attached to the inside of the front door. A list of all legends shall be included.

2. Panel Markings: All component parts in the control panel shall be permanently marked and identified as they are indicated on the drawing. Marking shall be on the back plate adjacent to the component. All control conductors shall be identified with wire markers as close as practical to each end of conductors.
3. Testing: All panels shall be tested to the power requirements as shown on the plans to ensure proper operation of all the components. Each control function shall be activated to check for proper operation and indication.
4. Guarantee: All equipment shall be guaranteed for a period of one (1) year from the date of acceptance. The guarantee shall be effective against all defects in workmanship or defective components. The warranty is limited to replacement or repair of defective equipment.
5. All cables shall be enclosed in electrical conduit from the control panel through the wet well wall. Conduit shall be sized to allow easy removal of the cables and shall be sealed at both ends.
6. Manufacturer: The manufacturer shall be a UL listed shop for industrial control systems and shall provide evidence of such on request from the Engineer or using authority.
7. All pump stations shall include a SCADA system provided by the developer to meet the requirements of the City's current system reporting to the treatment facility. The system shall be by radio communication. Any submittals shall be reviewed by the City and it's current supplier prior to the design of the system.

END OF SECTION

SECTION 15280
CHEMICAL FEED SYSTEM

PART 1 - GENERAL

1.01 GENERAL

- A. The work described in this section consists of furnishing and installing a complete chemical feed system for the Soda Ash, Alum, and Polymer feed system. The chemical feed system shall be approved by the engineer prior to purchase. Work shall include, but not be limited to, furnishing, and installing all piping, chemical feed tanks, pumps, controls and appurtenances, heat tracing, all trenching, excavation and backfill, installing all concrete structures and complete surface restoration and cleanup.

1.02 SUBMITTALS

- A. Six copies of manufacturer's drawings and catalog cuts of the following items shall be submitted for approval by the Engineer:
1. Duplex Chemical Feed Package
 2. Chemical feed controls
 3. Chemical storage tanks
 4. Pipe and appurtenance
 5. Heat Tracing

1.03 GENERAL EQUIPMENT DESIGN AND CAPACITY

- A. General equipment design shall be such that:
1. feeders will be able to supply, at all times, the necessary amounts of chemicals at an accurate rate, throughout the range of feed;
 2. feeders are adjustable to handle all plant flow rates;
 3. chemical-contact materials and surfaces are resistant to the aggressiveness of the chemical solution;
 4. corrosive chemicals are introduced in such a manner as to minimize potential for corrosion;
 5. chemicals that are incompatible are not stored or handled together;

6. all chemicals are conducted from the feeder to the point of application in separate conduits;
7. chemical feeders are as near as practical to the feed point;
8. chemicals are fed by gravity where practical, and shall not be siphoned into the water supply;
9. service water supply shall be protected from contamination by the chemical solutions. It should be equipped with backflow prevention devices, or an air gap should be provided between the supply line and the solution tank;
10. no direct connection shall exist between any sewer and drain or overflow from the feeder or solution chamber or tank. All drains shall terminate at least six inches or two pipe diameters, whichever is greater, above the overflow rim of a receiving sump, conduit, or waste receptacle;
11. Pumps must be sized to match or exceed maximum head conditions found at the point of injection;
12. calibration tubes or mass flow monitors which allow for direct physical measurement of actual feed rates should be provided;
13. a pressure relief valve should be provided on the pump discharge line; and
14. liquid Chemical Feeders shall be such that chemical solutions cannot be siphoned into the water supply, by assuring discharge at a point of positive pressure, or providing vacuum relief, or providing a suitable air gap, or other suitable means or combinations as necessary.

PART 2 – PRODUCTS

2.01 DUPLEX CHEMICAL FEED PACKAGE

- A. Duplex Chemical Feed Package shall be furnished as manufactured by ProMinent Sigma 2 16050PVT or approved equal.
- B. The chemical feed pumps shall have a capacity of 15.8 GPH @ max backpressure (75 psi min).
- C. The pumps shall be self-priming, capable of suction lifts, when dry, up to ten feet.

- D. The flow rate of each pump shall be adjustable based on a 4-20 mA signal.
- E. Pump suction and discharge shall be 1" I.D.
- F. Pump skid shall be 110 volt, 60 Hz, single phase and base-mounted.
- G. Each Pump Skid shall include:
 - 1. a minimum of two diaphragm metering pumps;
 - 2. Control Panel for pump speed control – SCADA
 - 3. Diaphragm Leak Detector
 - 4. Hydraulic Accessories as listed in Section 2.08
- H. A separate pump skid shall be provided for each chemical applied. In addition, spare parts should be available for all pumps to replace parts which are subject to damage.

2.02 DIAPHRAGM METERING PUMP SKID SYSTEM

- A. The metering pump skid system shall be designed and constructed of corrosion resistant materials for severe environments encountered in liquid chemical feed applications.
- B. The skid system shall be completely self-contained, including pumps, piping, fittings, accessories, and controls.
- C. The skid frame shall be constructed of welded structural steel frame, encapsulated in a PVC lining. Plastic frame construction metering skid system shall not be acceptable.
- D. Metering pump skid structure design shall be an open frame with support stand for mounting of controls and accessories, providing 360 degree accessibility to facilitate easy operation and system maintenance.
- E. The pump system components shall be easily accessible and have unions located for easy disassembly of system piping and accessories for maintenance and repair with no special tools.
- F. The skids shall be designed for installation on the floor and provide an integral chemical containment capability.

- G. Piping and fittings shall be constructed of Schedule 80 socket welded PVC, threaded at the pump head and accessories as specified. The piping shall be adequately supported with pipe clips and supported from the skid frame. Support of the piping of the pump head shall not be acceptable.
- H. Plugged tee at the inlet shall be provided for ganging of multiple metering pump skids.
- I. The metering pump skid system shall include two sets of back pressure valve and pressure relief valves on the discharge side with built in by-pass arrangement to prime the pump and fill the calibration column without the need to reset the relief valve.
- J. The two pump inlets shall be located at the lower rear of the skid base and have an inlet isolation ball valve off a pre-assembled with the main suction header. The two outlets shall be located at the top rear of the skid and have an outlet isolation ball valve off a pre-assembled main discharge header.
- K. A common calibration column shall be installed on the pump suction side, with isolation ball valve and vented top fill connection, sized for 30 seconds minimum retention capacity at maximum pump flow rate.
- L. Two (2) air charged bladder type pulsation dampeners shall be sized for 95% minimum dampening of the pump flow, with air fill connection and pressure gauge.
- M. Two (2) liquid filled pressure gauges with isolation diaphragm shall be installed on the pump discharge piping. The pump shall be installed on the skid with the pump head exposed to full accessibility for removal for service and maintenance with no disassembly of the system piping and accessories.
- N. All controls shall be mounted on the skid support frame and pre-wired by the metering pump manufacturer.
- O. All controls shall be functionally tested at the factory for proper operation prior to shipment.

- P. Chemical metering pump assembled on the skid shall be a non-loss of motion positive displacement, mechanical diaphragm type.

2.03 DIAPHRAGM METERING PUMP DESCRIPTION

- A. Chemical metering pumps shall be of the positive displacement, mechanical diaphragm type.
- B. A steel and nodular iron non-loss-motion stroke adjust mechanism, driven by a pulley coupled, variable speed DC motor, shall actuate a flat, Teflon-faced composite diaphragm.
- C. Solenoid-driven pumps, lost-motion mechanically actuated diaphragm pumps and hydraulically actuated diaphragm pumps will not be accepted.
- D. The liquid ends shall provide for easy maintenance and integral sight flow indication via clear PVC cartridge-type check valves.
- E. Conventional threaded and integral sight flow indicator will not be allowed.

2.04 DRIVE

- A. A steel and nodular iron non-loss-motion stroke adjust mechanism shall be housed in a corrosion resistant, epoxy painted, cast iron gearbox.
- B. All drive bearings shall be tapered rollers; all fasteners shall be 316 SS.
- C. The gearbox shall be oil-bath lubricated. Grease filled gearbox shall not be allowed.
- D. Stroke length shall be controlled manually via a 10-turn micrometer-type adjuster. Less than 10 turn micrometer type adjustment shall not be allowed.
- E. A percent scale and vernier shall indicate stroke length in 0.25% increments. Each revolution of the knob shall change stroke length by 10%. The motor shall be coupled to the gearbox via a field retrofittable, 4-step pulley and belt driven mechanism. This mechanism shall provide four separate individual capacities. Each speed range shall have 10:1 stroke turndown adjustment, thereby extending the

total operation turndown to 40:1 with a standard induction motor, 800:1 with a variable speed permanent Magnet DC motor.

2.05 LIQUID END

- A. The process diaphragm shall be Teflon-faced, fabric reinforced and bonded to pre-formed elastomeric support.
- B. It shall incorporate convolutions, for unconstrained rolling action and a steel backing plate for volumetric accuracy.
- C. An O-ring groove in the head's diaphragm cavity will provide for a complete leak-free seal.
- D. Positive flow shall be ensured via single ball cartridge-type check valves.
- E. The valve retainers shall be clear PVC, for integral sight flow indication and shall have compression seal to the pump head and pipe connectors via O-rings.
- F. Valve service or removal shall be accomplished by sliding the valve assembly cartridge horizontally. Valve removal shall not require any unscrewing or disturbances to the pump head pipe works.
- G. A rolling secondary diaphragm seal shall be provided and shall completely seal and separate the pump head from the drive unit, to eliminate any risk of cross-contaminating gearbox lubricant and process fluid. Sliding seal type arrangement shall not be allowed.
- H. Liquid end shall be PVC including head, valves, seats, and guides. Seals shall be Hypalon O-rings. Valve balls shall be made from Teflon material, with PTFE faced Viton gasket seals and ceramic valve balls.

2.06 CONTROLS AND MONITORING

Each pump shall be supplied with its own control panel to conform to the following:

- A. Feed rate shall be controlled manually, via a 10-turn micrometer-type stroke length adjuster with integral self-locking ratchet mechanism. A percent scale and vernier shall indicate stroke length in 0.25% increments. Each revolution of the knob shall change stroke length by 10%. Feed rate shall be infinitely adjustable from 0 through 100%. Stroke length shall be adjustable over a 10:1 operating range.

Repeatable metering accuracy shall be $\pm 2\%$ of full scale, at constant hydraulic conditions, over the operating range.

- B. Pump speed shall be controlled via DC drive and standard 56C frame motor attached via an external 4-20mA input signal.
- C. Control panel shall be housed in an external NEMA 4X fiber glass control box mounted on the skid providing pump speed regulation.
- D. Control panel shall utilize UL listed components and include following display and functionality.
 - 1. Pump speed digital meter
 - 2. Panel power ON pilot light
 - 3. Pump run pilot light
 - 4. Pump failure pilot light
 - 5. Main disconnect switch
 - 6. Start-stop control mode
 - 7. Hand-off-Auto
 - 8. Auto mode via remote customer contact
 - 9. Pump speed control mode
 - 10. Local and Remote speed control
 - 11. Local speed control via Potentiometer
 - 12. Remote speed control via external 4-20 mA input
 - 13. Remote stop function provision for customer supplied contact or stop button
 - 14. Pump motor overload input monitoring
 - 15. Remote alarm provision for customer supplied contact

16. Dry normally open 10 Amp contact for remote indication of pump run and pump failure
17. Pump speed 4-20 mA output
18. Spare terminal blocks
19. 120 VAC, 1 PH, 60 HZ input
20. Pump shall be supplied with ($\frac{3}{4}$ HP DC) motor

2.07 DIAPHRAGM LEAK DETECTOR

- A. The metering pump skid system shall be fitted with a diaphragm leak detection system for each pump head, to detect the early stages of diaphragm failure.
- B. The system shall consist of a solid-state electro-optic sensor that mounts to the liquid end and a NEMA 4X control box.
- C. Each control box shall be capable of monitoring two liquid ends and shall provide both local and remote indication of failure via LED's and a relay.

2.08 HYDRAULIC ACCESSORY

The following accessories shall be integral with the Skid system.

- A. Inlet Ball Valves
- B. Outlet Ball Valves
- C. Calibration Column Assembly with valve
- D. Backpressure Valve per pump
- E. Gauge w/ PVC isolators per pump
- F. Pulsation Dampener per pump
- G. Pressure Relief Valves per pump
- H. Flushing valve assembly

2.09 SPARE PARTS

1. Each spare parts kit to include suction and discharge valves and diaphragm.
2. A spare unit for each skid of sufficient capacity to replace the one of the pumps during shutdowns;

2.10 CHEMICAL STORAGE TANKS

- A. Provide two molded, seamless, filament wound, FRP tanks with a capacity of 4,500 gallons. The tanks shall be placed above ground on a concrete containment basin as shown on the drawings.
- B. The tanks shall have one 24" bolted manway, 3 - 3" flanged nozzles and 1 -6" "U" vent with screened opening.
- C. The tanks shall have a level gauge of 1½" clear PVC sight glass. Each tank shall have one 2" PVC filler line located in the top of the tank terminating with a 2" ball valve and stainless steel camlock male coupling with a PVC cap mounted on a stainless-steel shelf within the containment area.
- D. The chemical storage tanks shall have an overflow and a receiving basin or drain capable of receiving accidental spills or overflows.
- E. The chemical storage tanks shall be insulated.
- F. Shop drawings for fiberglass chemical storage tanks shall be stamped by an engineer registered in Georgia.
- G. Alum and caustic soda ash shall not be handled in open vessels but should be pumped in undiluted form from original containers through suitable hose, to the point of treatment or to day tanks.
- H. Chemicals shall be stored in covered or unopened shipping containers unless the chemical is transferred into an approved storage unit.
- I. Offloading areas shall be clearly labeled to prevent accidental cross-contamination.

- J. Acids shall be kept in closed, acid resistant shipping containers or storage units. Acids shall not be handled in open vessels but should be pumped in undiluted form from original containers, through suitable hose, to the point of treatment.

2.11 HOUSING

- A. Structures, rooms, and areas accommodating chemical feed equipment shall provide convenient access for servicing, repair, and observation of operation.
- B. Floor surfaces shall be smooth and impervious, slip-proof and well drained with 2.5 % minimum slope.
- C. Vents from feeders, storage facilities and equipment exhaust shall discharge to the outside atmosphere above grade and remote from air intakes.
- D. Open basins, tanks and conduits shall be protected from chemical spills or accidental drainage.

2.12 PIPING AND APPURTENANCES

- A. All piping, suction and discharge shall be 1" schedule 80 PVC. All valves, fittings and connectors shall be schedule 80 PVC.
- B. All fill line pipes shall be 2" schedule 80 PVC. All fill line valves, fittings and connectors shall be schedule 80 PVC.
- C. Fill line shall have a 2" stainless steel male camlock with a 2" plastic female camlock cap. There shall be a spill containment basin and an HDPE piping sump for the fill port.
- D. All casing pipe and appurtenances shall be schedule 80 PVC.

2.13 HEAT TRACING

- A. Provide heat tracing with controls for all exterior PVC lines on the chemical system.
- B. Heat tracing to maintain a temperature of 80° F and should be self-regulating.
- C. All exposed PVC lines to receive UV resistant pipe insulation.
- D. Heat tracing to be weatherproof for outside installation.

2.14 CHEMICAL INFORMATION

- A. For each chemical the information submitted shall include:
1. specifications for the chemical to be used;
 2. purpose of the chemical;
 3. proposed minimum non-zero, average and maximum dosages, solution strength or purity (as applicable), and specific gravity or bulk density;
 4. method for independent calculation of amount fed daily; and
 5. chemical hazards class, if any, and regulatory workplace health/safety and chemical exposure standards listed in Safety Data Sheets (SDS).
- B. Chemical containers shall be fully labeled to include:
1. chemical name, purity and concentration;
 2. supplier name and address; and
 3. expiration date where applicable.
- C. Chemicals shall be listed as meeting NSF Standard 60 and shall meet AWWA specifications, where applicable.
- D. Provisions should be made for assay of chemicals delivered.
- E. Chemicals shall not impart any toxic material to the water under recommended dosages.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. The Contractor shall be responsible for the complete installation which must be in accordance with equipment manufacturer's recommendation.
- B. Furnish and install the pumps, drives, and related accessories required for this Project.
- C. Ensure pumps operate at system fluid temperatures without vapor binding and cavitation and are non-overloading in parallel or individual operation.

- D. The manufacturer should furnish supervision of all installation and supply a qualified service representative to instruct the Owner in the operation and servicing of the equipment.
- E. All pipe penetrations through walls shall be cored and cased with schedule 80 PVC pipe. All penetrations shall be insulated and waterproofed.
- F. Check valve shall be installed at end of chemical feed pipe run prior to discharge into wet well.
- G. All piping shall be adequately supported with pipe clips and supported from frames constructed of galvanized steel, anchored to concrete. Support of the piping shall be at the minimum of 6' of pipe run. All piping shall be installed plumb and level.
- H. Support piping adjacent to chemical pump skid such that no weight is carried on pump skid.
- I. Provide drains for bases, seals, and air cocks piped to and discharging to floor drains.
- J. Lubricate pumps before start-up.
- K. Conduct field tests to demonstrate that capacities and operating characteristics specified are developed.
- L. Safety Items: Provide gloves, goggles, face mask, and apron suitable for use with the chemical involved. Provide signage to be mounted outside of door of chemical room as required by OSHA. Paint all tripping hazards with safety yellow paint. Provide carts and other appropriate means for lifting chemical containers to minimize excessive lifting by operators. The chemical building shall include an emergency shower and eye wash station.

END OF SECTION

SECTION 15282
BIOLOGICAL ODOR CONTROL SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to install and test the biotrickling filter odor control system at the Headworks. System shall be complete with all appurtenances as specified herein.
1. Manufacturer shall furnish biotrickling filter equipment including blower, biotrickling filter vessel, interconnecting ductwork between blower and vessel, flexible connectors, manual airflow dampers, nutrient addition system, water addition system and control panel along with instrumentation and controls for a fully functioning system.
 2. The System is designed as a once-through, non-recirculating system. If a recirculating system is proposed, any additional equipment, duty/standby pumps, pH probe, double containment recirculation pipe and transmitters, etc. will be provided for a complete and operating system. The Manufacturer will be responsible for all changes or modifications to the equipment shown on the project plans.
 3. Manufacturer shall provide shop drawings and Operation and Maintenance manuals.
 4. Manufacturer shall provide startup and performance acceptance testing services as specified herein.
 5. Placement, installation, bolting to the pad and connection of ductwork, water piping, drainage piping, power and control wiring provided by Contractor.
- B. The System shall comprise of the following major components:
1. Biotrickling filter and Activated Carbon combined in same vessel. The FRP vessel shall be comprised of at least one main module and one top piece and may contain additional modules as the design conditions require. Each media module shall house the structured synthetic media in series and contain a single water/nutrient injection spray system.

2. Structured, engineered, plastic, synthetic media to optimize mass transfer and facilitate the growth of bacteria necessary for biological oxidation of odorous compounds. The media bed shall be uniform and structured throughout and made entirely of a plastic, synthetic, non-reactive material.
3. A UL, factory-labeled electrical control panel housing a single Programmable Logic Controller (PLC) system and other components required for the control and monitoring of the System.
4. A water panel that houses all components necessary for the control and monitoring of the media irrigation system, including an Automatic Flow Control system with capability to automatically compensate for water supply pressure changes.
5. A single-pass irrigation system to allow the development of heterotrophic bacteria in the upper media zone. Systems that require recirculation will be considered for this application.
6. Odor control blower to move the odorous air from the source and be able to compensate for all pressure losses at the design airflow.

1.02 CONTRACTOR RESPONSIBILITY

- A. Installation of all Manufacturer-supplied equipment components, which includes among others, receiving, offloading, placement and bolting of all equipment to the concrete pad, connection of ductwork, water piping, drainage piping, and power and control wiring, all in accordance with the Manufacturer's installation instructions.
- B. If applicable, onsite storage and maintenance of all equipment, suitably protected, per the Manufacturers written instructions, from weather and any conditions that could adversely affect the material from its intended function.
- C. Supply of all odorous air ductwork including flex connectors and damper valves upstream of the blower.
- D. Site preparation and clearing.
- E. Construction of concrete equipment pad for placement of the biotrickling filter(s) and supply of system anchor bolts.

- F. External water piping and drain piping to and from the biotrickling filter(s) and Water Control Panels.
- G. Power supply to the electrical control panel, power to the odor control blowers and connection of all ancillary instrumentation mounted remotely to the System Control Panels.
- H. Installation of any additional items as noted on the contract drawings.
- I. Heat tracing and insulation of any air ductwork, water pipes/tubes, and/or nutrient storage tanks as required by this Specification or elsewhere in the Contract Documents.
- J. Adjusting and Balancing of all upstream odor sources.
- K. Temporary piping for startup of the system.

1.03 PROCESS DESCRIPTION

- A. The odor control system shall remove hydrogen sulfide, organic reduced sulfur compounds (RSCs) and/or other odorous compounds from the foul air stream, as required per Section 2.04 below, using a biotrickling filter operating in a counter-current fashion. Co-current systems shall not be allowed.
- B. The foul air shall enter the system at the bottom of each reactor and flow upward through each of the media layers. The media bed shall be intermittently irrigated from above using suitable reclaimed plant effluent or potable water in a once-through fashion. The water then trickles through the media and is collected in a sump at the bottom of the reactor. The drain water from the system will pass from the sump in the bottom of the reactor vessel and be piped to a discharge point as detailed on the Contract drawings.
- C. The hydrogen sulfide is oxidized by the autotrophic bacteria resident on the lower media layer(s). Because of the once-through irrigation configuration, a neutral-pH area of the media will be established, near the top of the media, providing conditions suitable for heterotrophic bacteria to oxidize other organic odorous compounds as required. The airstream is then released to the atmosphere via the exhaust stack at the top of the reactor.

1.04 REFERENCES

- A. ASTM E679: "Standard Practice of Odor and Taste Thresholds By a Forced-Choice Ascending Concentration Series Method of Limits".

- B. EN13725-2003 - Air Quality - Determination of Odor Thresholds by Dynamic Dilution Olfactometry.
- C. ASTM D-2563: "Recommended Practice for Classifying Visual Defects in Glass Reinforced Plastic Laminate Parts".
- D. ASTM D-2583: "Standard Test Method for Indentation Hardness of Rigid Plastics by Means of Barcol Impressor".
- E. ASTM C582: "Revision of C582-02 Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment".
- F. ASTM D-883: "Definition of Terms Relating to Plastics".
- G. ASTM D-3299: "Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks".
- H. ASTM D-2996: "Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
- I. ASTM D 4167 – Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.
- J. ASTM D-4097: "Standard Specification for Contact Molded Glass Fiber Reinforced Thermoset Resin Corrosion-Resistant Tanks".
- K. ASTM D-3982: "Standard Specification for Contact Molded Fiberglass Ducts".
- L. PS 15-69: National Bureau of Standards Voluntary Product Standard "Custom Contact Molded Reinforced Polyester Chemical Resistant Process Equipment".
- M. American National Standards Institute (ANSI).
- N. American Society of Mechanical Engineers (ASME).
- O. Institute of Electrical and Electronic Engineers (IEEE).
- P. National Electrical Manufacturers Association (NEMA).
- Q. National Electrical Code (NEC).
- R. National Fire Protection Agency (NFPA).

- S. National Bureau of Standards (NBS).
- T. Underwriters Laboratories (UL).
- U. American Society for Testing and Materials (ASTM).

1.05 SUBMITTALS

- A. The Manufacturer shall submit information as required to show complete compliance with these specifications. Submittals shall be provided as six (6) hard copies and one (1) digital copy. At a minimum, this information should include the following:
 - 1. A detailed list of any and all deviations and/or exceptions from this specification along with an explanation for the deviation/exception. Clearly list all benefits to the owner and the dollar figure refund due to the owner for the exception.
 - 2. References for ten (10) systems using the proposed media, treating a minimum of 2,000 cfm and that have been in operation for at least ten (10) years.
 - 3. Manufacturer's catalog/data sheets and descriptive literature for each piece of equipment supplied.
 - 4. Technical data on each major piece of equipment including weights of all items greater than 200 lb.
 - 5. Structural calculations and drawings for the main reactor vessel, to include wind and seismic load calculations, dead loads, live loads and anchor bolt sizing. Consideration shall be given to the effect of all cutouts and openings in the vessel. Calculations shall be signed and sealed by a Professional Engineer licensed in the State of Georgia.
 - 6. Modeling results, in graphical format, with velocity contour plots at 24" media height over the entire media cross section shall be provided to confirm that the airflow through the media is homogeneous at the average airflow rate. For the purpose of this specification, homogeneous is defined as being when the upflow velocity over the entire media cross sectional area is equal to the average upflow velocity $\pm 10\%$.
 - 7. Detailed bill of material complete with material of construction.

8. Dimensional drawings showing elevation and plan views of the System and all applicable connections.
 9. Process and Instrumentation Diagram (P&ID) showing all main equipment components, flow rates and instrumentation.
 10. Process control narrative.
 11. Complete details on the Electrical and Water Control Panels:
 - a. Heat calculations pertinent to installation in Georgia.
 - b. Indemnification certificate for all control strategies and programs made out to the owner.
 - c. Confirmation that all programming is done in-house and programs are the property of the Manufacturer.
 - d. Details on the in-house Factory Acceptance Testing (FAT) procedures for review and approval of the engineer.
 - e. Description of Automatic Flow Control equipment to demonstrate compliance with Section 2.05.D.3.
 12. A list of the Manufacturers recommended Spare Parts for one (1) year's operation.
 13. Equipment offloading and installation instructions with sufficient detail to allow the Contractor to complete the mechanical and electrical installation of all System components.
 14. Annual utility and nutrient usage calculations (if applicable).
 15. Statement of Manufacturer's Warranty.
 16. Information on hazards associated with the System and appropriate safety precautions, including applicable Material Safety Data Sheets (MSDS).
 17. Proposed Performance Testing Plan, to include a list of sampling and logging equipment and all sampling and testing methods and protocols.
- B. The Manufacturer shall submit the following information, as a minimum, for the Operation and Maintenance Manuals.
1. As-built dimensional drawings showing plan and elevation views of the System and all applicable connections.

2. As-built Process and Instrumentation Diagrams (P&IDs).
3. Detailed bill of material along with specification of System components and materials of construction. The list to include the make, model number and descriptive literature of all items furnished by the Manufacturer.
4. Performance data for the odor control blower, to include curves showing capacity, pressure, horsepower demand and efficiency over the entire operating range, including blower manufacturer's descriptive literature and blower model number(s).
5. Special precautions for any components or materials associated with the System and its operation that should be subject to particular safety precautions, including MSDS.
6. Manufacturer's Service Department contact information and service order form.
7. Statement of Manufacturer's Warranty.
8. System startup and restart instructions.
9. Detailed information on proper settings and operation of the Automatic Flow Control System.
10. Special maintenance procedures, including recommended weekly, monthly and annual preventative maintenance requirements.
11. Troubleshooting guide.
12. Individual Operation and Maintenance instructions for all major system components.
13. O&M manual shall be provided in digital copy for review/comment/approval. After approval, the Manufacturer shall provide four (4) hard copies for the owner's records.

1.06 SHIPPING, DELIVERY, STORAGE, & HANDLING

- A. All equipment and materials shall be properly protected such that no damage will occur from the time of shipment until the time of installation.

- B. All exposed openings shall be protected to prevent entrance of debris, moisture or water during transportation and storage.
- C. Contractor shall be responsible for offloading all shipped equipment and shall inspect all equipment upon arrival. Contractor shall notify the Manufacturer within 24 hours of any damage to equipment or surface finish due to shipping.
- D. Contractor shall store all equipment such that, for the duration of the storage period, there will be no deterioration in equipment appearance or performance. Manufacturer shall supply detailed storage instructions, as necessary, at the time of shipment.

1.07 WARRANTY

- A. The biotrickling filter Manufacturer shall warrant that the equipment supplied meets these specifications and the performances detailed in section 2.04 and that it is new and unused, free from defects in materials and/or workmanship. This warranty shall be for 18 months from equipment delivery to the job site or 12 months from equipment handover, whichever comes first. In the event that it is determined that a defect exists, at the Manufacturer's discretion, the Manufacturer shall repair or replace the defective components, provided that any such defect was not the result of misuse of the component by the Owner or his agents.
- B. The biotrickling filter Manufacturer shall warrant the plastic, synthetic media against defects in material and workmanship for five (5) years from equipment delivery. In addition, the manufacturer shall warrant the media against shrinking, swelling or plugging (such that the design airflow cannot be achieved) for a period of five (5) years. In the event that it is determined that a defect exists, at the Manufacturer's discretion, the Manufacturer shall repair or replace the defective components, provided that any such defect was not the result of misuse of the component by the Owner or his agents. The inability of the System blower (s) to provide the full design airflow will indicate failure of the media.
- C. The biotrickling filter Manufacturer shall warrant that the irrigation spray nozzles shall remain clog and maintenance free for ten (10) years.
- D. All System Warrantees are predicated on operation and maintenance of the System being in accordance with the Manufacturers written O&M manual and inlet conditions being in-line with these specifications. Demonstration of the above will be provided through written logs and records provided by the owner.

PART 2- PRODUCTS

2.01 GENERAL

- A. The odor control equipment supplied under this section must be provided by a single Manufacturer who will be solely responsible for the design, delivery and performance of the system. The equipment must be new and unused and meet the detailed specifications and warranty requirements stated herein.

2.02 QUALITY ASSURANCE

The Manufacturer shall be an industry recognized process company specializing in the design, manufacture and operation of biological odor and air emissions equipment utilizing a once-through (non-recirculated) irrigation system.

The System Manufacturer shall have the following full-time employees on staff to ensure proper system support: mechanical engineer, environmental engineer, electrical engineer and a dedicated service department.

Any manufacturer whose main business is FRP manufacturing will not be accepted as a supplier for the odor control system specified herein.

The biotrickling filter Manufacturer is responsible for the coordination of all equipment specified herein. Systems shall be as manufactured by BioAir Solutions, LLC. or pre-approved equal only. Proposal of an unnamed Manufacturer after the bid will not be considered.

A. Experience Requirements

The biological odor control system Manufacturer shall be experienced in the design, manufacture, installation and operation of biotrickling filters designed to remove hydrogen sulfide and organic RSCs from municipal water and wastewater odor sources. The System Manufacturer shall have a minimum of ten (10) years of experience producing substantially similar equipment and shall show evidence of at least thirty (30) systems (using the media specified herein) in satisfactory operation for at least ten (10) years in the United States.

B. Substitution

Any substitutions or deviations in equipment or arrangement from that shown on the drawings or specified herein shall be the responsibility of the Contractor. Any deviation must be accompanied by detailed structural, mechanical and electrical drawings and

additional supporting data for review by the Owner and the Owner's Engineer and must be stamped and certified by a registered Professional Engineer (PE) licensed in the State of Georgia.

All costs associated with the review of substitutions or deviations, and costs to the Engineer or Owner associated with project drawing changes as a result of approval of the substitution, shall be borne by the Contractor. There shall be no additional costs to the Owner due to substitutions or deviations.

C. Acceptable Manufacturers

Where a Manufacturer's standard equipment name is used in these specifications, the intent is to establish a minimum standard in terms of equipment quality, performance, functionality and experience. Substitutions as detailed above must be pre-approved by the engineer prior to bidding. Request for pre-approval must be received in writing 21 days prior to the bid opening date and must include the following supporting documentation and information –

1. A detailed list of any and all deviations and/or exceptions from this specification along with an explanation for the deviation/exception.
2. Provide project specific drawings showing arrangement of biotrickling filter, blower and electrical and water control panels.
3. Performance data from a minimum of ten (10) operating systems demonstrating media elimination capacity $\geq 10\%$ greater than the proposed system loading.
4. Provide project specific Process and Instrumentation Diagram (P&IDs)
5. Calculations showing cost of operation – power consumption, water consumption, nutrient consumption, expected biotrickling media life, carbon life calculations, etc.
6. A list of ten (10) similar installations with contact names and phone numbers, length of time in operation and volume of air being treated. Provide performance data for each reference, showing H₂S removal % and % of overall odor removed. Each of the installations must use the same media as proposed for this project and must be operating a once-through irrigation system. Systems using any form of recirculation will not be considered for evaluation as an equal for this project.
7. Installation list detailing equipment capacity, length of time in service, performance record and performance records for two installations for a minimum one (1) week duration for each system.
8. Resumes for in-house Mechanical and Electrical Engineering staff, Process Manager and all in-house Service personnel.
9. Local service center details.
10. Qualifications of key individuals

11. Company financial documentation – D&B report, Bonding Capacity, etc.

In addition, the following may be included to aid the evaluation process –

- i. Cut-sheets, bulletins, company brochures, etc.
- ii. Testimonial or recommendation letters from previous customers
- iii. Published Industry technical papers / bulletins

2.03 OPERATING CONDITIONS

The System shall be suitable to treat air coming from a continuous supply from the odor source and all equipment must be suited to the operating conditions to which it will be subjected and the various compounds/substances with which they will reasonably be expected to come into contact. The operating conditions, at a minimum, include the following:

Purpose:	Continuous air supply and odor source
Location:	Outdoors, Adjacent to Headworks
Inlet Air Temperature:	55-100°F
Inlet Relative Humidity:	60-100%
Contaminants:	Hydrogen Sulfide, Organic RSC's, Ammonia

2.04 DESIGN REQUIREMENTS

- A. At a minimum, the System shall treat the following and meet the following minimum performance criteria:
- B. Performance Requirements (H₂S):
- C. The system shall have passed the performance test if any one of the following conditions is true:
 1. Average H₂S removal efficiency is greater than or equal to 99% for inlet air H₂S concentrations that are greater than or equal to 50 ppmv but less than or equal to 300 ppmv.
 2. Average outlet H₂S concentration is less than or equal to 0.5 ppmv for inlet air H₂S concentrations that are less than or equal to 50 ppmv

2.05 SYSTEM COMPONENTS

A. Biotrickling Filter Vessel

1. The biotrickling filter vessel shall operate in a counter-current manner. Each vessel shall consist of one (1) or more modules containing structured media and one (1) top piece. Each module shall be constructed from Fiberglass Reinforced Plastic (FRP) and be designed with adequate strength to support the number of required modules. Each FRP module shall contain, as a minimum, a 100 mil vinyl ester resin corrosion barrier. The structural layer shall consist of isophthalic resin with chop strand and continuous glass. The exterior top coat shall be isophthalic resin with UV resistant pigment (minimum service life of 10 years). The exterior color shall be CCP base white enamel (W005).
2. Biotrickling filter vessels shall not provide access to any area beneath the media or any location within the vessel where there is a chance for dripping acidic filtrate or hydrogen sulfide gas.
3. The reactor vessels shall be skid mounted, pre-piped and pre-wired for plug and play installation.

B. Media

1. The structured media shall be EcoBase® or approved equal, high porosity, chemically resistant, engineered, plastic, synthetic porous material made from polyvinyl chloride, polyethylene or polyurethane. Organic media, carbon derived lava rock or lava rock media and/or random synthetic or non-synthetic inorganic media materials shall not be allowed.
2. The media characteristics (available surface area, density, and pressure drop) shall be structured and uniform throughout the media bed with pre-manufactured, engineered flow channels. Random media types (chips, clay balls, foam cubes, etc.) shall not be allowed.
3. The media shall have a minimum available specific surface area of 230 ft²/ft³ and a void opening of more than 96%. Pressure drop shall not exceed 0.1" w.g. per ft of media depth.
4. The media shall be guaranteed not to clog or require cleaning, scrubbing, backwashing, acid-washing or replacement for a period of ten (10) years.
5. Media beds / stages shall be self-supporting, enclosed in a shell or otherwise

removal as a single piece. Entry into the vessel shall not be necessary for media removal.

6. Media shall resist compaction or swelling due to varying moisture levels and shall not degrade when subjected to low pH (i.e. $\text{pH} < 2$) conditions.
7. The uniform structure of the media shall minimize the potential for short circuiting and encourage a uniform water and air flow pattern over the entire media cross sectional area.
8. The manufacturer shall provide evidence that the airflow through the media at 24" height from the bottom of the media is homogeneous at the average airflow rate. For purposes of this specification, homogeneous is defined as being when the upflow velocity over the entire media cross sectional area is equal to the average upflow velocity $\pm 10\%$. The airflow modeling results with velocity contour plots at 24" media height over the entire cross section shall be provided in graphical format as part of the Submittal requirements.
9. Sufficient media shall be provided to ensure the performance requirements listed in section 2.04 are met.
10. Media shall be pre-installed in the FRP module (s) by the system manufacturer prior to shipment to the job site. Medias that require a contractor for installation or placement are not permitted.

C. Irrigation System

1. Each reactor shall be configured with at least one (1) irrigation point which shall distribute the irrigation water evenly over the entire upper surface of the media layer.
2. The irrigation system will, without exception, be a once-through system.
3. Spray nozzles shall be 316 Stainless Steel, without exception and shall be warranted to not clog or require maintenance for a ten (10) year period.
4. Each spray nozzle shall be tested by the Manufacturer and a certificate of conformity supplied with the shop drawings to show that the nozzle has been tested and meets the specified standards for uniform distribution.
5. Spray nozzle array systems with multiple nozzles, shall not be acceptable.

6. The irrigation system shall be supplied with a nutrient addition system to provide the macro and micronutrients required by the bacteria for optimal metabolism of the odorous compounds being treated.

D. Control System

1. Electrical Control Panel (ECP)

The ECP enclosure shall be NEMA 4X and constructed of 316SS, and the panel shall come with a 316SS panel stand.

The ECP shall house the necessary electronic components and an Allen Bradley MicroLogix 1400 PLC with PanelView 800 (HMI) for the control and monitoring of the irrigation system. Dry contacts shall be provided for external notification of alarm status. Alarms, at a minimum, shall be provided for low irrigation water flow, high irrigation water flow, no nutrient flow (if applicable) and blower fail. An Ethernet connection shall be provided to allow for remote monitoring/control of the system. There shall be an allowance to manually open the irrigation spray valve (located in the water control panel) for the purpose of routine maintenance checks but the valve should be normally closed.

The system shall contain a PLC with an Ethernet/IP port, two (2) serial ports, on-line editing capability, a built-in backlit LCD screen, and a built-in high speed counter. The PLC shall be expandable with up to seven (7) additional input/output modules.

The ECP shall monitor and log water flow and provide the following summary –
Daily water consumption
Weekly water consumption, etc.

The ECP shall require a single electrical connection of 480V/3Phase/60Hz. Transformers shall be provided as necessary for power and control voltages. A 120 volt, GFCI convenience outlet shall be provided in the ECP.

2. Water Control Panel (WCP)

The Water Control Panel shall be constructed of 316SS and be mounted on the common 316SS panel stand, back-to-back with the ECP.

The WCP shall contain a panel heater, valves, motorized ball valves, strainers, instruments and piping for the control of the irrigation system and shall operate from control signals from the ECP.

The WCP shall contain, without exception, a pulse generating, paddlewheel water flow meter. Irrigation water flow shall be monitored and recorded to ensure proper operation and aid in trouble-shooting. Monitoring irrigation water pressure alone is not acceptable.

The WCP shall allow for a single connection to either a potable water source or suitable final effluent plant water source.

The WCP shall house the nutrient addition system.

The WCP shall also contain a flexible spray hose with a hand trigger to allow for convenient rinsing of the strainer, filling of the nutrient barrel, and general convenience. A dedicated ball valve shall be provided in front of the spray hose to allow for the operation of the water panel while simultaneously allowing for isolation in case of a leak in the hose.

3. Automatic Flow Control System

Without exception, the ECP and WCP shall contain the necessary programming, circuitry, and hardware for an Automatic Flow Control System, which shall have the following features and shall be capable of meeting the Automatic Flow Control System performance test outlined in Section 3.05.E.

4. The system will periodically monitor the irrigation water flow rate during the irrigation sequence.
5. If the irrigation water flow rate is outside of the target flow range the irrigation valve will automatically adjust to correct the irrigation water flow rate.
6. The following parameters shall be operator-adjustable:
 - a. Target irrigation flow rate
 - b. Allowable flow error
 - c. Amount of valve adjustment when error is detected
 - d. Flow evaluation period
7. The following non-adjustable readings shall be shown on the ECP HMI:
 - a. Instantaneous irrigation water flow rate
 - b. Actual irrigation valve open %

The following will NOT be considered to be meeting the Automatic Flow Control Systems requirements:

- a. Systems using irrigation valves that are only capable of fully-open or fully-closed operation. Solenoid Valves do not meet this requirement and are not allowed.
- b. Systems using mechanical-only means of adjusting the irrigation water flow such as manual diaphragm valves, globe valves, pressure reducing or adjusting valves.
- c. Systems that require operator interaction in order to correct the irrigation water flow.

E. Dampers

1. Flow Control Dampers shall be constructed of vinyl ester resin, of the single blade type complete with channel type frame, close fitting blade, full circumference blade stop, full length 316 stainless steel axle, and bearings. Dampers shall have the same inside dimensions as the connecting piping.
2. Isolation Dampers shall be constructed of vinyl ester resin, of the single blade type complete with channel type frame, close fitting blade, neoprene or EPDM blade and Viton shaft seals, full length 316 stainless steel axle, and bearings. Each damper shall have the same inside dimensions as the connecting piping.
3. Dampers shall be Swartwout, BioAir, Belco or approved equal.

F. Odor Control Blower

1. The blower(s) shall be single-width wheel, single-inlet as designed and manufactured by Verantis, The New York Blower Company or approved equal.
2. The blower shall be constructed such that all surfaces in contact with the odorous airstream are to be made of corrosion resistant FRP.
3. All nuts, bolts and fasteners in contact with the gas stream shall type 316 SS.
4. Blowers shall be AMCA Arrangement 9 or 10. AMCA Arrangement 4, which places the motor shaft in the odorous airstream, is not allowed.
5. Blower ratings shall be based on tests made in accordance with AMCA Standard 210 and licensed to bear the AMCA Certified Ratings Seal for Air Performance. Blowers not licensed to bear the AMCA Seal for performance shall be tested, at Contractor's expense, in an AMCA Registered Laboratory.

6. Blower brake horsepower shall have a capacity equal to or less than 550 CFM and 4 inches static pressure.
7. Blower shall be constructed in accordance with ASTM D-4167 standard specification for FRP blowers and blowers to ensure structural integrity.
8. Blower housing shall be constructed of polyester resin.
9. Wheel shall be radial, or backwardly inclined, non-overloading design. Wheel shall be fabricated of vinyl ester resin.
10. Wheel hub shall be securely fastened to the shaft and completely encapsulated in FRP to ensure corrosion-resistant integrity. Wheels shall be ground and polished carbon steel, encapsulated in FRP.
11. The blower motor shall be a standard efficiency, Class I, Div. 2, 480V/3Phase/60Hz electric motor as manufactured by US Electric Motors, Baldor, Reliance or approved equal.
12. Blower shall be equipped with a Teflon shaft seal.

2.06 EQUIPMENT NAME PLATES

Each separate piece of equipment shall be furnished with a unique name plate identifying the Manufacturer, model & serial number, date of manufacture and, if applicable, capacity and any performance limitations. The nameplates shall be Gravograph Gravoply 2 ply plastic and firmly affixed to the exterior surface of the equipment and in a location that is accessible and easily read.

2.07 SPARE PARTS

At a minimum, the following spare parts shall be supplied with the equipment.

One (1) set of fuses, one (1) for each fuse rating.

One (1) set of lamp lenses.

One (1) strainer.

Spare parts shall be stored, by the Contractor, on site and shall be handed over to the Owner at equipment handover.

PART 3- EXECUTION

3.01 FACTORY ACCEPTANCE TEST

A. Reactor Vessel

FRP reactor vessel shall be inspected prior to shipping for conformance to the following:

1. Dimensions match those shown on submittal drawings and are within Manufacturer's specified tolerances.
2. Flanges and connections between reactor parts fit securely without improper bending or stressing of parts.
3. Damage or imperfections to paint or fiberglass work, including cracking/crazing are minimal and in accordance with FRP specifications in Section 2.05A.
4. Manufacturer shall keep a record of the quality control document for each reactor vessel(s) that is available to the Engineer upon request.

B. Electrical Control Panel

Electrical control panel shall be inspected prior to shipping for conformance to the following:

1. NEMA rating according to Section 2.05D and bear the UL508 label.
2. PLC program and HMI shall be tested for proper communication and functionality.
3. PLC digital and analog inputs shall be electrically tested to ensure input recognition in the proper area of the PLC program.
4. All wiring between panel components and terminal strips shall be checked for proper labeling and connection.

C. Water Panel

All water panel piping and/or other pre-installed piping shall be tested prior to shipping for conformance to the following:

1. System shall have no leaks when subjected to a pressure test at 80 psi for a minimum of 1 hour.
2. All installed instruments, sensors, pumps, actuated valves, and other electrical components shall be tested for proper operation.
3. All wiring from terminal strips to all electrical components shall be tested to ensure proper wiring.

D. Spray nozzle

Spray nozzle shall be factory tested to ensure compliance with Manufacturer standards for uniform distribution.

E. FAT log

Prior to release for shipment, the Manufacturer shall Submit to the engineer for approval the results of the FAT demonstrating that Testing is complete and that the controls are ready for shipment and installation.

3.02 INSTALLATION & EQUIPMENT START-UP

As far as is reasonably possible, all equipment should be pre-assembled prior to shipment, to minimize the need for on-site assembly. Media should be pre-installed by the Manufacturer and certified to meet the specified performance requirements.

Installation of all equipment will be conducted by the Contractor and must be in accordance with Manufacturer's written installation and startup instructions and by workers experienced in the handling of fiberglass vessels, electrical work, plumbing and instrumentation. The final installation must be certified by the Manufacturer as complete and correct.

The Manufacturer shall provide the Contractor with required clearances, tolerances and limitations, such as smoothness/flatness of concrete pad and shall be available to answer questions prior to and during the installation of the equipment.

Once the installation has been certified by the Manufacturer, the Contractor, with assistance from the Manufacturer, shall start the System to begin the biological acclimation period. This startup period shall take no longer than six (6) weeks but at any point during this startup period, at the discretion and direction of the Manufacturer, the contractor shall switch the system over to normal operation. Any minor re-piping or plumbing required will be clearly detailed in the Manufacturer's installation and startup

manual and will be performed by the Contractor.

Any special tools or materials required for this startup/acclimation period shall be provided by the Manufacturer.

After satisfactory startup and the corresponding switch over to normal operation, the Contractor shall, in the presence of the Engineer, conduct the performance test as detailed in section 3.05 below.

3.03 FIELD PAINTING & CORROSION PROTECTION

If painted surfaces are damaged during shipment, off-loading or installation, as long as the damage is surface only and in no way affects the integrity of the equipment or its ability to perform, these blemishes, scratches or other imperfections shall be touched up by the Contractor in accordance with instructions from the Manufacturer. Materials used shall be compatible with the original coating material in quality and color.

3.04 PERFORMANCE TESTING

Performance testing shall not commence until the Manufacturer and Engineer agree that the system has been satisfactorily started-up and sufficient time has been allowed for the acclimation of the bacteria.

After the odor control system has been satisfactorily started-up and switched to normal operation, the Contractor shall, in the presence of the Engineer, demonstrate that the system will perform as specified in section 2.04 of this specification.

The Contractor shall provide the Engineer with a written test protocol and the performance test may not be conducted until the test protocol has been reviewed and approved by the Engineer.

The Manufacturer may be present during the performance test and, at its own discretion, may conduct a parallel performance test as long as they do not interfere with the performance test being conducted by the Contractor.

The Contractor shall supply, install and operate all equipment, sensors and instrumentation required to complete the performance test.

A. H₂S Testing procedure

1. Measure airflow into each unit and, if necessary, adjust to the design airflow of 550 cfm +/- 10%. Airflow balancing can be conducted by the Manufacturer and

witnessed by the Engineer and/or Contractor if desired. Airflow shall be measured at the beginning of the test period. The set position on the damper(s) will be marked or noted. Airflow will not change as long as damper(s) remain in position.

2. Measure pressure drop across each biotrickling filter at beginning of test period.
3. Measure temperature of the inlet, outlet and ambient air.
4. Performance test period to begin at a noted time and last for four (4) hours. H₂S data from the common inlet location and from the outlet of each odor control system will be measured and logged once every 10 minutes to demonstrate performance during test period.
5. The inlet H₂S data will be logged with a pre-calibrated gas data logger with appropriate range and accuracy for the inlet air stream (0-1000 ppmv or 0 - 200 ppmv range, 1 ppm display resolution or 0.0 - 50.0 ppmv range, 0.1 ppmv display resolution).
6. The outlet H₂S data will be logged with a pre-calibrated OdaLog gas data logger with appropriate range and accuracy for the outlet air stream. (0.00 - 2.00 ppmv range, 0.01 ppmv display resolution or 0.0 - 50.0 ppmv range, 0.1 ppmv display resolution).

B. H₂S Acceptance criteria:

1. The System's H₂S removal efficiency shall be determined by calculating the average inlet H₂S concentration and the average outlet H₂S concentration and using the following formula: $\text{H}_2\text{S removal efficiency (\%)} = (1 - (\text{average outlet H}_2\text{S concentration} / \text{average inlet H}_2\text{S concentration})) \times 100$. The system shall have passed the H₂S performance test if the H₂S removal efficiency is 99% or more for inlet air H₂S concentrations ≥ 50 ppmv but ≤ 300 ppmv, or the average outlet air H₂S concentration is ≤ 0.5 ppmv, whichever is greater.
2. In the event that the average inlet H₂S concentration during the four (4) hour test period exceeds the specified average inlet H₂S concentration as listed in this Specification, or the maximum inlet H₂S concentration during the four (4) hour test period exceeds the specified maximum inlet H₂S concentration as listed in this Specification, the H₂S acceptance criteria shall not apply and the system shall be considered to have passed the performance test.

C. Automatic Flow Control System testing procedure

In the presence of the Engineer, the Manufacturer shall demonstrate the operation of the Automatic Flow Control System as given below.

1. Review the requirements list given in Section 2.05.D.3 and prove or demonstrate compliance with each point.
2. The following procedure shall be followed for each irrigation valve in the system. The cycle time shall be minimized to allow the procedure to be completed within 30 minutes.
 - a. Open all manually controlled valves allow for maximum flow through the WCP. Set the target irrigation flow rate to 3x the normal irrigation flow rate (to allow the irrigation valve to fully open). Demonstrate that the valve will reach 100% open status within 20 s during irrigation.
 - b. In between irrigation cycles, while the irrigation valve is CLOSED, set the target irrigation flow rate to the proper design irrigation flow rate. Demonstrate that the irrigation valve will automatically close in order to reach the design flow rate within 30 s during its next irrigation cycle.
 - c. Repeat steps a. and b. above for a minimum of 3 additional set points both above and below the normal target irrigation flow rate.
 - d. Set the target irrigation flow rate to the normal target irrigation flow rate. Partially close at least one valve upstream of the modulating ball valve and demonstrate that the irrigation valve will automatically adjust to a more open position in order to reach the design flow rate within 30 s during its next irrigation cycle.
 - e. Return all Automatic Flow Control settings to their normal positions and fully open all upstream and downstream valves. Demonstrate that the system will return to normal flow control operation.

3.05 MANUFACTURER'S SERVICES

In addition to being available by phone to assist the Contractor during the offloading, installation, and startup of the equipment, the following Manufacturer's services shall be provided with the number of trips and days on site as a minimum.

Startup assistance	One (1) trip, two (2) days on site
Performance testing assistance/training	One (1) trip, one (1) day on site

Notwithstanding the above, the Manufacturer shall continue to assist the Contractor with questions, issues and remote assistance until the system is properly installed, running satisfactorily and handed over to the Owner.

END OF SECTION

**SECTION 15290
REFRIGERATED AUTO SAMPLER**

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. A refrigerated sampler for the representative collection of liquid water samples to monitor influent and effluent waters from municipal and industrial NPDES facilities, monitor effluent waters from indirect industrial dischargers for compliance with pre-treatment regulations, and environmental monitoring including CSO and SSO studies and storm water run-off.
- B. The sampler shall be an all-weather refrigerated sampler.
- C. Suitable for indoor or outdoor use
- D. UL Certified.

1.02 MEASUREMENT PROCEDURES

- A. The method of sample collection shall be via high-speed peristaltic pump for collection of the sample liquid.
- B. The method of sample detection shall be ultrasonic.

1.03 ALTERNATES

- A. Samplers that do not use a high-speed peristaltic pump will not be approved.
- B. Samplers that are not configured with the compressor at the top of the cabinet will not be approved.
- C. Sampler temperature control systems that rely on a knob to set “colder or warmer” will not be approved.
- D. Units that are not UL certified will not be approved.

1.04 PERFORMANCE REQUIREMENTS

- A. Sample cooling: maintain sample liquid at 4°C (39°F) in ambient temperature to 50°C (122°F) maximum; accurate to $\pm 0.8^{\circ}\text{C}$ ($\pm 1.5^{\circ}\text{F}$).
- B. Sample volume: programmable in 10 mL increments from 10 to 10,000 mL.

C. Sample volume repeatability $\pm 5\%$ of 200 mL sample volume with: 4.6 m (15 ft.) vertical lift, 4.9 m (16 ft.) of 3/8-in vinyl intake tube, single bottle, full bottle shut-off at room temperature and 1524 m (5000 ft.) elevation.

D. Pacing intervals: selectable in single increments from 1 to 9,999 flow pulses or 1 to 999 hours in 1 minute increments. Accepts 4-20mA input from an external device to pace the sampler.

E. Vertical lift: 8.5 m (28 ft.) using 8.8m (29 ft.) maximum of 3/8-in. vinyl intake tube at sea level at 20 to 25°C (68 to 77°F).

F. Sample volume accuracy: $\pm 5\%$ of 200 mL sample volume with: 4.6 m (15 ft.) vertical lift, 4.9 m (16 ft.) of 3/8-in. vinyl intake tube, single bottle, full bottle shut-off at room temperature and 1524 m (5000 ft.) elevation.

G. Sample transport velocity: 0.9 m/s (2.9 ft./s) at 4.6 m (15 ft.) vertical lift (16 ft. of 3/8-in. vinyl intake tubing at 70°F at 5000 ft. elevation).

H. Pump flow rate: 4.8 L/min (1.25 gpm) at 1 m (3 ft.) vertical lift with 3/8-in intake tube typical.

1.05 CERTIFICATIONS

A. Controller: CE

B. Cabinet: UL/CSA/CE

1.06 OPERATIONAL CRITERIA

A. Operating temperature: 0 to 50°C (32 to 122°F)

B. Operating temperature with optional controller compartment heater: -40 to 50°C (-40 to 122°F)

C. Storage temperature: -30 to 60°C (-22 to 140°F)

1.07 WARRANTY

A. The product includes a one-year warranty from date of shipment.

1.08 MAINTENANCE SERVICE

A. Scheduled maintenance: monthly: visual inspection, if necessary, clean.

- B. Unscheduled maintenance:
 - 1. Pump tube replacement
 - 2. Rotor removal and cleaning
 - 3. Distributor arm tubing replacement
 - 4. Desiccant replant

PART 2 – PRODUCTS

2.01 MANUFACTURED UNIT

- A. The hatch is to consist of a controller and all weather refrigerator.
- B. Tubing:
 - 1. Pump tube: 0.95 ID x 0.16 OD cm (3/8 ID x 5/8 in. OD)
 - 2. Intake tube: 9.5 mm (3/8 in.) ID vinyl or Teflon® lined polyethylene in 10- , 25- , or 100-ft. lengths
- C. Weighted strainer constructed of 316 stainless steel and Teflon.

2.02 EQUIPMENT

- A. The controller housing of the AS950 sampler is submersible, watertight, dust-tight, corrosion- and ice-resistant to NEMA 4X, 6, IP68 standards.
- B. The Graphics Display is 1/4 VGA, Color; self-prompting/ menu-driven program.
- C. The desiccant cartridge, which prevents moisture from accumulating inside the controller electronics area, shall be visual and accessible externally from the side of the controller; the replacement of the desiccant shall not require tools or disassembly of controller from base.
- D. The pump shall use spring loaded rollers and be accessible by a clear hinged cover with single thumbscrew.
- E. Refrigerated cabinet is insulated with 3-inch rigid foam insulation on the walls, 6 inches on the bottom and 5 inches on top. The cover for the controller compartment shall also be insulated.
- F. The cabinet shall have a heavy-duty compressible gasket on controller compartment lid, compressor compartment lid and refrigeration compartment door.

- G. The refrigeration components and copper plumbing shall be corrosion protected with conformal coating.
- H. The thermal control system is digital microprocessor-based and responds to a system of temperature sensors that continually monitor the evaporator plate, controller compartment air temperature, and refrigerated compartment air temperature.
- I. An air sensing thermostat is capable of maintaining sample liquid within specified limits.
- J. The power requirement is 115 Vac, 60 Hz (230 Vac optional)
- K. Communication choices include:
 - 1. USB and optional RS485 (Modbus)
 - 2. Permits embedded software upgrades in the field.
 - 3. FSData data management software used to download, analyze, and report data, save templates, download sample history, and event logs, create graphs for reports and presentations. Link directly to PC A to A USB cable.
- L. The membrane switch keypad user interface is self-prompting/menu driven program with 2 multiple function soft keys.
- M. Sampling pacing modes shall include Time Weighted, Flow Weighted, Timetable, Flow Table, and Event.
- N. Internal software shall be protected by a 7 amp fuse.
- O. Diagnostics: View event and alarm logs.
- P. A program lock shall be provided for access code protection to prevent tampering of program and system settings.
- Q. The sampler is convertible to composite operation by installing a composite container and full bottle shut off.
- R. Sample containers include choice of:
 - 1. Composite
 - a. (2) 2.5 gallon polyethylene bottle
 - b. (2) 2.5 gallon glass bottle
 - c. (2) 5.5 gallon polyethylene bottle

2. Discrete

- a. (2) sets of (8) 2.3 liter polyethylene bottles
- b. (2) sets of (8) 1.9 liter glass bottles
- c. (2) sets of (12) 2 liter polyethylene bottles
- d. (2) sets of (24) liter polyethylene bottles
- e. (2) sets of (24) 350 ml glass bottles
- f. (2) sets of (2) 2.5 gallon polyethylene bottles
- g. (2) sets of (2) 2.5 gallon glass bottles
- h. (2) sets of (4) 2.5 gallon polyethylene bottles
- i. (2) sets of (4) 2.5 gallon glass bottles

S. Sampling features include:

- 1. Dual programming: Up to two (2) sample programs can be run sequentially, in parallel, or according to day of week scheduling; enabling a single sampler to function like multiple samplers.
- 2. Cascade sampling: for two samplers in combination—the first sampler, at the completion of the program, initiates the second.
- 3. Status Screen: Communicates what program is running, if there are any missed samples, when the next sample will be taken, how many samples remain, number of logged channels, time of last measurement, memory available, number of active channels, if alarms were triggered, when alarms were triggered, active sensors and cabinet temperature.

T. Datalogging

- 1. Sample History: Stores up to 4000 entries for sample time stamp, bottle number and sample status (success, bottle full, rinse error, user abort, distributor error, pump fault, purge fail, sample timeout, power fail and low main battery)
- 2. Measurements: Stores up to 325,000 entries for selected measurement channels in accordance with the selected logging interval.
- 3. Event Log: Stores up to 2000 entries. Records Power On, Power Fail, Firmware Updated, Pump Fault, Distributor Arm Error, Low Memory Battery, Low Main Battery, User On, User Off, Program Started, Program Resumed, Program Halted, Program Completed, Grab Sample, Tube Change Required, sensor communication errors, cooling failed, heating failed, thermal error corrected.

U. Automatic

1. Multiple bottle mode: after complete revolution of distributor arm (unless continuous mode is selected).
2. Composite mode: after preset number of samples have been delivered to composite container, from one to 999 samples, or upon full container.

V. Sample distribution modes include single bottle composite, multi-bottle composite, multi-bottle discrete, bottles per sample, samples per bottle or a combination of bottles per sample and samples per bottle.

W. Manual grab sample can be made with the AS950 sampler or approved equal to deliver a grab sample to a specific bottle location.

X. The high-speed peristaltic sample pump uses four rollers with spring tension.

Y. The intake air purge is made automatically before and after each sample. The duration automatically compensates for varying intake line lengths.

Z. The The intake line is optionally rinsed with source liquid prior to each sample from one to three times.

AA. The The sample collection cycle is optionally repeated from one to three times if a sample is not obtained on the initial attempt.

2.03 COMPONENTS

A. Standard equipment shall be:

1. Controller: high impact injection-molded ABS/PC plastic
2. All weather cabinet: linear low-density polyethylene with UV-inhibitors
3. Pump enclosure: corrosion-resistant polycarbonate door, high impact-resistant plastic, polyphenylene sulfide track
4. Intake strainers in standard size, high velocity, or low profile for shallow depth applications. Choice of:
 - a. Teflon and 316 stainless steel construction
 - b. All 316 stainless steel
5. Exterior dimensions shall not exceed 51" H x 30" W x 32" D.

2.04 ACCESSORIES

- A. Controller compartment heater
- B. Bottle kits
- C. Tubing and strainers
- D. AC battery back up
- E. Cables and interfaces
- F. Anchor brackets
- G. FSData software
- H. IO9000 Input/output Module

END OF SECTION

SECTION 15300 VALVES (SEWER)

PART 1 - GENERAL

1.01 REFERENCE

- A. Requirements of Section 1500 apply to all work under this section.

1.02 GENERAL

A. All valves two inches in diameter and smaller shall be constructed of brass or bronze except the hand wheel which shall be of malleable iron construction. Valves two inches in diameter and smaller shall have screwed ends unless approved otherwise. All valves 2½ inches in diameter and larger shall have flanged ends unless otherwise approved. They shall be iron body, bronze mounted, except that in the smaller sizes the valves may be all bronze at the Contractors option and expense.

B. The Contractor shall prepare and submit for approval complete detailed drawings of all valves in accordance with the requirements of the appropriate section of these specifications. All valves of the same type shall be from a single manufacturer. Parts of valves of the same type and size shall be interchangeable. Spare parts shall be furnished as specified under the proposal items. Special tools required for repacking or disassembling valves shall be provided.

C. All valves shall be carefully mounted in their respective positions free from all distortion and strain. All valves shall be properly packed and left in satisfactory operating condition at the completion of the project. All valves shall open left.

PART 2 - PRODUCTS

2.01 NUTS AND BOLTS

- A. Flanged: square head MB/SF, hexagon nuts; ASTM 307B; ANSI B18.2, zinc plated.

2.02 GASKETS

- A. Flanged pipe gaskets shall conform to requirements of ASA A21.10 and shall be suitable for the indicated services.

2.03 VALVES

- A. Gate Valves

- 1. Unless otherwise specified or directed, gate valves three inches and larger shall have non rising stems and shall meet the requirements of AWWA Standard C 500. Valves for lighter pressures than the AWWA Standard shall meet the requirements of the above specifications except that the requirements for metal thicknesses and strengths and structural designs shall be adjusted as required to meet hydrostatic test pressures not less than 100 psi.

2. Unless otherwise specified or directed, gate valves smaller than three inches shall meet the requirements of Federal Specification WW V 54, Class A, 125 pounds.
3. All gate valves shall have standard stuffing box seals. Bonnet bolts, studs and nuts shall be cadmium plated. Seating devices shall be bronze to iron or bronze to bronze as specified or required. The glands shall be bronze or bronze brushed. Gland bolts and nuts shall be bronze.
4. All gate valves 2½ inches in diameter and larger shall be of the double disk type. All gate valves two inches in diameter and smaller may be of the double disk or the solid wedge type.

B. Plug Valves

1. Two way type.
2. Nonlubricated, eccentric with resilient faced plugs.
3. Port area of 4 to 20 inch valves shall be at least 70 percent of full pipe area.
4. Valves to be designed for 125 psi working pressure.
5. Bodies to be semi steel with raised seats.
6. Seats to have either a welded in overlay of approximately 90 percent pure nickel on surfaces contacting the plug face or shall be bronze conforming to ASTM B 62 and attached to the body by stainless steel set screws.
7. Upper and lower plug stem bushings to be stainless steel and shall be permanently lubricated.
8. Exposed nuts, bolts and washers to be zinc plated.
9. Flanges to be faced and drilled to ASA 125 pound standard.

C. Check Valves

1. Type: Ball Check
2. Ends: Flanged
3. Body: Cast Iron
4. Ball: Hollow steel with vulcanized nitril rubber coating.
5. Pressure Rating: 150 psi
6. Valves shall be suitable for sewage service as required.
7. Valve to be Flygt HDL or equal.

D. Automatic Sewage Air Release Valve

1. The automatic sewage air release valve shall be designed to allow entrapped air to escape from the sewage force main line. After the air escapes out of the air release valve, the valve shall shut off until more air accumulates in it and the opening cycle will repeat automatically.
2. The sewage release valve must have a compound internal linkage of precision molded delrin or stainless steel. All other internals must be stainless steel to positively prevent galvanic action. The float rod shall be 20" long to provide an air gap between the linkage and waste level inside the valve to retard the waste solids from clogging the linkage. The stainless steel float must withstand a minimum 1000 psi pressure. Each valve shall be complete with hose and blow off valves to permit back flushing without dismantling valve.

Body and cover cast iron	ASTM A48 Class 30
Internal Delrin linkage	ASTM D2133 (or Stainless Steel)
Stainless Float	ASTM A240
Buna N	ASTM SB800
Exterior Paint Red Lead	TTP 86 B Type IV

Valve height 28" with back flushing attachments 33 1/2".

If depth of trench is not deep enough, furnish short valve.

Valve height 17½" with back flushing attachments 23 ½".

3. Automatic sewage air release valve to be as manufactured by Crispin, Val-matic, or APCO equal to APCO Series 400 with accessories.

2.04 ACCESSORIES, PLUG AND GATE VALVES

- A. Valves to have a two-inch square operating nut unless otherwise indicated.
- B. Valves buried in ground or located in vaults or structures to have suitable extensions for socket operation with top of operating nut located six inches below finished grades.
- C. Furnish one wrench for each group of two (2) valves having the same service and which can be served from one operating location.

END OF SECTION

SECTION 15301 GATES

PART 1 - GENERAL

1.01 SCOPE

- A. The work of this section includes furnishing and installing all gates and gates for the piping systems shown on the drawings, as specified herein or as required for equipment operation. The gates shall be capable of isolating flow from the structure under all conditions without leakage.

1.02 SUBMITTALS

- A. The Contractor shall prepare and submit for approval, complete detailed drawings of all gates in accordance with the requirements of the appropriate section of these specifications. All gates of the same type shall be from a single manufacturer. Spare parts shall be furnished as specified under the proposal items. Special tools required for repacking or disassembling gates shall be provided. Contractor shall provide installations and references for gate manufacturer. Engineer shall review documents and approve prior to purchase.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

- A. The pre-Approved manufacturers are Fontaine Aquanox and Orbinox.

2.02 ALUMINUM SLUICE GATES

- B. The Contractor shall furnish and install aluminum sluice gates at the outlet structure of the sizes indicated.
- C. The gate frames shall be a one piece 1/4 inch 6061 T6 aluminum extrusion with a continuous mounting flange suitable for surface mounting to a concrete wall. The extruded aluminum frame shall be mitered and welded continuously and shall incorporate a one piece extruded polymer channel liner.
- D. The gate shall be 1/4 inch aluminum and shall be reinforced to deflect no more than 1/360th of the span. The bottom edge of the gate shall be beveled for positive seating.
- E. A cast aluminum handwheel shall be provided and shall work in conjunction with a brass lifting nut and a 1 1/2 inch stain-less steel acme rod. All hardware shall be stainless steel. The lifting nut shall be provided with a grease fitting for ease of lubrication. Polymer bearing pads shall be incorporated above and below the brass lifting nut.
- F. The sluice gate assembly shall include a wall thimble to ensure a watertight seal under all operating conditions.

2.03 ALUMINUM STOP/ SLIDE GATES

- A. The Contractor shall furnish and install aluminum stop gates at the location shown on the plans of the sizes indicated.
- B. The disc shall be aluminum plate ASTM B209 6061-T6 reinforced with structural aluminum shapes or extrusions welded to the plate. The disc shall not deflect more than 1/360th of the span of the gate under the design head.
- C. The guide shall be extruded aluminum plate ASTM B221 6061-T6. The guide shall be designed for maximum rigidity and shall have a weight of not less than 3.0 lbs. per linear foot. The guide shall be designed to embed into the face of the concrete and shall be provided with keyways to lock them into the concrete.
- D. A cast aluminum handwheel shall be provided and shall work in conjunction with a brass lifting nut and a 1 1/2 inch stain-less steel acme rod. All hardware shall be stainless steel. The lifting nut shall be provided with a grease fitting for ease of lubrication. Polymer bearing pads shall be incorporated above and below the brass lifting nut. Stem shall be ASTM A276 Type 304 stainless steel and shall have a rising stem cover of clear polycarbonate with vent holes.
- E. The gate assembly shall include a wall thimble to ensure a water tight seal under all operating conditions. Leakage shall be limited to 0.1 gpm per foot of seating perimeter.
- F. The seal shall be specifically extruded resilient neoprene mounted to the mounted to the bottom of the disc or installed into the invert member to provide flush bottom closure. The shape of the seal will produce a seating surface having a minimum surface having a minimum width of 3/4" and the seal shall extend into the secondary slot of the vertical guide.

PART 3 - INSTALLATION

- 3.01 All gates shall be carefully mounted in their respective positions free from all distortion and strain. All gates shall be properly packed and left in satisfactory operating condition at the completion of the project.
- 3.02 Mechanical joints shall be made in accordance with paragraph 3.01 (G) of Section 02555 of these specifications.
- 3.03 Flanged joints shall be made using full-face rubber gaskets 1/8" thick. Bolts and nuts on the gate shall be carbon steel conforming to ASTM A307.
- 3.04 Upon completion of the installation the contractor shall demonstrate that watertight form one side to the other and allows complete isolation of liquid.

END OF SECTION

SECTION 15302
FLOW METERING EQUIPMENT
PARSHALL FLUME

PART 1 - GENERAL

1.01 SCOPE

- A. The work of this section involves furnishing and installing a Parshall flume with ultrasonic flow meter.

1.02 SUBMITTALS

- A. Shop drawings shall be submitted in accordance with Section 01001, Paragraph 1.17 of these specifications.
- B. Operation and maintenance manuals shall be submitted in accordance with Section 01001, Paragraph 1.18 of these specifications.

PART 2 - PRODUCTS

2.01 PARSHALL FLUME

- A. The flume shall be a 12" Parshall flume designed to measure flows from .1 MGD to 2.5 MGD. The flume shall be a molded structure of fiberglass reinforced polyester. The interior surface shall have a ten (10) to fifteen (15) mil white ultraviolet-resistant gel-coat backed by a rich layer of resin and chopped glass forming a water and chemical resistant surface. The remainder of the laminate shall be fiberglass reinforced polyester containing not less than thirty percent (30%) glass content by weight. The thickness of the walls and floor of the flume shall not be less than one-fourth inch (1/4"); and shall be reinforced with stiffeners down the sides and across the bottom on flumes with a throat width of three inches (3") or greater. The stiffeners shall be joined together at the knee to form a rigid dimensionally stable flume.
- B. The flume shall be provided with anchoring clips fastened along the side of the flume to be used for anchorage into the concrete. Stiffeners made of FRP angle/channel shall be provided across the top of the flume to provide structural support during shipping and installation.
- C. Flume dimensions shall be in accordance with the United States Department of Interior, Water Measurement Manual, latest revision

- D. The flume shall be provided with a head gauge calibrated in tenths of a foot, molded into the side of the flume, at the point of measurement.

2.02 ULTRASONIC FLOW METER (Open Channel Flow)

- A. There shall be furnished a recording, totalizing open channel flow meter suitable for portable or fixed-site monitoring. An ultrasonic sensor capable of measuring up to 10' shall be used to measure level. The flow meter shall be programmable for measuring flow based on the type of flow monitoring device installed. Any application requiring level measurements over 10' shall be an ultrasonic flow transmitter along with a controller unit.
- B. The sensor shall consist of a single ultrasonic transducer housed in a corrosion resistant Xenoy plastic enclosure. The sensor shall include a temperature probe to automatically compensate for air temperature changes. The sensor shall automatically adjust its gain in response to echo strength to maximize performance in the presence of steam, foam and turbulence. The sensor shall include variable blanking distance to ignore echoes from within a programmable distance from the sensor.
 - a. The level measurement span shall be from 0 to 10 feet (0 to 3.05 m) for ISCO or 0 to 39 feet for Rosemount. The level shall be measured with a maximum error of ± 0.02 feet (± 0.006 m) over a head change of 1 foot or less (0.31 m or less), and ± 0.03 feet (± 0.009 m) over a head change of 1 to 10 feet (0.31 to 3.05 m).
 - b. The sensor cable shall be 25 feet (7.62 m) long. The cable shall terminate in a sealed, military style connector so that the sensor can be easily replaced in the field. [An optional (25 ft. -7.62 m) extension cable shall be supplied.] A stainless steel mounting bracket shall be supplied for mounting the sensor and a sunshade. It shall be possible to suspend the sensor using only the cable.
- C. Measured liquid level readings shall be converted into corresponding flow rate readings using internal conversion algorithms. The flow meter shall contain conversions for V-notch weirs, rectangular weirs with and without end contractions, Cipolletti weirs, and Parshall, Palmer-Bowlus, Leopold-Lagco, trapezoidal, H, HS and HL flumes. For monitoring in applications using the Manning formula in round, U-shaped, rectangular and trapezoidal channels, the flow meter shall accept information for channel shape and size, and slope and roughness coefficient. The flow meter shall accept 4 sets of level-flow rate points, with up to 50 pairs of points in each set. The flow meter shall accept a two-term, level flow rate polynomial equation.

- a. The flow meter shall be connected to tipping bucket rain gauge that tips every 0.01 inch (0.25 mm) or 0.004 inch (0.1 mm) of rainfall.
- b. The flow meter shall include an input for a pH probe with a built-in temperature probe, a dissolved oxygen probe and a temperature probe.
- c. The flow meter shall be capable of activating a connected sampler based on an AND/OR combination of any two of level, flow rate, rainfall, pH or dissolved oxygen, and temperature.
- d. The flow meter shall have a 12 volt pulse output for signaling a connected automatic sampler to collect flow proportioned samples. The flow meter shall have inputs to accept signals from the sampler indicating when a sample is collected and the bottle in which the sample is placed.
- e. The flow meter shall contain a tactile keypad and a 2 line, 80 character, backlit alphanumeric liquid crystal display (LCD). The LCD shall visually prompt the user through the programming sequence. The LCD shall display level, flow rate, total flow, pH or dissolved oxygen, and temperature in user-selectable units of measure. The totalizer on the LCD shall be resettable. The flow meter shall include a non-resettable, mechanical totalizer. The LCD shall display the signal strength from the ultrasonic sensor to aid in installation and troubleshooting.
- f. The flow meter shall contain a programmable transmitting unit that will allow output to the SCADA system.
- g. The internal data storage memory in the flow meter shall have a capacity of 80,000 bytes, divided into up to 6 user-defined partitions. Each partition shall be programmable to store level, flow rate, rainfall, pH or dissolved oxygen, temperature or sample data. Timing for the data storage shall be selectable in 1, 2, 5, 10, 15, 30, 60 or 120 minute intervals. Each partition shall be programmable to operate in either rollover, slate or triggered slate mode. Triggering events in slate mode shall be selectable from level, flow rate, rainfall, pH or dissolved oxygen and temperature.
- h. The flow meter shall have a 4 to 20 mA output proportional to flow rate.
- i. The flow meter shall have 2 form C relays with user-selectable trip points based on flow rate.

- j. The program memory in the flow meter shall be non-volatile, programmable flash memory. The program memory shall be capable of being updated via the serial port on the flow meter without opening the enclosure.
- k. The flow meter shall require 12 volt DC power for operation. Power shall be supplied from a rechargeable lead acid battery with solar panel battery charger.
- l. The flow meter shall be housed in a rugged, lockable, watertight, dusttight, corrosion resistant (self-certified NEMA 4X and IP65) enclosure. The enclosure shall include a carrying strap, wall mounting bracket and a clear polycarbonate window for viewing flow data. An internal, easily replaceable, rechargeable desiccant canister shall keep the inside of the flow meter free of moisture.

PART 3- EXECUTION

3.01 INSTALLATION

- A. Follow all instructions provided by the project engineers in the form of specifications, blue prints, etc.
- B. There should be no drops, bends, flow junctions, etc. immediately upstream of the flume location. The flume should be located in a straight section of the open channel.
- C. The approaching flow should be uniformly distributed across the channel, tranquil, and subcritical.
- D. The approaching flow should not be turbulent, surging, unbalanced, or possessing a poorly distributed velocity pattern.
- E. As a general guideline, a straight upstream approach length of 10-20 times the throat width will meet these entrance conditions:
 - a. 10 throat widths may be used where the throat width of the flume is larger than half the width of the approach channel
 - b. 20 throat widths should be used where the throat width of the flume is less than half the width of the approach channel
- F. If baffles are used to correct or smooth the flow, they should be placed upstream of the flume at a distance of at least 10 times the maximum head. Baffles are not recommended for sanitary or solids laden flows.
- G. If the crest of the flume (the converging section's floor) is set above the floor of the channel, the channel should rise at a 1:4 slope just before the flume.

- H. For channels wider than the entrance of the flume, radius or flat 45° wingwalls should be used to smoothly direct the flow into the flume. Refer to the U.S. Department of the Interior, Bureau of Reclamation's Water Measurement Manual for wingwall radii.
 - I. 1" and 2" throat width flumes should not be used on sanitary flows.
 - J. Downstream channels should be straight for 5-20 times the throat width.
 - a. Note: Do not use cables or chains to unload flumes. Unload flumes with fabric slings in conjunction with a spreader bar or by lifting eyes (if provided), spreading the load.
 - b. The crest of the flume must be set upstream and must be level from front to back and from side to side. A level installation is critical to the proper operation of the flume.
 - K. Set the flume in place and at the elevation indicated on the engineer's drawings.
 - L. For larger flumes, concrete piers may be poured perpendicular to the direction of flow for the flume to sit on. Pre-cast concrete blocks may also be used. When piers or blocks are used, the floor of the flume should rest on them and not on the stiffening ribs or flanges.
 - M. The flume must be secured from flotation. One of the following methods should be used:
 - a. Wire should be run from the anchor clips to rebar, or
 - b. Rebar should be run through the anchor clips.
- Line the interior of the flume with plywood and brace the flume internally with 2x4's to ensure that the distortion does not occur.
- N. Sandbags should be placed inside the flume to prevent it from floating in wet concrete.
 - O. Grout the flume in place. The first pour should flow from only one side of flume, cover the entire bottom of the flume, and must be allowed to cure before the sidewalls are grouted. Once the first pour has set, grout the sidewalls in 6" (15,24 cm) lifts, letting each lift cure before proceeding.
 - P. Grout must encapsulate the entire upstream and downstream flanges of flume and be made water-tight.

- Q. With large flumes, grout one section between the piers (or blocks) at a time. Due to the distances involved, a grout hose may be required.
- R. The use of a vibrator should be minimized as excessive use may bulge or distort the flume sidewalls and bottom. Chaining is recommended in lieu of vibrator sticks.
- S. Top bracing should remain attached during operation of flume.
 - a. No voids or air pockets should remain in any grout pour. Failure to eliminate voids or pockets will result in settling or bulging of the flume and it not warrantable.

END OF SECTION

SECTION 15305
MAGNETIC FLOW METER

PART 1 - GENERAL

1.01 SCOPE

- A. This work shall consist of furnishing, and installing magnetic flow meters and all appurtenant work suitable for wastewater, at ambient temperatures, complete and operable, and capable of continuous operation.

1.02 SUBMITTAL OF INFORMATION

- A. Shop drawings shall be submitted in accordance with Section 01001, Paragraph 1.17 of these specifications.
- B. Submit manufacturers data showing dimensional information and materials of construction including accessories.
- C. Operation and maintenance manuals shall be submitted in accordance with Section 01001, Paragraph 1.18 of these specifications.

1.03 WARRANTY:

- A. The Contractor shall warrant the listed equipment being supplied to the Owner, including installation, against defects and material for a period of one year commencing upon approval and acceptance of a fully functioning system.

PART 2 - PRODUCTS

2.1 MAGNETIC FLOW METER

- A. The magnetic flow meter shall be FMG490 Series as manufactured by Omega or approved equal, installed as shown on the plan.
- B. Flow meter shall have an accuracy of 0.75%.
- C. Flow meter shall match the size of the pipe shown on the plan.
- D. Flow meter shall be designed to measure flow rates of the material contained in the pipe line (i.e. sludge, raw wastewater or partially treated wastewater).
- E. Flow meter must be capable of submersible or buried environment.

- F. Flow meter power consumption should be < 20VA with transmitter.
- G. Housing shall be NEMA 6P.
- H. Transmitter shall be remote mounted for below grade conditions. The interconnecting cable shall be furnished by the manufacturer of the metering system. Remote transmitters shall be housed in NEMA-4X enclosures suitable for wall/post mounting. The transmitter shall produce a 4-20 mA dc output signal into a minimum load of 800 ohms linear to flow, and a scaled pulse when called for above for totalization Meter lining shall be Teflon bonded (FEP)
- I. Electrode shall be 316 stainless steel.
- J. Flange shall be carbon steel.
- K. Flow meter shall not lose calibration if the pipe fails to stay full and will be capable of accurately measuring flow through the pipe at flows less than 100%.
- L. Converter shall contain a keypad to allow changes to output information (to include flow rate, flow units) and must be compatible with SCADA system reporting flow.
- M. The unit shall include a self test and diagnostic mode.
- N. Output must be 4 – 20 mA signal to the SCADA system

PART 3 - EXECUTION

3.1 INSTALLATION

- O. Contractor shall install the meter and transmitter at the locations shown on the plans. Installation shall comply with manufacturer's instructions and recommended installation practices. Contractor shall advise of any conflict between field conditions and manufacturers recommended installation procedures prior to installation.

END OF SECTION

SECTION 15501
ULTRAVIOLET ("UV") DISINFECTION EQUIPMENT

PART I – GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment, and appurtenances required to provide an open channel, gravity flow, low pressure, high intensity ultraviolet lamp (UV) disinfection system complete with an automatic mechanical/chemical cleaning system and variable output electronic ballasts. The UV system to be complete and operational with all control equipment and accessories as shown and specified herein. The system will be capable of disinfecting effluent to meet the water quality standards listed in this section.
- B. The ultraviolet disinfection system will be purchased from Trojan Technologies or approved equal by the Contractor. The system shall be installed by the Contractor and tested and commissioned by the manufacturer, as specified in this section. The Owner will consider alternatives if all requirements of this specification are met without exception including Pre-qualification Requirements in section 1.02.
- C. The unit(s) shall be furnished with all necessary accessory equipment including but not limited to the UV lamp assemblies, power distribution centers, monitor and/or system controls, automatic Cleaning system as an option if available, lifting system and other auxiliaries, whether specifically mentioned in this Section or not, as required for an installation incorporating the highest standards for the type of service including field testing and instructing the regular operating personnel in the care, operation and maintenance of all equipment.
- D. For purposes of standardization, and to achieve a common operator interface for control systems within the facility, the major items of instrumentation and process control equipment provided for the UV disinfection system local control panels shall be sufficient for full operation. The proposal shall be complete and require only power in accordance with 2.06 to become fully operational. This equipment shall include but not be limited to system monitor and operator interface devices.
- E. The UV system shall be capable of disinfecting existing effluent as well as future flows to meet the water quality standards listed in this Section.
- F. Each proposer shall supply a list of at least three comparable installations of current technology within the United States of America.

1.02 QUALITY ASSURANCE

- A. Pre-qualification Requirements: Any alternative UV manufacturer that is not named or listed as approved equal must submit the following 15 days prior to bid to be considered for approval:
1. To be considered, the manufacturer will be regularly engaged in the manufacture of UV systems with a proven track record of at least two hundred (200) operating installations of the proposed UV system.
 2. The manufacturer will provide documentation of previous experience with municipal UV disinfection systems in wastewater applications with variable output electronic ballasts.
 3. Pre-qualification submittals from manufacturers will include a complete and detailed proposal of equipment offered, including the number of lamps proposed and a detailed description of any exceptions taken to the specification.
 4. To be considered, the manufacturer will submit a bioassay evaluation for the proposed reactor, without exception. The bioassay will have been completed by an independent third party and have followed protocols described in the NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003) using MS2 bacteriophage as the surrogate test organism. The bioassay must demonstrate that the proposed UV system design and number of lamps will deliver the specified dose.
 5. Independent certification of fouling factor and lamp aging factor must be submitted if values other than the specified default values are being proposed.
 6. Documentation of UV manufacturer's service capabilities including location and experience.
 7. Sample disinfection performance guarantee including scope and duration of guarantee.
 8. All UV manufacturers will be required to pre-qualify unless the manufacturer is the base bid manufacturer.

1.03 SUBMITTALS

- A. Complete shop and installation drawings of all materials and equipment furnished under this Section shall be submitted for approval in accordance with the Request for Proposal. Submittals shall include, but not be limited to, the following:

1. Complete description in sufficient detail to permit an item comparison with the specifications.
2. Detailed drawings showing all details of construction of the UV system and installation details of all equipment.
3. Detailed schematic and layout drawings and a description of operation of all control panels.
4. Detailed schematic and layout drawings and a description of operation of all control panels.
5. All interconnections and interface requirements, dimensions, and locations of all major elements of the UV system including critical clearance requirements.
6. Basis of design, including background data, calculations, operational plant data and other information showing the development of the proposed design and that it will conform to the requirements of Paragraph 1.04D.
7. The startup/performance testing report and manufacturer's certification as required in Part 3.
8. Complete operation and maintenance manuals shall be submitted. The manuals shall recognize that UV disinfection technology is not common knowledge to most plant operators, so the manuals shall be thorough and instructive to such personnel. O&M manuals shall be delivered 2 weeks before delivery of system.

1.04 SYSTEM STARTUP

- A. The ultraviolet light system supplier shall provide a representative for startup services once the installation is complete.
- B. Manufacturer's Representative
 1. The manufacturer's representative shall inspect the construction plans and the installation and recommend any required modifications, additions, or other changes required to allow the manufacturer to certify that the complete installation is appropriate and is expected to operate as expected.
 2. The manufacturer's representative shall instruct the Owner's and Engineer's personnel on the operation and maintenance of the UV disinfection system.

The instruction shall include classroom training on UV technology, and field training on proper operation and maintenance procedures, along with complete demonstrations of the same.

3. The manufacturer's representative shall supervise the performance testing of the installation.
4. The manufacturer's representative shall provide minimum services in accordance with the following table:

<u>Purpose</u>	<u>No. of Days</u>
Installation Supervision	As required of proper installation
Functional Testing	2
Performance Testing	3
Operator Training	1

5. The number of days indicated above shall be provided on an 8-hour-day on-site basis and shall be in addition to travel time.

1.05 DESCRIPTION OF THE SYSTEM

A. The equipment specified herein shall be low pressure, low or high output ultraviolet light disinfection equipment designed to reduce the fecal coliform micro-organisms of a domestic wastewater treated to secondary standards utilizing SBR system as specified in Paragraph 1.05B so that the final effluent shall meet the effluent discharge conditions as specified in Paragraph 1.05D. The UV system shall be hydraulically rated for at least 1.3 mgd peak flow and be installed in a stainless steel channel.

B. Influent Characteristics to Disinfection Channels

1. The UV disinfection system shall be designed to disinfect an influent at the flow rates and with the characteristics as shown below:

a. Peak Flow (mgd)	1.3 MGD
b. Total Suspended Solids (mg/l)	5 mg/L
c. 5-day B.O.D. (mg/l)	5 mg/L
d. UV Transmittance at 253.7 nm	65% minimum
e. Annual Effluent Temperature Range	33° to 85° F
f. Effluent Standards to be Achieved	23/100 ml fecal coliform, based on 30 day geometric mean of daily samples

g. Design Dose:	35 mJ/cm ² MS2 (bioassay validated)
h. Validation Factors	0.98 end of lamp life factor
	0.95 fouling factor
i. Redundancy	1 UV Bank at ADF of peak flow

C. UV Channel Configuration

1. The system shall be installed in open channels having the characteristics shown on the attached Drawings.
2. The minimum design requirements of the UV system supplied shall be as follows:

Channel

a. Number of UV Channels at each site	1
b. Approximate Channel Length Req.	24'-4"
c. Channel Width	1'-10"
d. Channel Depth	1'-11"

UV Modules

e. Number of UV banks per channel	2 (1 Duty + 1 Redundant)
f. Number of UV lamp modules per bank	6
g. Number of lamps in each UV lamp module	4
h. Total number of lamps	48 (including 24 redundant)

UV Panels

i. Power Distribution Center	2
j. System Control Center	1

Misc. Equipment

k. Level Controller	1
l. Lever Controller Type	Fixed Weir
m. Auto Chemical Cleaning	Trojan ActiClean-WW™ or approved similar
n. UV Module Lifting Device	Davit Crane
o. Standard Spare Parts	Included
p. Minimum and maximum water levels above channel floor shall be specified as part of the proposal.	

These requirements are considered minimum. Each supplier shall present the specific number of units proposed for his installation.

D. Bacteriological Inactivation Requirements

1. Flow Characteristics
 - a. Number of channels in service 1
 - b. Total average flow (mgd) Initial = 0.65 mgd
2. Fecal Coliform Testing Criteria
 - a. 30-day geometric mean of daily samples 200 per 100 ml
3. Grab samples of the influent to and effluent from the UV disinfection system shall be collected during the performance testing period specified in Part 3 of this Section. The samples shall be tested for fecal coliform content in accordance with the procedures recommended in "Standard Methods."

E. Performance Requirements

1. The UV system will be designed to deliver a minimum UV dose of 35 mJ/cm² at peak flow, in effluent with a UV Transmission of 65 % at end of lamp life (EOLL) after reductions for quartz sleeve fouling. The basis for evaluating the UV dose delivered by the UV system will be the independent third-party bioassay, without exception. Bioassay validation methodology to follow protocols described in NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003) using MS2 bacteriophage as the surrogate test organism.
2. The UV Dose will be adjusted using an end of lamp life factor of 0.5 to compensate for lamp output reduction over the time period corresponding to the manufacturer's lamp warranty. The use of a higher lamp aging factor will be considered only upon review and approval of independent third party verified data that has been collected and analyzed in accordance with protocols described in NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003).
3. The UV Dose will be adjusted using a quartz sleeve fouling factor of 0.8 when sizing the UV system in order to compensate for attenuation of the minimum dose due to sleeve fouling during operation. The use of a higher quartz sleeve fouling factor will be considered only upon review and approval of independently verified data that has been collected and analyzed in accordance with protocols described in NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003).
4. Independent Validation for use of higher factors (lamp aging and sleeve fouling) must be submitted to the Engineer a minimum of fifteen (15) days prior to bid.

5. The system will be able to continue providing disinfection while replacing UV lamps, quartz sleeves, ballasts and while cleaning the UV lamp sleeves.
6. The system will be designed for complete outdoor installation.

1.06 MAINTENANCE

A. Spare parts shall be provided with the UV disinfection system. The parts shall not be consumed by the manufacturer or Contractor and shall be in the hands of the Owner upon Substantial Completion. The parts shall be provided in sturdy containers, labeled on all sides with information concerning the contents and suitable for long term storage in a room without environmental controls.

B. Spare Parts

The following spare parts shall be provided:

1. Four (4) UV Lamps
2. Four (4) Lamp Sleeves
3. Four (4) Lamp Holders

C. Operators Kit

The following items will be furnished:

1. One (1) face shield to protect operator from UV light
2. One (1) gallon of cleaning solution. (Lime-A-Way manufactured by Ecolab or approved similar)

1.07 WARRANTY

A. The equipment furnished under this section shall be free of defects in materials and workmanship, including damages that may be incurred during shipping, storage, and installation for a period of one year from the date of the startup or for one and half years from the date of shipment.

B. The UV lamps shall be warranted for a period of 12,000 hours at full power when in automatic mode, prorated after 9,000 hours. On/off cycles are limited to four (4) per day.

C. Ballasts to be warranted for 5 years, prorated after 1 year.

PART 2- PRODUCTS

2.01 MANUFACTURER

- A. The physical layout of the system shown on the contract drawings and the equipment specified herein are based upon the UV3600PTP System, as manufactured by Trojan Technologies, London, Ontario, Canada.
- B. If other equipment is proposed, the Contractor will demonstrate to the Engineer and the Owner that all requirements of materials, performance, and workmanship have been met or exceeded by the equipment proposed. Contractors proposing alternate manufacturers will be responsible for all costs associated with system evaluation and redesign including all electrical, mechanical, and civil aspects of the installation.

2.02 DESIGN, CONSTRUCTION, AND MATERIALS

A. General

- 1. All module welded metal components in contact with effluent will be Type 316 stainless steel.
- 2. All metal components above the effluent will be Type 304 stainless steel with the exception of the ballast enclosure, which is constructed of anodized aluminum.
- 3. All wiring exposed to UV light will be Teflon™ coated.
- 4. All wires connecting the lamps to the ballasts will be enclosed inside the frame of the UV Module and not exposed to the effluent. To be considered as an alternate, wires that are exposed to the effluent will be warranted for 15 years and will be Teflon™ coated to prevent degradation under constant exposure to UV light.

B. Lamp Array Configuration

- 1. The lamp array configuration will be the uniform array with all lamps parallel to each other and to the flow.
- 2. The system will be designed for complete immersion of the UV lamps including both electrodes and the full length of the lamp tube in the effluent.

C. UV Module

- 1. Each UV module will consist of four (4) UV lamps with an electronic ballast enclosure mounted on a Type 316 stainless steel frame. To be considered as an alternate, ballasts housed in a separate enclosure located external to the channel will be equipped with a suitable air conditioning system, supplied by

the UV manufacturer, to maintain internal enclosure temperatures below 80°F (26°C). No forced air ventilation will be allowed.

2. Each lamp will be enclosed in its individual quartz sleeve, one end of which will be closed, and the other end sealed by a lamp end seal. To be considered as an alternate, lamp quartz sleeves that are open at both ends will be supplied with twice the amount of specified spare seals and lamps.
3. The closed end of the quartz sleeve will be held in place by means of a retaining O-ring. The quartz sleeve will not come in contact with any steel in the frame.
4. The ends of the lamp sleeve will not protrude beyond the stainless steel frame of the UV Module.
5. Lamp wires will terminate in the electronic ballast enclosure located at the top of the UV Module.
6. All lamp to ballast connections will be made by and tested by the UV Manufacturer.
7. The electronic ballast enclosure will contain the electronic ballasts and addressable lamp status monitoring systems.
8. Each UV Module will be connected to a receptacle on the Power Distribution Center.
9. At the point of exit from the UV Module frame the multi conductor cable will pass through a waterproof strain relief.
10. Each UV module will have a rating of Type 6P.

D. Ultraviolet Lamps

1. Lamps will be high intensity low pressure amalgam design. The lamp will be preheated to promote longevity. Lamps that are not amalgam or that are based on driving a low pressure lamp at amperages greater than 500 milliamps will not be allowed.
2. The filament will be of a clamped design, significantly rugged to withstand shock and vibration.
3. Electrical connections will be at one end of the lamp and have four pins, dielectrically tested for 2,000 Vrms. Lamps that do not have 4 pins will be

considered instant start. To be considered as an alternative, instant start lamp systems will supply replacement spare lamps equal to 50% of the total number of lamps in the system.

4. Lamps will be operated by electronic ballasts with variable output settings.
5. Changing of lamps and sleeves shall be easily performed by the operating personnel at the plant. Systems whereby the lamp assemblies have to be returned to the factory for lamp replacement will not be allowed.
6. The UV lamps in the UV reactor should be submerged at all times to prevent overheating and UV equipment damage. This is accomplished by installing the UV reactors at an elevation below the hydraulic grade line elevation and maintaining submersion by installing a flow control weir downstream of the UV reactor.

E. Lamp End Seal and Lamp Holder

1. Each lamp will be enclosed in its individual quartz sleeve, one end of which will be closed, and the other end sealed by a lamp end seal and holder.
2. The open end of the lamp sleeve will be sealed by means of a sleeve nut which threads onto a sleeve cup and compresses the sleeve O-ring.
3. The sleeve nut will have a knurled surface to allow a handgrip for tightening. The sleeve nut will not require any tools for removal.
4. The lamp will be held in place by means of a molded lamp holder that will incorporate two seals. The lamp holder will incorporate a double seal against the inside of the quartz sleeve to act in series with the external O-ring seal.
5. The second seal on the lamp holder will isolate and seal the lamp from the module frame and all other lamps in the module.
6. In the event of a quartz sleeve fracture the two seals of the lamp holder will prevent moisture from entering the lamp module frame and the electrical connections to the other lamps in the module.
7. The lamp holder will also incorporate a UV resistant PVC molded stop that will prevent the lamp sleeve from touching the steel sleeve cup.

F. UV Lamp Quartz Sleeves

1. Type 214 clear fused quartz circular tubing as manufactured by General Electric or approved equal.
2. Lamp sleeves will be domed at one end.
3. The nominal wall thickness will be 1.5mm.

G. UV Module Support Rack

1. The UV module support rack will be minimum Type 304 stainless steel and be mounted above the effluent in the channel allowing adjustment to the precise height of the channel.

H. Effluent Level Controller

1. Level Control Weir
 - a. Located at the discharge end of the UV channel.
 - b. Designed to maintain a minimum channel effluent level as required to keep lamps submerged.
 - c. Constructed of Type 304 Stainless Steel.

I. Low Water Level Sensor

1. One low water level sensor will be provided by the UV Manufacturer.
2. During manual, automatic, and remote modes of system operation, the water level sensor will ensure that lamps extinguish automatically if the water level in the channel drops below an acceptable level.
3. The low water level sensor will be powered by the Power Distribution Center.

J. Electrical

1. Each UV module within a bank will be powered from the bank's dedicated Power Distribution Center.
2. UV manufacturer to supply all cabling and conduit between lamps and ballasts.
3. UV manufacturer to perform all terminations between lamps and ballasts.
4. Each electronic ballast within a UV module will operate two lamps.
5. Power factor will not be less than 98% leading or lagging.

6. Electrical supply to each Power Distribution Center will be 120V 60Hz, 20 A.
7. Electrical supply for the water level sensor will be provided by the PDC and be 12 Volt DC.
8. Electrical supply to the System Control Center will be 120V 60Hz, 5 A.

Note to Specifier: The UV System electrical panels are not provided with electrical disconnects. Each electrical power supply should be provided with a separate disconnect to be supplied under the electrical contract.

K. Power Distribution Center

1. Power distribution will be through environmentally sealed receptacles on the PDC(s) to allow for local connection of UV modules.
2. Data concentration will be through integrated circuit boards located inside the Power Distribution Center.
3. PDC enclosure material will be Type 304 Stainless Steel - Type 4X (IP66).
4. All internal components will be sealed from the environment.
5. All Power Distribution Centers to be UL listed and UL listed to Canadian safety standards or equivalent with a rating of Type 4X.
6. One separate sealed Power Distribution Center will be provided per bank of lamps.
7. To be considered as an alternative, systems that have ballasts mounted in cabinets, the UV manufacturer will provide one complete cabinet for each bank of lamps, to ensure that each bank is electrically isolated for safety during maintenance and to provide redundancy under average flow conditions.

Note to Specifier: If the System Controller is installed outdoors, it is recommended that the operator interface side be positioned away from direct sunlight.

L. UV Detection System

1. A submersible UV sensor will continuously monitor the UV intensity produced in each bank of UV lamps.

2. The sensor will measure only the germicidal portion of the light emitted by the UV lamps. The detection system will be factory calibrated. Detection systems that can be field calibrated will not be permitted.

M. Dose-Pacing

1. A dose-pacing system will be supplied to modulate the lamp UV output in relationship to a 4-20 mA DC signal from an effluent flow meter (by Others).
2. The system to be dose-paced such that as the flow and effluent quality change, the design UV dose is delivered while conserving power.
3. The dose-pacing system will allow the operator to vary the design dose setting. Logic and time delays will be provided to regulate UV bank ON/OFF cycling.

N. Cleaning System

1. An automatic cleaning system will be provided to clean the quartz sleeves using both mechanical and chemical methods. Wiping sequence will be automatically initiated with capability for manual override.
2. The cleaning system will be fully operational while UV lamps and modules are submerged in the effluent channel and energized.
3. Cleaning cycle intervals to be field adjustable.
4. Remote Manual and Remote Auto cleaning control options will be provided.
5. The cleaning system will be provided with the required solutions necessary for initial equipment testing and for equipment start-up.
6. To be considered as an alternate, systems that use only mechanical wiping must have the ability to periodically be cleaned out of channel using a chemical bath. Out of channel cleaning will include lifting slings, removable banks, cleaning tanks, agitation system and air compressors, as required. The UV manufacturer will be responsible for supplying all equipment including any equipment not specifically listed required to perform out of channel chemical cleaning. Contactor will be responsible for installation.

O. Module Lifting Device

1. One Davit crane, base and lifting sling will be supplied to assist in removing individual modules from the effluent channel.

2. Lifting device will be a crane with hand winch and will include an adjustable boom to ensure adequate reach and height.
3. Lifting device to include a swivel handle for rotation and positioning.
4. Crane and base will be supplied by the Manufacturer and will be installed by the Contractor.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The City of Pembroke will obtain a qualified contractor to install the ultraviolet system in strict compliance with the manufacturer's instructions and recommendations.
- B. In accordance with contract drawings, manufacturers' shop drawings, instructions, and installation checklist. Contractor Installation Checklist to be completed and returned at least two (2) weeks prior to date requested for commissioning. Photographs illustrating site readiness are required. The Contractor assumes all responsibility for the installation readiness of the UV system.
- C. All labor, materials, and test apparatus necessary for completing the installation shall be furnished by the Contractor at no additional cost to the Manufacturer.

3.02 MANUFACTURER'S SERVICES

- A. Start-up and field testing: Start-up and Field Services will only be scheduled upon written request. Contractor shall notify Trojan of schedule requirements at least ten (10) working days in advance. Upon arrival to commission the equipment, if the Trojan's Certified Service Technician determines the Contractor work is not complete and the start-up cannot be completed in the allotted time. A return visit will be scheduled at the Contractors expense. Contractor will issue a change order or purchase order for the return trip and additional time required.
- B. Operator Training: Contractor responsible for scheduling the training with manufacturer.
- C. Warranty Service: As outlined in warranty agreement.

3.03 GENERAL TESTING REQUIREMENTS

- A. The manufacturer shall furnish the services of a factory trained engineer as given in Paragraph 1.04 to supervise start-up and testing of the system. The system shall operate to the specified requirements. If the system fails to meet specified requirements, it shall be adjusted, repaired, and/or replaced at no additional cost to the Owner.

3.04 FUNCTIONAL TESTING

- A. Prior to startup, the Engineer shall inspect the installed UV disinfection system for proper alignment, correct operation, proper connection, and satisfactory function of all components, including ground fault circuit interrupters and a safety inspection of wet cable connectors. The Engineer shall approve the installation and provide certification that the system components have been installed correctly and are ready for operation.
- B. Proposed check list shall be developed by the manufacturer and submitted to and reviewed by the Engineer prior to scheduling the verification of the check list.

3.05 PERFORMANCE TESTING

- A. Tests shall be performed by an Independent Certified Testing laboratory. Testing shall commence after installation and start-up of the UV system. Samples will be collected at times when the flow through the plant is at or near the peak flow rating of the UV system.
 - 1. The samples collected shall be analyzed for the following, using standard testing procedures.
 - a. Fecal coliform count just prior to disinfection.
 - b. Fecal coliform count just after disinfection.
 - c. Suspended solids prior to disinfection.
 - d. BOD5 prior to disinfection.
 - e. Percent transmission at 254 nm prior to disinfection.
 - 2. The duration of the performance testing shall be three days and the frequency of sample collection will be three times per 24 hour period at intervals directed by the Owner. The data obtained shall be recorded and included in the formal test report.
- B. Analytical Method. Test and sample preservation methods for test contaminants shall be in accordance with the latest revisions of AWWA Standards Method for Examination of Water and Wastewater.

- C. The contractor is responsible for local laboratory costs and coordination, and the supplier will provide the procedure and compile the results. An allowance for testing shall be included in the proposal.

END OF SECTION

SECTION 15512
SLUDGE DEWATERING SYSTEM

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. The contractor shall furnish a complete dewatering system as specified and indicated on the drawings to meet the specified performance requirements. The Tower Belt Filter Press shall comply with the following specifications which are based upon time-proven design. That design combines high strength structural integrity, extensive material longevity, minimal maintenance and utility requirements, and state of the art process resulting in superior overall performance.
- B. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless noted by the engineer.

1.02 SYSTEM DESCRIPTION

- A. The Tower Belt Filter Press shall be Charter Machine Company model TP 17.43 or approved equal.
- B. The conveyor shall be made by the same manufacturer of the Belt Filter Presses. Acceptable manufacturers: Charter Machine Co. or approved equal.
- C. The Tower Belt Filter Press model furnished shall feature a vertical arrangement of pressure rollers that permits 205 degree minimum wrap on each roller.
- D. The sludge dewatering system shall consist of a skid mounted belt filter press with slurry feed pump, wash water pump, and polymer conditioning system, and includes all necessary controls, piping and wiring to provide a turnkey system.
- E. The minimum belt width required shall be 1.7m. The overall width, length, and height shall be 8'-5", 21'3", and 8'3", respectively.
- F. A sludge discharge conveyor shall be supplied as shown in the Contract Drawings. The conveyor shall receive dewatered sludge cake from the belt filter press and convey the material to the sludge storage area.

- G. The screw conveyor system shall include conveyor troughs with liners, spiral flighting, conveyor drive w/motor, gearbox adaptor w/packing rings, trough ends, covers, inlet hopper, outlet hopper and all hardware.
- H. The conveyor shall be 10" diameter shafted screw conveyor approximately 20' long capable of conveying the dewatered cake solids to a dumpster. This conveyor shall discharge via a chute. All of the conveyors shall be of the latest design and shall be fabricated of materials and in a fashion which will fully perform the necessary functions.

1.03 QUALITY ASSURANCE

- A. System Responsibility: Vested responsibility for operation and control of the BFP system, which is comprised of all equipment controlled by the BFP control panel, is the BFP manufacturer.
- B. Experience Qualification: BFP equipment shall be provided by a manufacturer who is qualified and experienced in the production, installation, operation, and process control of dewatering polymer, conditioned, aerobically digested sludge dewatering polymer, conditioned, aerobically digested sludge from municipal wastewater treatment facilities. A qualified manufacturer is one having a minimum of ten (10) units of the proposed model, each having been in operation for a period of not less than five (5) years.
- C. The belt filter press manufacturer is to have a minimum of 20 years of development, assembly, and manufacturing experience. No exceptions to this requirement shall be accepted.
- D. Equipment submitted for approval which does not meet the specified experience period shall be considered only if the Contractor provides a bond or certified check which shall guarantee replacement in the event of failure to comply with all other criteria contained in the procurement documents. The amount of the guaranteed bond or certified check shall be 200% of the full bid price of the equipment. The period of time for which the guaranteed bond or certified check is required shall be equal to the experience period specified.
- E. Source Quality Control: The belt filter press shall be designed, fabricated, assembled, and tested by the belt filter press manufacturer in their own facility. In order to provide maximum quality assurance, all aspects of the design, fabrication, and assembly shall be performed by personnel employed by the manufacturer. The belt filter press manufacturer shall at the same facility

1.04 MANUFACTURER'S WARRANTY

- A. The manufacturer shall warrant, in writing, that all equipment supplied by them shall be free from defects in material and workmanship, for a period of twelve (12) months from the date of startup, not to exceed eighteen (18) months from the date of delivery, unless noted otherwise within the specifications.

1.05 CONDITIONS OF SERVICE

- A. The sludge dewatering equipment shall be designed to adequately condition and dewater the sludge so that a dewatered sludge cake is produced that easily discharges from the dewatering unit without blinding and that may be handled by the pump or conveying equipment.
- B. Each unit shall be designed to operate in the environment for which it is intended, continuously or intermittently on demand, and shall perform the required dewatering operations without spillage of water or sludge beyond the nominal machine envelope.

1.06 PERFORMANCE REQUIREMENTS

- A. Each belt filter press shall be capable of meeting the following minimum performance criteria provided the above Conditions of Service are furnished:

Sludge throughput, lbs. d.w.s./hour	200-800
Hydraulic capacity, gpm.	0-50
Cake solids, percent d.w.s.	13-18%
Solids capture, percent	93-95%
Polymer consumption lbs./ton of active polymer in feed, d.w.s.	6-10

PART 2 – PRODUCTS

2.01 MATERIALS OF CONSTRUCTION

- A. All materials used in the construction of the sludge dewatering equipment shall be of the best quality and entirely suitable in every respect for the service required. All structural steel shall conform to the ASTM Standard Specification for Structural Steel, Designation A36/A36M. All iron castings shall conform to the ASTM Standard Specifications for Gray Iron Castings, Designation A48, and shall be of a class suitable for the purpose intended. All structural carbon steel plates and shapes shall have a minimum thickness of 1/4 inch and shall be hot dip galvanized in accordance with ASTM A-123

B. The following materials and coatings shall be provided for the belt filter press and related components unless specified otherwise herein:

1. Main Frame	Box frame of welded and bolted MC channels conforming to ASTM A36, then hot dip galvanized according to ASTM A123.
2. Flocculator	Type 304 stainless steel and UHMW polyethylene.
3. Perforated Roller	Carbon steel, hot dip galvanized according to ASTM A123.
4. Sludge Plows	Polyethylene
5. Drive Rollers	Carbon steel coated with 3/8" thick synthetic rubber, 60 durometer.
6. Tracking Rollers	Carbon steel coated with 3/8" thick synthetic rubber, 60 durometer.
7. Other Rollers approved equal.	Carbon steel coated with 25 mil Rilsan II Nylon or
8. Bearings	Double row spherical roller type.
9. Bearing Seals	Quadruple lip contact seals with gasketed cast iron end caps.
10. Pneumatic	200 psi rating, anodized aluminum tube
11. Cylinders	with stainless steel tie rods, teflon seals, graphite bearing, lubrication not required.
12. Belt Tracking	Fully pneumatic analog.
13. Belt Tensioning	Fully pneumatic.
14. Belt Wash Stations:	Hand wheel operated internal brush type with stainless steel manifold, valve, nozzles, brush, aluminum handwheel and type 304 stainless steel enclosure with neoprene seals.
15. Belts	Monofilament polyester weave selected for function and particular sludge. Seams are 316 stainless steel clipper type.
16. Filtrate Pans	Type 304 stainless steel.

- 17. Sludge Chutes Type 304 stainless steel.
- 18. Cake Discharge Type 304 stainless steel.
- 19. Chute
- 20. Water Plumbing PVC, schedule 80.
- 21. Pneumatic Polyethylene tubing, 120 psi work, 625 psi
- 22. Plumbing burst.
- 23. Doctor Blades UHMW polyethylene
- 24. Junction Box NEMA 4X type 304 stainless steel
- 25. Pneumatics Station NEMA 4X type 304 stainless steel
- 26. Assembly Hardware Type 304 stainless steel

2.02 STRUCTURAL FRAME

- A. The structural main frame shall be a box frame of welded and bolted MC channels conforming to ASTM A36 Standard Specifications for Structural Steel, into a rigid structure, adequately braced to withstand intended loads without excessive vibration, deformation, or deflection. Maximum load on the frame, rollers and bearings shall be based on the summation of forces applied to the frame from roller mass forces; weight of the rollers; the sludge and belts and static belt tension of 50 lbs. per inch plus friction forces; roller, equipment, and sludge loads; the tension produced by the driving torque of the motor; and any loads induced by the belts or the torque of the drive. The frame shall have a minimum design safety factor greater than 7.1, and the pressure load main beams shall have a moment of inertia of at least 60 inches to the fourth power.
- B. The structure shall be designed for installation on an equipment manufacturer supplied skid foundation and secured with anchor bolts. The entire system shall be enclosed and protected by removable 14-gauge stainless steel safety shields. The construction of the belt press with the shields removed shall allow easy access and visual inspection of all internal components.
- C. Main frame coating is crucial to the protection of the press main frame. All frame members shall be prepared and coated according to ASTM A123; hot dip

galvanized to a minimum 5 mil thickness. All frame members shall be drilled and machined, and all bolted connections shall be disassembled prior to galvanizing.

2.03 FLOCCULATOR

- A. The belt filter press shall be furnished with an upstream sludge-conditioning device consisting of an inline adjustable orifice venturi type mixer complete with polymer injection device. The mixer shall be designed to condition the sludge with polymer to result in a degree of flocculation that will produce the greatest amount of dewatering while maintaining the highest quality filtrate.
- B. Location of the flocculation device will vary with the application. Several locations may be specified with the unused locations plumbed with spool pieces.

2.04 GRAVITY DRAINAGE SECTION

- A. Each belt filter press shall be furnished with a gravity drainage section to accept sludge from the sludge conditioning system.
- B. The gravity-dewatering zone shall consist of an extending horizontal belt with neoprene sealed sidewalls. Sludge shall be distributed on the horizontal belt through a stainless-steel head-box. A series of rows of plows shall be arranged along the sludge path to achieve maximum drainage of free water from the sludge. The individual sludge plows shall be constructed of polyethylene. Belt press manufacturers' whose gravity deck height exceeds 72" (as measured from the base plane of the press frame to the top of the plow assembly), shall supply an elevated walkway with safety handrails and access stairs along three (3) sides of the press.
- C. The complete sludge plow assembly can be raised away from the filter belt for cleaning purposes by operating a 4-way pneumatic hand valve. The free-floating, individual plows shall ride on the belt. Each individual plow shall be replaceable without disassembly and removal of the plow grid, and without the use of hand tools.
- D. Sludge from the upper gravity area shall be distributed onto the lower horizontal belt by a baffled type 304 stainless steel chute.
- E. Midway through the lower gravity area, an adjustable stainless steel sludge leveling bar shall evenly apply the sludge across the full belt width.
- F. The gravity belts shall be supported by rollers and a grid of high-density polyethylene wear bars.

2.05 PRESSURE SECTION

- A. Each belt filter press shall be furnished with a pressure section following the gravity drainage section. The pressure section shall consist of two stages.
- B. The first stage of the pressure section shall be the increasing pressure (wedge) zone, where the upper and lower belts gradually converge with the sludge between the belts, by gently applying and increasing pressure. The wedge zone shall be adjustable by a 6" handwheel that will allow for opening of 0.5" to 4" for the inlet of the wedge zone. This adjustment can be performed while the press is in operation. Designs that do not allow for this type of adjustment while in operation shall not be acceptable. In the wedge zone the sludge cake is prepared for the shear pressure zone by generating continuously increasing pressure on the sludge as it travels through the zone.
- C. Grids as defined in the materials of construction section shall support the belt in the increasing pressure zone.
- D. The wedge zone shall utilize horizontal support bars to give a wiping action to the bottom of the belt that will quickly remove water allowing faster drainage.
- E. The second stage of the pressure section shall be the shear pressure zone consisting of radius curved grids and rollers arranged to provide an S shaped pattern of belt travel.

2.06 CAKE DISCHARGE ZONE

- A. Adjustable pneumatically loaded doctor blades shall be mounted at the discharge rollers for removing sludge cake from both belts. The doctor blades shall be power retractable and can be held away from the filter belts for cleaning and maintenance. The amount of pressure the doctor blades exert equally against both belts can be varied while the machine is operating. The adjustment of the doctor blades can be regulated from a pneumatic control panel located on the press.
- B. The doctor blades shall be made from UHMW polyethylene. The blades shall be rigidly reinforced to provide even gentle pressure on the belts with a minimal amount of abrasiveness and shall be capable of providing passage clearance for the belt seam without injuring the seam.
- C. A 14-gauge type 304 stainless steel chute shall be provided for directing the sludge to the next destination.
- D. Doctor blades assemblies that utilized spring loaded designs shall not be acceptable.

2.07 ROLLERS

- A. All Drive rollers and tracking rollers shall be coated with a minimum 3/8" thick synthetic rubber of 60 durometers to provide the friction required for efficient belt drive and tracking. All other solid rollers shall be coated to the point of insertion of the bearing with Rilsan Nylon II to a thickness of 25 mil by the Electrostatic, Fusion Bonded Rilsan Powder Dispersion Process. The perforated drum shall be hot dip galvanized to a minimum thickness of 5 mil and shall be totally free of projections that may shorten belt life.
- B. The perforated drum shall be of through shaft design with internal bulkhead and matched deflection of shaft and end plates. All other rollers shall be of stub shaft design with each stub secured by an end plate and an internal bulkhead. Assembly of rollers, shafts, end plates, and bulkheads shall be of machined concentricity and by means of continuous weld. The first roller shall have a minimum of 89% open area on the inside belt utilizing a tubular construction. Punch plate designs are not acceptable.
- C. All roller assemblies shall be designed to have a minimum yield roll safety factor of 5.89, and a maximum deflection of 0.0133 inches when under maximum load. Maximum loading shall be defined as the sum of the belt tension load at 50 pli; friction loads; equipment and sludge loads; any loads induced by the elasticity of the belts; and any loads induced by the torque of the drive.
- D. The pressure rollers shall be arranged vertically on alternating sides of the main pressure channel. The diameters of the rollers starting with the perforated roll shall decrease in size up through the vertical stack to the first of five 10 3/4" diameter rolls, with each roller separately pan drained to prevent rewetting of the sludge on the preceding rollers.

2.08 ROLLER BEARINGS AND SEALS

- A. All rollers shall be supported by greaseable type, high-capacity bearings, in pillow block housings. The bearings shall be directly mounted on the shaft with a locking sleeve assembly. Bearing lubrication shall be performed through a stainless-steel grease fitting mounted on the bearing housing. All bearings shall be outboard (externally mounted) and shall be greaseable while the unit is in operation.
- B. Roller bearings shall have an L-10 rating greater than 1,000,000 Hours per AFBMA test procedure under maximum loading conditions as the sum of the belt tension load at 50 pli and calculated at a belt speed of 5 meters per minute. All bearings shall be greaseable with all grease fittings located for servicing from the machine exterior. All roller bearings shall be double row spherical roller type. All bearings shall have quadruple lip contact seals.

- C. All bearing housings shall be class 30 cast iron one-piece pillow block type with end cap as manufactured by Charter Machine or approved equal. Bearing housings shall be coated with Rilsan Nylon II to a thickness of 12 mil by the Electrostatic, Fusion Bonded Rilsan Powder Dispersion Process.
- D. All Tower Press roller bearings shall be guaranteed for five (5) years.

2.09 BELT WASH SYSTEM

- A. Each belt filter press shall be equipped with individual belt wash stations for both the upper and lower belts. Each station shall consist of a manifold with removable stainless-steel nozzles, internal handwheel operated brush, handwheel operated flush valve, and stainless-steel neoprene skirted enclosure for containing spray mist. Belt spray water and flush water shall be collected in stainless steel pans and plumbed to the base sump to prevent rewatering of sludge process. Spray nozzles shall be suitable for use with non-potable plant effluent water. Each belt wash spray tube shall be furnished with a drain valve having an external handwheel to which is mounted a stainless-steel cleaning brush located inside the spray pipe. One full turn of the handwheel shall cause the brush bristles to enter each spray nozzle, and dislodge any solid particles which have accumulated, open the valve, and allow the solids particles to be flushed into the drainage system.
- B. A wash water booster pump shall be provided and neatly installed near the belt press. The pump shall be centrifugal type with replaceable wear rings and shall be plumbed into the belt wash system by the Contractor.
- C. The spray tube assembly shall be readily removable. Nozzle spacing and spray pattern shall be such that the sprays from adjacent nozzles overlap one another at the belt surface. Individual spray nozzles shall be replaceable. Each belt wash station shall be positioned so that the washing is performed after the cake has been discharged from the belt. The belt wash station shall extend beyond the full width of the filter belt by a minimum of two (2) inches per side. The belt wash system shall be suitable for use with plant effluent water with a maximum suspended solids content of 50 mg/l. The belt wash system shall be designed to operate at the minimum flow of 40 gallons per minute, and at a minimum pressure of 85 psig.

2.10 BELT TENSIONING SYSTEM

- A. Each belt shall be provided with a belt tensioning system that shall be pneumatically actuated. The design of the tensioning system shall be such that adjustments in tension shall result in immediate changes in dewatering pressure. Belt tensioning shall be maintained pneumatically and controlled from the press

mounted pneumatic control center and not require additional adjustment by the operator to maintain the set point.

- B. The belt tensioning system shall be designed to accommodate maximum belt stretching during the useful life of the belt. The tensioning system shall have a pair of noncorrosive pneumatics for each belt, directly connected to a rigid tensioning yoke, to provide absolute parallel tension across the entire width of the belt. The tension force shall be constant over the full range of the cylinder.
- C. Each belt shall be tensioned individually, with capability of changes with the machine operating. Tensioning pressure shall be gauged at the pneumatic control center. Tensioning cylinders shall be power retractable for belt replacement and emergency de-tensioning.
- D. The tensioning arrangement shall accommodate a minimum of $\pm 2\%$ increase in belt length throughout the anticipated belt life.

2.11 FILTER BELTS

- A. Filter belts shall be of polyester monofilament wovenware with minimum tensile strength of 890 pounds per lineal inch. Edges shall be chamfered, and belt seams shall be type 316 stainless steel clipper type. Mesh shall be selected for optimal pressure dewatering of the pertinent sludge. Belts shall be self-threading under power for replacement.
- B. Replacement of filter belts shall be accomplished without any disassembly of any part of the belt filter press except the belt joints.

2.12 BELT DRIVE

- A. The belt drive shall be variable speed, shaft mounted on one drive roller shaft. Drive shall transfer to the second drive roller by means of a gear combination. The gears shall be enclosed by a solid, stainless-steel enclosure. The drive motor shall be severe duty TEFC of ample power for starting and operating under normal conditions without exceeding the nameplate horsepower and shall have a service factor of 1.15.
- B. The drive shall be Variable Frequency Drive using AC motor and quadruple gear speed reducer. Speed control of the drive shall be in the belt press control panel. The inverter, start/stop and speed control of the drive shall be in the belt press control panel.

2.13 BELT TRACKING

- A. Belt tracking shall be totally pneumatic and shall function as a continuous automatic belt guidance system. Each belt shall be tracked individually by a type 304 stainless steel paddle arm and analog system sensor which monitors one edge of the belt and pneumatically signals a noncorrosive pneumatic cylinder for corrective positioning when required. That corrective motion shall be smooth, minimal, and adjustable.
- B. Each belt tracking assembly shall be center pivoting complete with bearings to minimize dewatering belt stretch and wear.

2.14 PNEUMATIC CONTROL SYSTEM

- A. All belt press pneumatic system controls, belt tensioning, tracking, doctor blade, and sludge plow grid controls shall be frame mounted on the belt press in a 304 S/S NEMA 4X enclosure. Belt and doctor blade tensioning adjustments, sludge plow grid adjustments, low air alarm switch, and tensioning valves for on/off control shall be mounted inside the enclosure. Belt and doctor blade tensioning on/off, tension gauges, and plow grid lift levers and adjustment controls shall extend through the enclosure for easy access. The enclosed controls shall be preceded by an oil coalescing filter and a three (3) micron air filter regulator with gage. One (1) 1/2" female NPT supply air connection shall only be required to the total pneumatic system. Lubrication of the pneumatic system shall not be required.
- B. Each belt press shall be furnished with a receiver mounted single stage air compressor. The unit shall be complete with 17 gallon ASME Code receiver rated for 200 psi, pressure gauge, automatic overload protector, intake air filter-muffler, pressure switch, safety valve, tank drain, outlet valve, and constant speed regulator.

2.15 DISCHARGE CONVEYOR TROUGHS

- A. The troughs of the conveyor shall be formed and constructed from 304 stainless steel and conform to CEMA standards.
- B. The minimum trough thickness shall be 11 gauge.
- C. A silicone gasket shall be applied at each trough connecting flange and a Neoprene rubber gasket shall be applied between the trough top edge and covers.
- D. Stiffeners shall be placed across the top of the trough and fastened to both sides of the trough to maintain trough shape.

- E. 14 gauge 304 SS covers in 4 foot sections shall be provided over the top of the trough to enclose the unit with the exception of the inlet hopper section. OPTIONAL hinged access covers can be provided if desired.
- F. A drain shall be provided at least 4" from the drive end trough flange, bottom mounted and welded perpendicular to the trough.
- G. Each trough shall be equipped with filling and/or discharge spouts at the location shown on the drawings. If required, each filling and discharge spout shall be flanged and shaped suitable for interconnection to other devices.

2.16 DISCHARGE CONVEYOR WEAR LINER

- A. The wear liners for the conveyor shall be made from anti wear material Tivar Ceram P with incorporated micro-glass beads designed for use in dewatering equipment with a high abrasive filter content.
- B. The wear liner shall be furnished in 4' sections with a minimum thickness of ¼" for ease of replacement. The liner shall be held in place with welded hold down clips.

2.17 DISCHARGE CONVEYOR SPIRAL FLIGHTING

- A. The spiral flights shall be designed to convey material without a center shaft. The spiral flights shall be designed with the stability to prevent distortion and jumping in the trough. The torsional rating of the spiral shall be such that, at 150% of the nameplate horsepower, the drive unit cannot produce more torque than the torsional rating of the flighting.
- B. Spiral flights shall be manufactured from 8620 high strength alloy steel with a Brinell hardness of 225, and a maximum yield strength of 80,000 psi. The spiral flighting shall be painted with gray 2-part epoxy paint.
- C. The spiral flighting shall be manufactured in a two-stage process. Single stage forming is not acceptable. Sectional flighting formed from plate shall not be permitted. Such two stages shall first consist of tightly cold rolling at zero pitch on a mandrel which uses a device to control the plastic flow of the spiral during forming and maintain a uniform outside and inside diameter. The second stage of spiral forming shall consist of pulling the closely wound spiral in tension to the specified pitch in a device permitting free spiral rotation.
- D. Spiral flighting shall have full penetration welds at all splice connections, the flights shall be aligned to assure true alignment when assembled in the field and shall be

made in accordance with supplier's requirements. The spiral flights shall be coupled to the end shaft by a flanged, bolted connection.

- E. The connection of the spiral to the drive system shall be through a flanged connection plate that is welded to the spiral forming a smooth and continuous transformation from the flange plate to the spiral. The drive shaft shall have a mating flange and shall be bolted to the spiral connection plate.
- F. A gland packing ring consisting of two Teflon coated packing rings shall seal the drive shaft at its penetration through the end plate, along with a greased labyrinth sealing system.

2.18 DISCHARGE CONVEYOR SUPPORTS

- A. The conveyor supports shall be capable of supporting the equipment weight when fully loaded. Support legs shall be sufficiently cross braced so as to form a rigid structure.
- B. Supports shall be constructed of carbon steel channel shapes and plates. Conveyor support base pads shall be pre-drilled for anchor bolt installation by the contractor.
- C. Supports shall be shop blasted and hot dipped galvanized. OPTIONAL 304 Stainless Steel supports may also be provided in lieu of carbon steel support legs with hot dipped galvanized coating.
- D. All structural supporting members shall be designed such that the ratio of the unbraced length to least radius of gyration shall not exceed 120 for any compression member and shall not exceed 240 for any tension member. In addition, all structural members and connections shall be designed so that the unit stresses will not exceed the American Institute of Steel Construction allowable stresses by more than 1/3 when subject to loading of twice the maximum design operating torque of the spiral conveyor drive motors.

2.19 DISCHARGE CONVEYOR DRIVE SYSTEM

- A. Drive assembly shall consist of an integral gearmotor, mounted directly to the screw shaft. Gearmotor housing shall be cast iron, furnishing complete protection under all conditions of service. Gears shall be manufactured and rated for continuous duty in accordance with AGMA standards, of heat-treated alloy steel. Gear reducer shall be Class II speed reducer.
- B. 3 phase, 60 cycle, TEFC induction motor and speed reducer shall be supplied to drive the conveyor belt at a constant speed of 60 feet per minute. The conveyor

drive shall be directly mounted to the head pulley shaft. A counterweight belt scraper, with replaceable blade, shall be installed just after the head pulley to remove material from the conveyor belt.

- C. The gear reducer and drive shall be designed to provide an applied torque adequate to start a fully loaded conveyor.
- D. Gearboxes and motors shall be factory assembled on the conveyor, factory tested and shipped fully assembled with the conveyors.

2.20 SLUDGE FEED PUMP

- A. The dewatering system shall be provided with a feed pump to deliver the sludge through a progressive cavity in line sludge/polymer mixer to the belt filter press.
- B. The feed pump shall be a progressive cavity slurry feed pump with a 5 horsepower drive motor. The sludge flow is controlled via a mechanical handwheel located on the motor and gearbox assembly.
- C. The pump shall be designed to handle flows up to 50 gallons per minute with a maximum pressure differential of 50 psi.

2.21 SLUDGE CONDITIONING SYSTEM

A. Polymer Dilution System

- 1. Liquid polymer dilution system, designed to dilute and feed liquid solution polymers to the proper solution concentrations by varying water flow and neat polymer flow. Equipment includes, mixing system, metering pump, check valve, rotameter, pressure gauges all mounted on 304 stainless steel frame which will be bolted to the equipment skid system. Control features include NEMA 4X FRP control panel designed to accept 120 VAC / 60Hz / single phase.

B. Inline Variable Orifice Mixer and Polymer Injection Ring

- 1. The inline mixer and injection ring shall be mounted after the sludge feed pump and prior to the belt filter press inlet. The assembly shall consist of a flow splitting manifold, a four-port vortex polymer injection ring, an in-line, non-clog, variable orifice mixer and all the necessary piping to complete the system. Polymer addition systems which utilize tanks with mixers or inject polymer directly into the sludge line are not an acceptable equal to the system specified due to the excess amounts of polymer required by these inefficient systems.

2. The sludge conditioning system shall be capable of providing the following performance:
 - a. The polymer and sludge must be instantly mixed (less than 1.0 second at 60 GPM).
 - b. Mixing energy must be independently adjustable during operation.
- C. The sludge conditioning system shall meet the following mechanical specifications:
 1. The in-line mixer shall have a flanged, cast housing, an adjustable orifice plate, with shaft and O-ring seal, connected to an externally mounted lever and counterweight and a removable side plate for inspection and cleaning.
 2. The inlet to the flow splitting manifold shall be fitted with a 3/4-inch male hose fitting connection. The four manifold outlets and polymer injection ring inlets shall be fitted with 1/2-inch male hose fittings that provide for the interconnection of clear flexible tubing.
 3. The open throat area of the mixer shall be fully adjustable downward and shall open automatically to prevent clogging.
 4. The position of the counterweight on the externally mounted orifice plate lever shall be fully adjustable, within a 360-degree circle, to allow for adjustment of the mixing energy, regardless of the mounting angle, while the unit is in operation.
- D. The polymer mixer shall be designed specifically for its intended use. The use of modified check valves, static mixers, or mixers requiring a tank and motor driven propeller shall not be acceptable to this specification.

2.22 CONTROL PANEL

A. System Controls:

1. General Requirements: Each belt filter press shall be provided with a control panel that will contain the necessary control devices and equipment for controlling the dewatering process as described herein. The control panel shall meet the following general requirements:
 - a. The control panel shall accept 460 volts, 60 hertz, and 3-phase AC power input. A main disconnect circuit breaker and operator mechanism shall be

included. When the disconnect is in the open position, all power shall be removed from the control system.

- b. IEC rated motor starters shall be provided for the air compressor, belt wash water booster pump, cross conveyor, and the discharge conveyor.
 - c. Variable frequency drive (VFD) shall be provided for the belt drive and sludge feed pump.
 - d. Short circuit protection for each motor shall be accomplished utilizing fuses. Individual thermal overload protection shall be provided (except for the belt drive and sludge feed pump).
 - e. A control power transformer shall be included that will provide 120 volts, AC control power to the system.
 - f. An industrial programmable logic controller (PLC) located in the control panel shall perform all logic functions for the system.
 - g. A CONTROL POWER ON/OFF switch shall be located on the front of the control panel. When in the ON position, the CONTROL POWER ON pilot light will be illuminated and control power shall be distributed to the control system. When in the OFF position, the control system shall be held de energized.
 - h. An EMERGENCY STOP pushbutton shall be located on the control panel. It shall be a mushroom head style pushbutton that when depressed shall immediately de energize all moving equipment in the system.
 - i. An alarm horn shall be included with the control panel for audible alarm annunciation along with a horn silencing button in the front of the panel.
2. Control and Pilot Devices: As a minimum, the following control and pilot devices shall be located on the front of the control panel with nameplates as worded below in UPPERCASE LETTERS:
- a. Pushbuttons:
 - i. AUTO START
 - ii. AUTO STOP
 - iii. SYSTEM RESET
 - iv. ALARM SILENCE
 - v. AIR COMPRESSOR START
 - vi. AIR COMPRESSOR STOP
 - vii. WASHWATER PUMP START

- viii. WASHWATER PUMP STOP
- ix. BELT DRIVE START
- x. BELT DRIVE STOP
- xi. SLUDGE PUMP START
- xii. SLUDGE PUMP STOP
- xiii. POLYMER SYSTEM START
- xiv. POLYMER SYSTEM STOP
- xv. CROSS CONVEYOR START
- xvi. CROSS CONVEYOR STOP
- xvii. DISCHARGE CONVEYOR START
- xviii. DISCHARGE CONVEYOR STOP

b. Selector Switches:

- i. PRESS HAND/OFF/AUTO MODE
- ii. CONTROL POWER ON/OFF

c. Indicator Lights:

- i. PREWET CYCLE ON
- ii. POSTWASH CYCLE ON
- iii. AIR COMPRESSOR RUNNING
- iv. WASHWATER PUMP RUNNING
- v. BELT DRIVE RUNNING
- vi. SLUDGE PUMP RUNNING
- vii. POLYMER SYSTEM RUNNING
- viii. CROSS CONVEYOR RUNNING
- ix. DISCHARGE CONVEYOR RUNNING
- x. LOW AIR PRESSURE
- xi. BELT OVERTRAVEL
- xii. BELT BROKEN
- xiii. LOW POLYMER

d. Speed Potentiometers:

- i. SLUDGE PUMP SPEED
- ii. BELT DRIVE SPEED

3. Signal Input and Output Devices:

- a. Discrete Input Signals: The control panel shall receive the following discrete input signals from normally open dry contacts in external devices (contacts close when the equipment runs, or a fault occurs):
 - i. POLYMER SYSTEM RUNNING
 - ii. POLYMER SYSTEM FAIL
- b. Discrete Output Signals: The control panel shall provide the following discrete signals for transmission using normally open dry contacts (contacts close when the equipment is called to run, or a fault occurs):

- i. PRESS RUNNING
- ii. PRESS FAULT

4. Sequence of Operation:

a. Automatic Mode of Operation:

- i. The press may be operated in the automatic mode by placing the HAND/OFF/AUTO selector switch in the AUTO position. The operator will next press the AIR COMPRESSOR START pushbutton and allow the pressure to reach normal operating level.
- ii. After the air pressure has reached operating level, the operator will press the AUTO START pushbutton, this will energize the wash water pump and belt drive, illuminate the PREWET CYCLE ON pilot light and start the pre wet time delay. After the pre wet timer times out, the sludge pump, polymer system, cross conveyor and the discharge conveyor will be energized.
- iii. Pressing the AUTO STOP pushbutton will de-energize the sludge pump and polymer system, illuminate the WASHDOWN CYCLE ON pilot light and start a washdown time delay. After the washdown timer has timed out, the belt drive, wash water pump, cross conveyor and discharge conveyor will be de energized.

b. Manual Mode of Operation

- i. To operate the press in the manual mode, the operator will place the HAND/OFF/AUTO selector switch in the HAND position. The operator will next start the air compressor by pressing the AIR COMPRESSOR START pushbutton. After the air pressure has reached operating level, start the wash water pump by pressing the WASHWATER PUMP START pushbutton.
- ii. The operator will not proceed until the belts are allowed to be fully tensioned. No interlock shall be provided to prevent the operator from starting the belt drive in the manual mode. Pressing the BELT DRIVE START pushbutton will energize the belt drive. At this time, the operator will start the cross conveyor by pressing the CROSS CONVEYOR START pushbutton, the discharge conveyor by pressing the DISCHARGE CONVEYOR START pushbutton, the sludge pump by pressing the SLUDGE PUMP START pushbutton and the polymer pump by pressing the POLYMER SYSTEM START pushbutton.

- iii. The system will be stopped by pressing the respective STOP pushbutton in the reverse order stated above.

5. Faults:

- a. When any of the following fault conditions occur, in automatic or manual mode, the appropriate fault indicator will be illuminated, the alarm horn will sound, and the belt filter press and associated equipment will be de-energized:
 - i. LOW AIR PRESSURE (amber light)
 - ii. BELT OVERTRAVEL (amber light)
 - iii. BELT BROKEN (amber light)
 - iv. LOW POLYMER (amber light)
 - v. BOOSTER PUMP FAULT (flashing run light)
 - vi. BELT DRIVE FAULT (flashing run light)
 - vii. SLUDGE PUMP FAULT (flashing run light)
 - viii. CROSS CONVEYOR FAULT (flashing run light)
 - ix. DISCHARGE CONVEYOR FAULT (flashing run light)

6. Components:

- a. Enclosures: Control panel enclosures shall be free-standing, fabricated of type 304 stainless steel and shall be suitable for NEMA 4X service. Enclosures shall be manufactured by Saginaw Manufacturing.
- b. Wiring: All power and control wiring shall be 600 volt, type SIS insulation stranded copper and shall be sized for the required load, 14 AWG minimum.
- c. Circuit Breakers: Circuit breakers for the main disconnect shall be thermal magnetic molded case units. Circuit breakers shall be Square D, Class 650, Type FAL.
- d. Motor Starters: Motor starters shall be full voltage, non-reversing, IEC style across the line units. Coils shall be 120 volts ac. Siemens type Sirius 3RT10.
- e. Selector Switches: All selector switches shall be heavy duty, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10-ampere continuous service. Selector switches shall be Idec Series TWTD or approved equal.
- f. Pushbuttons: All pushbuttons shall be heavy duty, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10-ampere

continuous service. Pushbuttons shall be Idec Series TWTD or approved equal.

- g. Pilot Lights: Pilot lights shall be heavy duty, corrosion resistant units rated for NEMA 4X service. Units shall be 120 VAC full voltage incandescent type. Pilot lights shall be Idec Series TWTD or approved equal.
- h. Terminal Blocks: Terminal blocks shall be high density, solderless box lug style, with 600-volt rating. Terminal blocks shall be Allen Bradley type 1492 or approved equal.
- i. Control Relays: Control relays shall be general purpose type with a 10 amp contact rating, miniature square base and internal on status pilot light. Relays shall be Allen Bradley Type 700-HF Series or approved equal.
- j. Programmable Logic Controller (PLC): The PLC shall be a modular type with discrete and analog capabilities. The CPU shall have 6K minimum RAM for user instructions. The unit shall have battery backed RAM and EEPROM backup. The PLC shall be an Allen Bradley Micrologix Type or approved equal.
- k. Variable Frequency Drive (VFD): The VFD shall be UL listed and shall be manufactured by Omron.

2.23 SAFETY FEATURES

- A. Each belt filter press shall be equipped with a lanyard type safety switch with cable encircling three sides of the press at an easily accessible height.
- B. Each belt tensioning system shall have a limit switch that shall shut down the system in the event of total belt failure.
- C. The belt tracking system shall have a limit switch on each side of the press that shall shut down the system in the event of belt tracking failure.
- D. Each pneumatic control center shall have a pressure switch that shall shut down the system in the event of low air pressure.
- E. Each gear drive shall have a solid stainless-steel enclosure.
- F. A zero speed switch shall be provided for the discharge conveyor system. The switch shall be mounted on the side of the conveyor.

- G. All controls, interlocks, and motor starts for the conveyor shall be contained in the belt press control panel.

2.24 FACTORY WIRING

- A. All power and control wiring shall be 600 volt, type THHN/THWN insulation stranded copper and shall be sized for the required load, 12 AWG for power, 14 AWG for control and 18 AWG for instrumentation.

2.25 SKID SYSTEM

- A. The entire sludge dewatering system, including belt press, wash water pump, feed pump, and polymer system shall be mounted on a carbon steel hot dipped galvanized skid. The skid shall not exceed the following dimensions: 350 inches long, and 150 inches wide.
- B. The skid shall contain a sump under the entire area that will capture filtrate, wash water, and any hose down or excess water used during clean up. The water captured by the sump shall discharge out of both sides of the skid through 4 inch NPT outlets located approximately mid-length of the skid. Grating shall be provided over the entire area of the skid, except where equipment is present.
- C. The skid system and all components listed herein shall be pre-piped and wired. Connections required by the owner/contractor shall consist of one electrical supply landing, one sludge feed pipe landing, water connections to the washwater pump and the polymer system. Connections to the polymer system from the neat polymer solution shall be by others.

PART 3 – EXECUTION

3.01 FIELD SERVICE

- A. The manufacturer shall include the services of a factory trained field engineer for the purposes of installation inspection, equipment start-up, polymer selection, performance testing and training of plant personnel regarding proper operation and maintenance of the equipment.

3.02 QUALITY CONTROL TESTING

- A. Prior to shipment, the belt filter press and control panel shall be factory tested at the place of assembly. Factory test each pre-assembled, pre-wired, lubricated, and aligned BFP and its associated control panel to be supplied to the job site. Prior to shipment, verify through a one-hour continuous operating test that the BFP and associated equipment operate smoothly, noiselessly, vibration free, and without

overheating of any bearing or motor. Particular attention must be given to ensure that the BFP is properly aligned for maintaining the centerline-to-centerline tracking of the belts relative to the machine. Submit a certified test report to the Engineer for approval, prior to shipping that demonstrates compliance with all applicable industry standards, manufacturing quality control, and the functional intent of these Specifications.

- B. Alternate manufacturers shall, at no cost to the Owner, conduct a field performance test, at the plant site, within 30 days of the bid opening to demonstrate compliance with the specified performance criteria. This test must be conducted with a belt filter press of the same design and configuration as the unit proposed for this project, with a minimum effective belt width of 0.7 meters. Test procedures shall assure meaningful results and shall be subject to the approval of the Owner. The Owner, on the basis of qualitative results of this testing, will select the equipment to be supplied.
- C. Testing will be conducted as follows:
 - 1. The objective of the test will be to measure throughput, dewatered sludge solids concentration, polymer usage and filtrate solids.
 - 2. Suitable means, acceptable to the Engineer, shall be provided to measure sludge feed rate, filtrate flow rate, washwater feed rate and polymer feed rate.
 - 3. Testing shall be conducted for at least one 6-hour period. During the test period the following data shall be collected at 30-minute intervals by the Construction Manager:
 - a. Measure belt speed
 - b. Record polymer type, concentration, and feed rate
 - c. Collect polymer sample
 - d. Record sludge feed rate
 - e. Record filtrate feed rate
 - f. Record washwater feed rate
 - g. Collect 200-ml filtrate sample for lab analysis
 - h. Collect 200 ml dewatered sludge sample for lab analysis
 - i. Collect 200 ml dewatered sludge sample for lab analysis
- D. The alternate bid manufacturer and Contractor shall absorb all costs associated with changes in layout, piping, controls, electrical wiring, etc. (including engineering costs) if the alternate bid manufacturer is accepted.

3.03 START-UP AND OPERATOR TRAINING

- A. Services of the manufacturer's factory trained representative, who is specifically knowledgeable in the type of equipment specified herein, shall be provided during the equipment installation period. Upon complete installation of equipment by installing contractor, including placement of equipment, setting, and leveling the equipment, piping, and electrical connections to all the equipment specified herein, the manufacturer's service representative will approve the installation and begin start up and training.
- B. Upon approval of the installation, the services of the manufacturer's factory trained representative shall be provided at the project site for equipment start-up and calibration. During the start-up and calibration phase the manufacturer's representative shall inspect all system components for proper connection and alignment and assist the installation contractor in placing the equipment in a proper operating condition.
- C. Upon satisfactory completion of the start-up and calibration, a representative of the manufacturer shall be provided to instruct Owner's personnel in the proper operation and maintenance of the equipment. The manufacturer's representative who will be providing the instruction shall have prior operation, maintenance and instructing experience acceptable to the Engineer.
- D. The manufacturer's representative shall complete all of the above sessions in **one trip** to the jobsite. The equipment manufacturer will request in writing that all installation prior to arriving at the jobsite be completed by the contractor. If the equipment manufacturer arrives at the jobsite and equipment installation is not complete, the equipment manufacturer shall bill the contractor for the installation time, which is not covered under this contract.

<u>Purpose</u>	<u>No. of Days</u>
Installation Supervision	As required for complete installation
Start-up and Calibration	1 per press
Initial operation, Performance Test and	
Maintenance Instruction	3
Follow-up Instruction and Optimization	2

- E. Additional services, other than those provided for by warranties or as specified herein, may be charged to the Owner/Contractor at the manufacturer's standard service rates or as agreed to at the time of the service request.

END OF SECTION

SECTION 15520
GRIT SEPARATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section shall include furnishing, unloading at the jobsite, handling, storage and installing of a complete grit separation system. This system shall include two (2) spiral sand separation units, two (2) grit airlift units, and all ancillary equipment, as needed to meet the specified performance requirements.
- B. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the engineer.

1.02 SUBMITTALS

- A. Complete shop and installation drawings of all materials and equipment furnished under this Section shall be submitted by the Contractor for approval in accordance with the bid document. Submittals shall include, but not be limited to, the following:
 - 1. Complete description in sufficient detail to permit an item comparison with the specifications.
 - 2. Detailed drawings showing all of the details of construction pertaining to the grit separation system. This shall include installation details of all equipment associated with this system.
 - 3. Detailed electrical schematic and layout drawings and a description/narrative explaining the operation of all control panels.
 - 4. All interconnections and interface requirements, dimensions, and locations of all major elements of the grit separation system including critical clearance requirements.
 - 5. Basis of design, including background data, calculations, operational plant data and other information showing the development of the proposed design and that it will conform to the requirements of this specification.
 - 6. The startup testing report and manufacturer's certification as required in Part 3.

1.03 CODES AND STANDARDS

- A. Equipment specified herein shall meet or exceed the applicable sections of the following codes and standards authorities.
1. AGMA, American Gear Manufacturers Association.
 2. ASME, American Society of Mechanical Engineers.
 3. ASTM, American Society of Testing and Materials.
 4. ANSI, American National Standards Institute.
 5. IEEE, Institute of Electrical and Electronics Engineers.
 6. NEC, National Electrical Code.
 7. U.L., Underwriters Laboratories.
 8. AWS, American Welding Society

1.04 SYSTEM STARTUP

- A. It is the responsibility of the contractor to ensure that the grit separation system supplier will provide a representative for startup services upon completion of the systems installation. The manufacturer shall provide the following activities.

B. Manufacturer's Representative

1. The manufacturer's representative shall inspect the construction plans and the installation, and recommend any required modifications, additions, or other changes required to allow the manufacturer to certify that the complete installation is appropriate and will operate as expected and intended.
2. The manufacturer's representative shall instruct the Owner's personnel on the operation and maintenance of the grit separation system. The instruction shall include both classroom and field training on proper operation and maintenance procedures, accompanied with complete demonstrations.
3. The manufacturer's representative shall provide at a minimum, services in accordance with the following table:

<u>Purpose</u>	<u>No. of Days</u>
Installation Supervision	As required for complete installation
Start-up and Calibration	1 per system
Initial Operation, Performance Test and Maintenance Instruction	1
Follow-up Instruction and Optimization	1

4. The number of days indicated above shall be provided on an 8-hour-day on-site basis and shall be in addition to travel time.

1.05 DESCRIPTION OF THE SYSTEM

- A. The grit separation system shall consist of two (2) spiral separation units, two (2) grit airlift units and all accessories.
- B. The minimum clearance requirements specified herein shall not relieve the contractor from allowing additional clearances for the proper installation, operation, and maintenance of the units. Should equipment other than that specified be proposed, the contractor shall be responsible for any redesign based on the requirements contained herein.
- C. The grit removal device shall have less than $\frac{1}{4}$ " head loss. The device shall be capable of removing grit from wastewater and depositing the grit in a storage chamber. The grit removal and storage device shall have no moving parts. Rotating turbines, blades, or submerged bearings will not be approved. Baffling, if required, shall be constructed of fiberglass and installed according to the manufacturer's drawings.

1.06 SPARE PARTS

- A. No spare parts shall be required for this system.

1.07 QUALITY ASSURANCE

- A. General
 1. Only manufacturers of sand separation units and grit airlift units of the type specified herein operating for a period of five years in a minimum of five wastewater treatment plants in the Southeastern United States shall be considered. Manufacturers not meeting the experience requirement shall not be acceptable.
 2. All components of the grit separation system shall be of high quality and sized to accommodate, without failure or compromise, all forces encountered during fabrication, installation and operation. Compliance with the performance requirements of the specification shall not relieve the contractor of his responsibility to supply equipment having the specific structural, mechanical, operational and surface corrosion protection features as specified herein.

3. The sand separation unit and grit airlift unit shall be factory assembled and tested prior to shipment to ensure proper operation of all systems.

1.08 WARRANTY

- A. The equipment furnished under this section shall be free of defects in materials and workmanship, including damages that may be incurred during shipping, storage, and installation for a period of one year from the date of the startup. In the event that any equipment failure occurs during this time period, it is the responsibility of the manufacturer to repair and/or replace the equipment at no cost to the owner

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General

1. The grit separation system must be designed to fit within the specified dimensions shown on the attached drawings and be of modular design.
2. The system to be furnished shall include the latest components and equipment available at the time of shipment.
3. All components exposed to or in contact with plant effluent, including all anchoring hardware, shall be comprised of corrosion/degradation resistant materials. Approved materials shall be as described in this section.
4. The grit separation system shall be able to continuously provide grit and water separation services under varying flow conditions for extended periods of service.
5. The individual unit of the grit separation and removal system shall have a hydraulic capacity of 1.3 MGD design and a peak flow of 1.95 MGD.
6. The system shall be capable of removing 95% of the grit greater than 50 mesh in size, 85% of the grit greater than 70 mesh in size, and 65% of the grit greater than 100 mesh in size.

B. Approved Materials

1. All materials used in the construction of the grit separation system shall be of the best quality and approved in every respect for the service intended by the engineer. All structural steel shall conform to the ASTM Standard Specification for Structural Steel, Designation A36/A36M. All iron castings shall conform to the ASTM Standard Specifications for Gray Iron Castings, Designation A48, and shall be of a class suitable for the purpose intended by the engineer. Other materials shall conform to the ASTM Specifications where such specifications exist and the use of such materials shall be based on continuous and successful use under similar conditions of service.
2. All electrical components shall be U.L. listed where such listings exist, and all electrical control panels shall be assembled in U.L. approved facilities.

2.02 SPIRAL SAND SEPARATION UNIT

A. Spiral Assembly

1. The spiral assembly will consist of a shaftless spiral bolted to a drive shaft attachment.
2. The spiral will be constructed of high-strength carbon steel bar stock, having a minimum thickness of 0.79 inches. The spiral will be prime coated for protection during shipment. The spiral will have a 9.0 inch minimum OD and a minimum flight height of 2.3 inches. The drive end of the spiral will be provided with a welded coupling plate.
3. The drive shaft will be welded to a coupling plate that bolts to the mating coupling plate on the spiral. The shaft will be a solid carbon steel shaft keyed for direct insertion into the hollow shaft of the gear reducer.

B. Trough Assembly

1. The trough assembly shall consist of the trough, trough liner, discharge section, drive system mounting flange, cleanout coupling and trough cover.
2. The U-shaped trough shall be fabricated, at a minimum, of 11 gauge type 304L stainless steel with a 10.24 inch ID. The trough will be mounted at a minimum 25 degree angle.
3. The trough liner shall be fabricated, at a minimum, of a 3/8 inch thick wear resistant rubber liner adhered to a 16 gauge type 316L stainless steel liner that shall be tack

welded to the inside of the trough. Four (4) wear bars shall be longitudinally mounted and tack welded to the inside of the trough liner. Each wear bar shall be, at a minimum, made of 5/16 inch by 1 ¼ inch carbon steel bar stock. One (1) wear bar shall be supplied with a type 18-8 stainless steel cap screw (removable from the outside of the trough), that shall be used as an indicator of the wear rate on the bars.

4. A bottom discharge section will be fabricated at the drive end of the trough. The discharge section will be, at a minimum, fabricated of 11 gauge type 304L stainless steel. A flexible neoprene discharge chute/guard will be fastened to the discharge section and shall guide discharged solids into the customer supplied receptacle. This discharge chute/guard shall not have to be removed or tampered with to empty the disposal receptacle.
5. The drive end of the trough will be capped off with a painted carbon steel plate that will serve as a mounting flange for the drive system.
6. The bottom end of the trough will be equipped with a 4 inch NPT drain. This drain shall be fitted with an aluminum valve and 3" male cam and groove coupling so that a hose drain line can be attached.
7. A 14 gauge type 316 stainless steel cover shall cover the trough from the tank to the drive.

C. Drive Assembly

1. The drive assembly will consist of a motor and gear reducer.
2. The motor shall be, at a minimum, a ¾ HP, 1200 RPM, 230/460 volt, 3 Phase, 60 Hz, Class 1 Division 2 explosion proof motor, NEMA Design B motor with Class F insulation, 1.15 S.F. and rated for severe duty.
3. A shaft-mounted helical gear reducer shall be directly coupled to the motor. The cast iron reducer shall have an output speed of 6.6 RPM, produce 7160 inch-pounds of torque and have a 1.8 S.F. The gear reducer shall be fastened to the mounting flange on the trough assembly.

D. Tank Assembly

1. The tank assembly shall be mounted above the trough assembly and consist of a tank with an overflow chamber and tank covers. The tank assembly shall be designed to support the weight of the spiral and trough, as well as the imposed hydrostatic loads. Approved provisions for lifting the tank shall be supplied by the Contractor.
2. The tank shall be fabricated of 11 gauge type 304L stainless steel, with sides sloped toward the trough assembly. The tank shall be welded to the top of the trough assembly.
3. An overflow chamber, fabricated of 14 gauge type 304L stainless steel, will be mounted inside of the tank assembly. An overflow chamber will be provided with a 6.63 inch OD plain-end discharge pipe stub. The discharge pipe will be located on the left-hand side of the unit, as viewed from the solids discharge end.
4. Tank covers shall be mounted on top of the tank assembly. The cover above the overflow chamber shall be hinged for viewing access. All other covers shall be bolted to the tank. The bolt-on cover section adjacent to the hinged cover shall be supplied with a 4.50 inch OD influent pipe stub. The influent pipe shall be a plain-end pipe connection, centered between the access doors and positioned as is shown on the construction drawing. The doors shall not interfere with the designed pipe configuration. All covers shall be fabricated of 11 gauge type 316 stainless steel and be gasketed.

E. Support Legs

1. Four (4) support legs shall be provided on the unit; two (2) attached to the trough assembly (near the discharge end), and two (2) attached to the tank assembly (near the influent end). Each support leg will be fabricated of 11 gauge type 304 or 316 stainless steel. A 5/16 inch thick mounting pad with a 0.63 inch diameter anchor bolt hole will be provided at the bottom of each support leg.
2. The installing contractor will furnish four (4) ½"-13UNC by 5½ inches long type 304 stainless steel expansion anchors.

F. Surface Finish

1. All welds in stainless steel subassemblies shall be electro-chemically cleaned or acid passivated after welding for corrosion resistance and to provide a superior surface finish. This shall be accomplished by electro-chemically removing heat tint and

discoloration with a device designed for that purpose or by full dipping of weldments, or by using an acid passivation paste in the weld and heat effects areas and spray-on acid solutions elsewhere. After passivation, the weldments shall be thoroughly rinsed with clean water and allowed to air dry. No heat tint or carbon steel contamination shall be evident after this process. If there is contamination evident, the contaminated areas shall be cleaned by the above method and rechecked after rinsing and drying. Sandblasting, bead blasting or grit blasting of stainless steel surfaces shall not be allowed in lieu of the above procedures.

2. The spiral and wear bars shall be prime coated for protection during shipment.
3. The motor and reducer shall be provided with the manufacturer's standard finish.
4. The drive system mounting flange and drive shaft shall be finished with 3.0 mils DFT epoxy powder coating.

G. Emergency Stop

1. A unit mounted emergency stop push button shall be provided in a NEMA-4X polycarbonate enclosure. Emergency stop button to be located on support leg of unit near the grit discharge.

2.03 GRIT AIRLIFT UNIT

- A. The grit airlift unit, air-liquid separation unit, circulating motive jet, and grit airlift shall be supported from the existing bridge work.
- B. Air shall be introduced at the base of the unit so as to lift and recirculate water in the grit chamber for aerating and scouring. An air-liquid separation unit shall be provided at the top of the airlift unit to separate most of the air from the recirculation stream. The elevated water from the unit shall be used to drive the circulating jet motive nozzle. The jet motive nozzle shall be designed to impinge upon the sloped section of the transition section and provide circulation in the grit chamber.
- C. The airlift pump shall be furnished to facilitate grit washing and removal. The diameter airlift pump shall be designed to be concentric with the unit. The airlift pump shall be approved for manual or automated operation by control of the compressed air supply to the airlift unit. The air supply line shall terminate above the bridge work. The terminal end of the air supply pipe shall be furnished with a 1½" diameter automatic control valve. Air supply piping from the source of the air supply to the control valves shall be furnished by the contractor.

- D. All parts that are submerged or partly submerged shall be produced of a corrosion resistant, structurally sound, fiberglass reinforced resin in accordance with National Bureau of Standards PS-15-69.
- E. Regenerative blower with intake filter shall be provided to supply 110 SCFM at 2.5 psig. Unit shall be provided with a 3.0 HP, 460 V, 3 phase TEFC motor.
- F. A positive displacement blower with intake filter, silencer and accessories shall be provided to supply 50 SCFM at 47 psig. The unit shall be provided with a 3.0 HP, 460 V, 3 phase TEFC motor.

2.04 CONTROL PANELS

- A. One control panel shall be provided for each spiral sand separation unit. The control panel shall be a NEMA-4X stainless steel enclosure capable of wall mounting. It shall contain the following devices for operation of the equipment:
 - 1. Pump interlock contacts
 - 2. Settling timer
 - 3. Discharging timer
 - 4. Repeat discharge cycle timer
 - 5. Hand-off-auto selector switch
 - 6. Run time meter
 - 7. System start button
 - 8. Fault reset button
 - 9. Emergency stop push button
 - 10. Indicating lights
 - 11. Relays
 - 12. 480/120 V control power transformer
 - 13. Main disconnect switch motor starter and motor current monitor

The incoming power service to the control panel will be 480V, 3 Phase, 60 Hertz.

The spiral motor starter shall be provided with a hand-off-auto selector switch. In the "hand" position, the spiral shall rotate continuously.

When the AUTO mode is selected, an automatic cycle will be initiated upon receiving a signal from the customer's pump operation. AUTO cycle includes:

- 1. Tank fill (based upon pump signal)
- 2. Solids settling
- 3. Solids discharge (continuous or intermittent)

A fault condition (motor thermal overload or motor current overload) will disable the unit and illuminate a Fault light.

- B. One control panel shall be provided for each Hydro-Grit Separation Unit. The control panel shall be a NEMA-4X stainless steel enclosure suitable for wall mounting.

The panel shall house starters for regenerative blower and airlift positive displacement blower. The control panel shall include a "Hand-Off-Auto" selector switch and indicating light for the airlift blower. In the "Auto" position, a 24 hour timer settable in ten minute increments shall start the airlift blower, start a second timer and open the air scour solenoid. When the second timer times out, it shall close the air scour solenoid, open the air lift solenoid, and start a third timer. The third timer shall stop the airlift blower, close the airlift solenoid and reset when the contact on the 24 hour timer releases. Provide an auxiliary contact for airlift pump "run status" to interlock with the spiral sand separation unit specified elsewhere in these specifications.

The power service for the control panel will be 480 V, 3 phase, 60 Hertz.

- C. SCADA Requirements: Each unit shall be equipped to communicate with proposed system. The proposed system will incorporate Allen-Bradley PLCs. All vendor furnished field control panels shall be capable of interfacing with the Owner's proposed SCADA system using one of the two methods described below:

1. Field Control Panels without a Programmable Logic Controller (PLC)(Not Preferred -2 points): For field control panels which do not incorporate a programmable logic controller, status, alarm and control signals shall be wired to field terminals in the field control panel for hardwired connection a SCADA panel.

Digital status or alarm signals from Field Control Panels to the SCADA system (such as equipment running, Hand-Off-Auto selector switch in Auto Mode, motor overload, high level alarm, low level alarm, etc.) shall be wired as dry contacts to field terminal strips. These dry contacts shall be rated at 5 amps minimum at 250 VAC.

Digital control signals from the SCADA system to Field Control Panels (such as Pump Call-to-Run, Valve Open/Close, etc.) shall be wired as dry contacts to field terminal strips in a SCADA system PLC cabinet. Dry contacts in the SCADA panel shall be rated at 10 amps minimum at 250 VAC.

Analog status signals from Field Control Panels to the SCADA system (for signals such as level, flow, pH, etc.) shall be 4 to mA isolated signals into 600 ohms minimum.

Analog output signals from the SCADA system to Field Control Panels (for signals such as Pump Speed, set points, etc.) shall be 4 to mA isolated signals into 600 ohms minimum.

2. Field Control Panels with a Programmable Logic Controller (PLC)(Preferred): For field control panels which incorporate a programmable logic controller, the PLC must be capable of Ethernet communications using Allen-Bradley's Ethernet/IP protocol. No other communications protocols will be approved. Input/Output (I/O) signals for status, alarm, set points, controls, etc. shall be mapped within the PLC to contiguous data registers to facilitate efficient data transfer to/from the SCADA system.

The equipment vendor shall furnish to the Owner's System Integrator detailed I/O listings containing each signal name, range or status, PLC address and all other pertinent information as required for interface of the vendor's equipment into the existing SCADA system.

As a minimum, each Field Control Panel that incorporated a programmable logic controller shall include a 4-port Ethernet switch to facilitate programming connections and connection to the Owner's existing SCADA system via Cat 6 cable.

2.05 FIBERGLASS REINFORCED POLYESTER GRIT PIPING

- A. The grit slurry piping shall be cylindrical having an inner diameter of 4-inches and shall be internally smooth and free from protrusions which might collect solid material. The grit slurry pipe shall be fabricated of machine filament wound, fiberglass reinforced thermosetting resin pipe conforming to ANSI/ASTM Specification D-2996 and classified according to ASTM D-2310.

The piping shall use an isophthalic, corrosion resistant laminating resin; reinforced with glass fibers and a surfacing material of commercial grade chemical resistant glass having a coupling agent. The pipe shall have a 50 psig pressure rating. The piping shall have a minimum structural thickness of 0.375-inch. The piping shall include an abrasion resistant 20-mil internal liner. All piping shall be provided with an UV inhibiting gelcoat. FRP piping shall be provided by Fluidyne Corporation as part of the overall grit removal system.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The Contractor shall be responsible for the complete installation of each of the two grit separation systems. Installation shall not be considered to be complete until the equipment has been tested under normal and peak loading conditions for the facility and has been proven to successfully handle such flow rates.
- B. It shall be the responsibility of the Contractor to install each component of the system as it is received.
- C. It shall be the Contractor's responsibility to ensure a safe installation, free from: flaws in equipment alignment, damage, and damage to any of the existing structures or components. If damage to the grit separation system, any of its equipment, or any of the existing structures does occur, it is the Contractor's responsibility to repair these items to their original specifications at no charge to the owner. If the equipment or structure is deemed to be beyond repair by the engineer's representative, it shall be the responsibility of the Contractor to replace the item at no charge to the Owner.
- D. It is the responsibility of the Contractor to make all specified pipe connections. These connections shall be seated properly and free of all leaks. Piping for the system shall be installed as specified in the construction drawings and shall include all required pipe lengths and spacing.
- E. The Contractor shall be responsible for assembly and installation of all electrical and accessory equipment required by the manufacturer and engineer for successful and efficient equipment operation. Installation of all electrical equipment shall be performed by a licensed qualified electrician and in accordance with the NEC and all federal, state, and local regulations.

3.02 GENERAL TESTING REQUIREMENTS

- A. The manufacturer shall furnish the services of a factory-trained engineer as given in Paragraph 1.04 to supervise start-up and testing of the system. The system shall operate to the specified requirements as set forth by the manufacturer and engineer. If the system fails to meet the specified requirements, it shall be adjusted, repaired and/or replaced at no additional cost to the Owner.

3.03 FUNCTIONAL TESTING

- A. Proposed functional testing shall be developed by the manufacturer and submitted to and reviewed by the Engineer two (2) weeks prior to installation of the grit removal system. If the proposed testing requirements are found to be insufficient by the engineer, the engineer will submit the changes that must be made in the testing program back to the manufacturer. The manufacturer will then have two (2) working days to resubmit the testing program to the engineer for approval.
- B. Prior to startup, a manufacturer's and engineer's representative shall inspect the system for proper alignment, correct operation, proper connection, and satisfactory function of all components. When final approval of the system is given, the manufacturer's and engineer's representative shall provide certification that the system components have been installed correctly and are ready for operation. Until such time as written approval is given by both the manufacturer's and engineer's representative, it is the Contractors responsibility to make the required repairs, changes, and adjustments to the ensure delivery of a system free from defects of any kind.

END OF SECTION

**SECTION 15530
SEWAGE SCREENING
AUTOMATIC SELF-CLEANING**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section shall include furnishing, unloading at the jobsite, handling, storage, and installation of one (1) model AWP8-2 Aqua Washpress unit, as supplied by Parkson Corp., Vernon Hills, IL or approved equal. The unit will consist of a Main Body, Screw, Wash Sprays, Flush Sprays, Drive System, Covers, Feed Hopper, Discharge Piping and Controls as specified at the Rincon Water Pollution Control Plant. The system shall include one (1) fully automatic self-cleaning filter screen, complete with accessory equipment (e.g., waste compaction system), as required to meet the specified performance requirements.
- B. The equipment will be of the latest design and will be fabricated of the specified materials and in a fashion that will fully perform the functions described in these specifications.
- C. The filter screen shall be approved for installation and operation in the appropriate flow channel as specified in the attached drawings. The angle-of-inclination for both required filter screens shall be within 75 to 80 degrees from the horizontal, and the channel floor shall have a minimum recess of that specified by the manufacturer. The geometry of the channel shall be verified with the attached drawings, by the contractor prior to installation of the filter screen to ensure continuity between the existing and proposed filter screen installations.
- D. Each screen shall fit in the existing opening with minimal channel wall modifications. Both filter screens shall be provided by the same manufacturer and be the same model. This will provide consistency for operations and maintenance. The filter screens shall be capable of presenting a clean filtration surface to the oncoming liquid stream at all times during continuous operation. Each filter screen shall meet the following criteria:

<u>Parameter</u>	<u>WWTP</u>
Avg. flow rate	0.65 MGD
Max. daily flow rate	1.30 MGD
Peak hourly flow rate	1.95 MGD
Channel width	2.0 ft
Channel depth	4 ft
Screen angle	75°
Element size	6 mm

Max. downstream water level	1 ft
Max. upstream water level	1.71 ft
Max. height above floor	4.708 ft

- E. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the engineer.
- F. Only equipment defined as a filter screen and meeting the requirements herein will be accepted. No bar screens, screw auger filtering devices, or the like will be accepted.

1.02 SUBMITTALS

- A. Complete shop and installation drawings of all materials and equipment furnished under this Section shall be submitted by the Contractor for approval in accordance with the bid document. Submittals shall include, but not be limited to, the following:
 - 1. Complete description in sufficient detail to permit an item comparison with the specifications.
 - 2. Detailed drawings showing all of the details of construction pertaining to the filter screen system. This shall include installation details of all equipment associated with this system.
 - 3. Detailed schematic and layout drawings and a description/narrative explaining the operation of all control panels.
 - 4. All interconnections and interface requirements, dimensions, and locations of all major elements of the filter screen system including critical clearance requirements.
 - 5. Basis of design, including background data, calculations, operational plant data and other information showing the development of the proposed design.
 - 6. The startup/performance testing report and manufacturer's certification as required in Part 3.

1.03 CODES AND STANDARDS

A. Equipment specified herein shall meet or exceed the applicable sections of the following codes and standards authorities.

1. AGMA, American Gear Manufacturers Association.
2. ASME, American Society of Mechanical Engineers.
3. ASTM, American Society of Testing and Materials.
4. ANSI, American National Standards Institute.
5. IEEE, Institute of Electrical and Electronics Engineers
6. NEC, National Electrical Code.
7. U.L., Underwriters Laboratories.
8. AWS, American Welding Society

1.04 SYSTEM STARTUP

A. The supplier/manufacturer shall provide a representative for startup services upon completion of the system's installation. The following activities shall be provided by the manufacturer.

B. Manufacturer's Representative

1. The manufacturer's representative shall inspect the construction plans and the installation, and recommend any required modifications, additions, or other changes required to allow the manufacturer to certify that the complete installation is appropriate and will operate as expected and intended.
2. The manufacturer's representative shall instruct the Owner's and Engineer's personnel on the operation and maintenance of the filter screen system. The instruction shall include both classroom and field training on proper operation and maintenance procedures, accompanied by complete demonstrations.
3. The manufacturer's representative shall supervise the performance testing of the installation.
4. The manufacturer's representative shall provide at a minimum, services in accordance with the following table:

<u>Purpose</u>	<u>No. of Days</u>
Installation Supervision	As required for complete installation
Start-up and Calibration	1 per screen
Initial operation, Performance Test and	3

5. The number of days indicated above shall be provided on an 8-hour per day on-site basis and shall be in addition to travel time.

1.05 DESCRIPTION OF THE SYSTEM

- A. The filter screen system shall consist of one (1) filter screen and all accessories. All filters shall have dual or mixed media and be operated at a rate between 2 and 5 gpm/ft².
- B. Filter screen units shall be the Aqua Guard Filter Screen Model AGUC-MN-A 75° as manufactured by Parkson Corporation with Aqua Washpress Screenings Washer/Compactor Model AWP8-2, Raketec screen as manufactured by Aqualitec with compactec washer compactor or approved equal.
- C. Designs employing the use of cables, hydraulic cylinders, or rakes to remove debris from the channel will not be approved. As well as the use of two (2) or more motors to complete a screening cycle will not be approved.
- D. The design shall be such to ensure that all planned maintenance to the raking/screening mechanism can be accomplished at the operating floor level.
- E. No moving parts shall be located permanently below the channel water surface at maximum design flow.

1.06 SPARE PARTS

- A. The following spare parts shall be furnished with each of the filter screens and shall be of factory direct parts:
 - 20 - Filter Elements
 - 10 - Side Plates
 - 10 - Snap Rings, 1 3/8" Dia.
 - 10 - Snap Rings, 1 5/8" Dia.
 - 4 - Rotating Brush Elements or Scraper Blade Elements

1.07 QUALITY ASSURANCE

- A. Only manufacturers of fully automatic self-cleaning filter screens of the type specified herein operating for a period of five years in a minimum of five wastewater treatment plants in the Southeastern United States shall be considered. Manufacturers not meeting the experience requirement will not be approved.
- B. All components of the filter screen equipment shall be of high quality and sized to accommodate, without failure or compromise, all forces encountered during fabrication, installation, and operation. Compliance with the performance requirements of the specification shall not relieve the contractor of his responsibility to supply equipment having the specific structural, mechanical, operational, and surface corrosion protection features as specified herein.
- C. The filter screen shall be factory assembled and tested prior to shipment to ensure proper operation of all systems.

1.08 WARRANTY

- A. The equipment furnished under this section shall be free of defects in materials and workmanship, including damages that may be incurred during shipping, storage, and installation for a period of one year from the date of the startup.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General

- 1. The filter screen system must be designed to fit within the specified dimensions shown on the attached drawings and be of modular design.
- 2. The system to be furnished shall include the latest components and equipment available at the time of shipment.
- 3. All components exposed to or in contact with plant effluent, including all anchoring hardware, shall be comprised of corrosion/degradation resistant materials (see Paragraph 2.01B).
- 4. The filter screen system shall be able to continuously provide waste separation services under varying flow.

- B. All moving wetted parts, all wetted parts on which the moving parts ride, and all components under guiding, bearing or driving loads including, but shall not be limited to the shafts, links, and guide rails must be fully corrosion-resistant and shall be made of 304 stainless steel for the filter screen, 316 stainless steel for the WWTP filter screen or wear resistant heat treated 400 series stainless steel for either screen, except as noted in the following:
1. The screening element shall be constructed of a material that will not shred trash or cause jamming due to the self-relieving nature of the material.
 2. The roller and bushings shall be of 400 series heat treated stainless steel with a minimum Rockwell of 39C hardness or approved equal for reduced wear and increase the long life of the equipment.
 3. The stationary frame, main drive shaft and sprockets shall be constructed of 316 stainless steel for the WWTP.
 4. The take-up screws shall be constructed of 316 stainless steel for the WWTP.
 5. The front seal brush and rotating brush, if required, shall have nylon bristles.
 6. The side seals shall be made of neoprene rubber with backing plates constructed of 316 stainless steel for the WWTP.
 7. All nuts and bolts will be 316 stainless steel for the WWTP.
 8. The discharge chute shall be 316 stainless steel for the WWTP.
 9. All other appurtenances including chains, brush sprockets, bearing housings, etc. shall be of the manufacturer's standard coating material.
 10. The WWTP filter screen shall have a 316 stainless steel removable outer covering. This outer covering shall not interfere with the machine's separation and shall serve the intended purpose of trapping all waste gases inside the machine. This cover shall fit with the proposed channel covering system and create an airtight barrier.

2.02 FILTER SCREEN MECHANICAL DETAILS

- A. The screening rollers shall be at a minimum 1 ¼" diameter and shall ride on ½" thick 316 stainless steel at the WWTP. A submerged curved ½" thick stainless-steel rail shall be provided at the foot of the screen. No submerged bearings or

sprockets shall be allowed in order to eliminate maintenance required on submerged components.

- B. To prevent deflection, the filter shafts shall have a minimum thickness of $\frac{3}{4}$ " diameter and spaced on 4" centers in the travel direction of the belt; and shall be made of 316 stainless steel for the WWTP. This is required to ensure structural integrity and smooth operation without jamming or binding.
- C. The tension of the moving screen belt assembly shall be completely supported by a stainless-steel link chain. The chain must connect the filter shaft ends, on both sides of the belt assembly, so that no weight is supported by the filter elements. The chain assembly shall provide a minimum cross section of 0.114 square inches, at the weakest point of any individual link.
- D. The shafted screw will be provided to convey screenings through the various stages of the unit. The screw will be constructed of carbon steel and finished with alkyd enamel paint. The spiral will be 8.00 inches OD and have minimum 0.63 inch thick flights. A replaceable 0.25 inch wide nylon brush with a stainless-steel casing will be attached with bolted clips to the spiral OD throughout the inlet area to scour the perforated sheet. The brush OD will be 8.50 inches.
- E. No plastic elements shall be used as structural members for load bearing purposes.

2.03 SCREEN BELT CLEANING

- A. The filter screen shall be automatically self-cleaning without requiring water or external mechanical devices. The drive mechanism shall be protected from the trash stream and the driving force must be transmitted to clean, trash free components to avoid mistracing or binding which may render the filter screen inoperable and thereby requiring manual cleaning and realignment. In addition, no auxiliary cleaning devices, which may cause trash to be dropped into the interior of the filtration belt will be allowed to prevent jamming of the filtration belt.

2.04 FILTER SCREEN MOUNTINGS

- A. The filter screen shall require no mounting or fastening to the sidewalls or bottom of the channel. Routine service shall be possible with the filter screen in the channel.

2.05 DRIVE UNIT

- A. The drive unit shall be a hollow shaft, helical worm type reducer equipped with anti-friction bearings, and designed in accordance with AGMA recommendations for 24 hours, Class II service. The unit drive system will consist of a gearmotor mounted on a sealed drive mounting bracket and a drive shaft that connects the gear reducer output to the shaft of the screw. Overload protection shall be provided by an electrical overload device that senses motor current draw.
1. The motor shall have the following characteristics:
 - a. Minimum of 0.5 HP, maximum of 5 HP
 - b. 3 phase
 - c. 230/460 volt
 - d. 60 HZ
 - e. Class 1 Division 2 Explosion Proof
 - f. NEMA Design B
 - g. Class F insulation
 - h. 40° C ambient temperature rise
 - i. rated for severe duty
 2. The gear reducer will meet the following criteria:
 - a. AGMA class 1 (1.6 service factor, 1.4 minimum)
 - b. 94% efficiency
 - c. Output speed of 14 rpm
 - d. Output torque of 13,900 inch-pounds
 - e. Heavy duty roller bearings provide max thrust capacity of 6,740lbs
 3. Drive Mounting Bracket: A drive mounting bracket will be provided to mount the gearmotor to the drive end support leg of the unit. The bracket will be made of type 304L stainless steel. A compression type packing gland seal will be provided on the mounting bracket to seal the drive shaft. PTFE packing rings will be fitted into the seal housing and held in place by a two-bolt stainless steel gland follower.
 4. Drive Shaft: The drive shaft will be directly coupled to the spiral and constructed of carbon steel. The shaft will be painted, except in the area of the shaft that extends into the hollow bore of the reducer.

2.06 SCREENINGS COMPACTOR (One (1) compactor for two (2) screens)

A. General

1. Only compaction systems utilizing an auger type screw to transport the screenings through a compression/dewatering tube will be accepted.

2. The press housing shall be made of 316 stainless steel for the WWTP (ASTM 240).
3. The new press screw shall be made of 304 stainless steel (ASTM 240) or high strength carbon steel that has been coated for corrosion resistance. The screw shall be attached to the drive shaft in a manner, which allows for ease of maintenance.
4. The reject water trough and removable splash guard shall be of 316 stainless steel for the WWTP.
5. The spray filter shall be made of 316 stainless steel for the WWTP.
6. The drive shaft shall rotate on two axial/radial tapered roller bearings.

B. Support Structures

1. The support plates shall be integral to the main body of the unit and shall be made of 304 stainless steel (ASTM 240).

C. Drive Unit

1. The drive unit shall be a helical, worm gear reducer, hollow shaft, with a shrink disk.
2. The drive unit meet the following criteria:
 - a. 230/400 V
 - b. phase
 - c. 60 HZ
 - d. minimum of 2 HP
 - e. NEMA Design B
 - f. Class F insulation

D. Solids Discharge Zone

The solids discharge zone shall be of a specified type and be one of the following:

1. A spring-loaded counterforce attached to the outside of the compactor and plate hinged at the outlet of the unit.
2. A stainless-steel pipe extension flanged to the outlet to extend dewatering time and enhance frictional dewatering forces.

E. Dimensions of Compactor

1. The compactor shall be specifically manufactured and guaranteed by the Contractor to fit into the existing areas without any modifications to existing structures. The compactor and screen housings shall be connected for the main purpose of trapping all waste gases in an enclosed mechanical system.

F. Performance Capabilities

1. The compactor shall be capable of handling a minimum of 35 ft.³/hr. (or 4m³/hr.) of wet screenings with a minimum feed concentration of 8-10% dry solids and shall be capable of compressing the screenings to achieve and 75% reduction in volume.

2.07 DISCHARGE PIPING

- A. A 14 gauge (.075 inch) stainless steel discharge pipe will be fitted to the discharge end support leg to direct screenings into a customer provided receptacle. All discharge pipe flanges will be 304L/316L stainless steel. Aluminum flanges will not be allowed.
- B. Pipe supports, if needed, will be supplied by Parkson or approved equal.
- C. All fasteners will be type 18-8 stainless steel.
- D. Weld size, type, and procedure will provide the necessary strength and facilitate the manufacturing of the specific component.

2.08 CONTROLS

- A. A NEMA 4X stainless steel control panel shall be provided for operation of the filter screen/compactor combination. If secondary control panel(s) are utilized, they must also be of that specified for the primary.
- B. The main control panel wiring shall contain all power and control devices shown on the drawings (wiring diagrams) which shall include, but not be limited to, the following:
 1. One (1) Hand/Off/Automatic selector switch for manual operation of the filter screen drive.
 2. One (1) Forward/Off/Reverse selector switch for manual operation. Spring return form reverse.

3. One (1) pilot light for "Screen Forward" run status.
 4. One (1) pilot light for "Screen Reverse" run status.
 5. One (1) pilot light for control power
 6. One (1) control power "Off/On" selector switch
 7. One (1) 24-hour single channel electronic control timer to automatically initiate operation of the filter screen
 8. Control relays, wiring and circuitry required to implement the control logic.
- C. Controls shall operate the screen and compactor on a timed, liquid level control signal or continuous basis.
- D. Main Power Control
1. The control panel shall be totally enclosed, front access type with top/side/bottom entry. All controls shall be manufactured by a U.L. listed control panel facility.
 2. Construction of the control panel shall be NEMA 4X, 304 stainless steel construction with indicating devices and switches mounted on the front door.
 3. The solenoid valves will meet the following criteria:
 - a. 120 Volt
 - b. Single phase
 - c. 60 HZ
 - d. 18 inch long integral leads
 - e. 1/2 inch NPT conduit connections
 4. A NEMA 4X polycarbonate emergency stop push button station will be mounted to the drive end flange and will have a 3/4 inch NPT conduit connection.
 5. Main control panel:
 - a. wiring shall be neatly cabled and supported in nonflammable wiring raceways.
 - b. Programmable relay to monitor equipment mounted electrical devices to perform necessary logic functions.
 - c. Emergency Stop push button.
 - d. Hand-Off-Auto selector switches for the drive, wash, and flush water sprays.

- e. Control power and spiral run incandescent indicating lights.
- f. Current monitor
- g. Fault and fault reset push button incandescent light.
- h. Run and fault auxiliary output contacts for customer use.

E. SCADA Requirements: Each unit shall be equipped to communicate with proposed system. The proposed system will incorporate Allen-Bradley PLCs or approved equal. All vendor furnished field control panels shall be capable of interfacing with the Owner's proposed SCADA system using one of the two methods described below:

1. Field Control Panels without a Programmable Logic Controller (PLC)(Not Preferred -2 points): For field control panels which do not incorporate a programmable logic controller, status, alarm, and control signals shall be wired to field terminals in the field control panel for hardwired connection a SCADA panel.

Digital status or alarm signals from Field Control Panels to the SCADA system (such as equipment running, Hand-Off-Auto selector switch in Auto Mode, motor overload, high level alarm, low level alarm, etc.) shall be wired as dry contacts to field terminal strips. These dry contacts shall be rated at 5 amps minimum at 250 VAC.

Digital control signals from the SCADA system to Field Control Panels (such as Pump Call-to-Run, Valve Open/Close, etc.) shall be wired as dry contacts to field terminal strips in a SCADA system PLC cabinet. Dry contacts in the SCADA panel shall be rated at 10 amps minimum at 250 VAC.

Analog status signals from Field Control Panels to the SCADA system (for signals such as level, flow, pH, etc.) shall be 4 to 20 mA isolated signals into 600 ohms minimum.

Analog output signals from the SCADA system to Field Control Panels (for signals such as Pump Speed, set points, etc.) shall be 4 to 20 mA isolated signals into 600 ohms minimum.

2. Field Control Panels with a Programmable Logic Controller (PLC)(Preferred): For field control panels which incorporate a programmable logic controller, the PLC must be capable of Ethernet communications using Allen-Bradley's Ethernet/IP protocol. No other communications protocols will be approved. Input/Output (I/O) signals for status, alarm, set points, controls, etc. shall be mapped within the PLC to contiguous data registers to facilitate efficient data transfer to/from the SCADA system.

The equipment vendor shall furnish to the Owner's System Integrator detailed I/O listings containing each signal name, range or status, PLC address and all other pertinent information as required for interface of the vendor's equipment into the existing SCADA system.

As a minimum, each Field Control Panel that incorporated a programmable logic controller shall include a 4-port Ethernet switch to facilitate programming connections and connection to the Owner's existing SCADA system via Cat 6 cable.

2.09 OVERLOAD PROTECTION

- A. Positive overload protection against an object, which is too large to be passed over, shall be provided by the use of a control panel mounted, current sensitive relay (CSR). The CSR shall continuously monitor the motor current to prevent damage to the drive assembly due to a jam obstruction or system malfunction. Machines that rely solely on rake arm rotation in conjunction with mechanical limit switches or proximity switches to provide over torque protection shall not be allowed. Designs that utilize shear pins are specifically excluded.

PART 3 - EXECUTION

3.01 PROPOSED FILTER SCREEN INSTALLATION

- A. The Contractor shall be responsible for the complete installation of the bar screen. Installation shall not be considered to be complete until the equipment has been tested under normal and peak loading conditions for the facility and has been proven to successfully handle such flow rates (as determined by representative of the engineer and manufacturer).
- B. The filter screen will be received onsite as one unit and it shall be the responsibility of the Contractor to install the press as it is received.
- C. It shall be the Contractor's responsibility to ensure a safe installation, free from flaws in equipment alignment, equipment damage, and damage to any of the existing structures or components. If damage to the filter screen, any of its equipment, or any of the existing structures does occur, it is the Contractors responsibility to repair these items to their original specifications at no charge to the owner. If the equipment or structure is deemed to be beyond repair by the engineer's representative, it shall be the responsibility of the Contractor to replace the item at no charge to the Owner.

- D. Each filter screen shall be attached to the channel as shown in the construction drawings and as specified by the manufacturer's and engineer's representative. If the attachment method is by means of bolting, the bolts shall be torqued to that specified by the manufacturer to ensure a securely anchored support for the screen and all of the associated equipment.
- E. It is the responsibility of the Contractor to make all required pipe/hose connections as specified. These connections shall be seated properly and free of all leaks.
- F. The Contractor shall be responsible for assembly and installation of all electrical and accessory equipment required by the manufacturer and engineer for successful and efficient equipment operation. Installation of all electrical equipment shall be performed by a licensed qualified electrician and in accordance with the NEC and all federal, state, and local regulations.

3.02 PERFORMANCE REQUIREMENTS

- A. The screens unit will be capable of the following performance:

- 1. The screens unit will be designed to receive and wash screenings, then reduce the volume and water content by means of a pressing action. Screenings to be washed will be gravity fed to the drainage trough and conveyed by the screw towards the washing section. Wash water is added, which back flows the screenings, while the spiral alternately stops and restarts to convey the screenings through the wash section. The wash water is then turned off and the screenings are discharged and dewatered by the back pressure generated in the discharge pipe.
- 2. The unit will be installed outdoors in a non-hazardous area.
- 3. The unit's controls will be installed outdoors in an unclassified area.
- 4. The unit will be suitable for installation and operation in the designated space.
- 5. The unit will have an inlet capacity of 35 cubic feet per hour, handling wet screenings with an approximate dry weight of not less than 8% solids.
- 6. Utilities
 - a. Total Spray wash (max @ 60 psi): 15 gpm
 - b. Power Supply 460 / 3/ 60

3.03 GENERAL TESTING REQUIREMENTS

- A. The filter screen shall be factory assembled and tested for a minimum of 8 hours prior to delivery and shall be delivered to the site as fully assembled as possible. It shall be capable of being set in place and field erected by the contractor with minimal assembly.
- B. The manufacturer shall furnish the services of a factory-trained engineer as given in Paragraph 1.04 to supervise start-up and testing of the system. The system shall operate to the specified requirements as set forth by the manufacturer and engineer. If the system fails to meet the specified requirements, it shall be adjusted, repaired and/or replaced at no additional cost to the Owner.

3.04 FUNCTIONAL TESTING

- A. Proposed functional testing shall be developed by the manufacturer and submitted to and reviewed by the Engineer two (2) weeks prior to installation of the filter screen. If the proposed testing requirements are found to be insufficient by the engineer, the engineer will submit the changes that must be made in the testing program back to the manufacturer. The manufacturer will then have two (2) working days to resubmit the testing program to the engineer for approval.
- B. Prior to startup, a manufacturer's and engineer's representative shall inspect filter screen system for proper alignment, correct operation, proper connection, and satisfactory function of all components. When final approval of the filter screen system is given, the manufacturer's and engineer's representative shall provide certification that the system components have been installed correctly and are ready for operation. Until such time as written approval is given by both the manufacturer's and engineer's representative, it is the Contractors responsibility to make the required repairs, changes, and adjustments to the ensure delivery of a filter screen system free from defects of any kind.

END OF SECTION

**SECTION 15540
SEWAGE SCREENING
MANUAL CLEANING**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section shall include furnishing, unloading at the jobsite, handling, storage and installing of one (1) model OR-TEC Manually Cleaned Bar Screen, as supplied by OR-TEC Inc., Cleveland, OH or approved equal. One (1) Manually Cleaned Bar Screen will be used at the headworks of the wastewater treatment plant to remove debris including stringy rag-like materials from the influent sewage. The screen unit will consist of a perforated drying deck, manual rake, bar screen panel, and two side frames. The system shall include accessory equipment as required to meet the specified performance requirements.
- B. Manufacture screen complete with related accessories as indicated on the included drawings and specified herein.
- C. The filter screen shall be approved for installation and operation in the appropriate flow channel as specified in the attached drawings. The angle-of-inclination for the required filter screen shall be within 45 to 60 degrees from the horizontal, and the channel floor shall have a minimum recess of that specified by the manufacturer. The geometry of the channel shall be verified with the attached drawings, by the contractor prior to installation of the filter screen to ensure continuity between the existing and proposed filter screen installation.
- D. The screen shall fit in the existing opening with minimal channel wall modifications. The filter screen shall be capable of presenting a clean filtration surface to the oncoming liquid stream at all times during continuous operation. The filter screen shall meet the following criteria:

<u>Parameter</u>	<u>WWTP</u>
Total Average Flow	0.65 MGD
Max Flow Rate	1.30 MGD
Peak Hourly Flow Rate	1.95 MGD
Channel width	2.0 ft
Channel depth	4 ft
Screen angle	60°
Element size	1/2"

- E. Manufacture screen complete with related accessories as indicated on the included drawings and specified herein.

1.02 SUBMITTALS

- A. Drawings: Shop drawings shall be submitted for the screen and its associated components. Scaled dimension drawings, layout drawings, anchor and installation details, and details of major components will be included.
- B. Product Data: Manufacturer's technical data and installation instructions will be submitted along with pertinent data to substantiate material compliance with project requirements.
- C. Operation and Maintenance Manuals: One (1) copy of installation and operational manuals complete with operation and maintenance instructions will be submitted including an arrangement drawing for layout/installation.

1.03 CODES AND STANDARDS

- A. Equipment specified herein shall meet or exceed the applicable sections of the following codes and standards authorities.
 - 1. AGMA, American Gear Manufacturers Association.
 - 2. ASME, American Society of Mechanical Engineers.
 - 3. ASTM, American Society of Testing and Materials.
 - 4. ANSI, American National Standards Institute.
 - 5. IEEE, Institute of Electrical and Electronics Engineers
 - 6. NEC, National Electrical Code.
 - 7. U.L., Underwriters Laboratories.
 - 8. AWS, American Welding Society

1.04 DESCRIPTION OF THE SYSTEM

A.	Model Number:	OMS
B.	Type:	Manual Cleaned Bar Screen
C.	Screen Opening:	½"
D.	Screen Angle:	60°
E.	Channel Size:	24" wide
F.	Max Depth in Channel:	48" deep
G.	Drying Deck:	Provided at grade
H.	Rake:	Provided
I.	Material :	Main Frame, Bar, Rake : STS 304L

1.05 QUALITY ASSURANCE

- A. Acceptable Manufacturer: Or-Tec Inc, Manual Bar Screen or Engineer pre-approved equal.
- B. Manufacturer: Shall furnish a fully functioning screen as dictated by the accepted Scope of Supply. Manufacturer shall have produced similar process configurations for a period of at least (5) five years.
- C. Manufacturer's Services: Manufacturer's personnel, for the equipment specified herein, shall be present at the job site for a minimum of one (1) day, travel time excluded, for inspection of installation, certification of field testing and adjustment. Additional field service will be provided at a reasonable fee or at no charge, depending on the circumstances of the visit. Manufacturer's representative must have a full equipped service facility with qualified technicians certified to service the equipment.

1.06 WARRANTY

- A. The equipment furnished under this section shall be free of defects in materials and workmanship, including damages that may be incurred during shipping, storage, and installation for a period of one year from the date of the startup.

PART 2 - PRODUCTS

2.01 STRUCTURE

- A. The Manual Bar screen shall be consist of a bar screen panel, two side frames, perforated drying deck and manual rake.
- B. Equipment shall be installed so as not to obstruct the flow of sewage to bar screen. Screen components including shapes (rods, angles, and channels), side frames, bar rack, rake, drying deck, fasteners and anchor bolts shall be manufactured from Type 304 stainless steel. Manual screens with any of these items manufactured from materials other than 304 stainless steel shall not be acceptable.

2.02 BAR SCREEN PANEL

- A. Screen panel face shall be made of a parallel array of bars with even spaces between them. Bars shall be 1/4" wide and 1" deep. Bars shall be fully welded in a stainless steel frame.

- B. The mid-section of the bar is cross-supported by support beams at every 20" interval.
- C. All material for bars, drying deck, rake and the support beams shall be made of 304 Stainless Steel. The bar screen panel shall be mounted and bolted between a pair of side frames. Screens which utilize material other than stainless steel as the main screen media shall not be acceptable for this project.
- D. The screen shall be supplied with a rake that allows operators to manually clean the screen face. The rakes penetrating teeth shall fully clean the gaps between the bars and keep the screen operational. Screens shall be drawn up the face of the screen and discharged onto a perforated drying deck at grade.

PART 3 - EXECUTION

3.01 PROPOSED FILTER SCREEN INSTALLATION

- A. General: Install screen and associated components as shown on the plans

3.02 TESTING AND INSPECTION

- A. General: Notify Owner and Engineer in writing when the installation is complete and ready for testing and start up.
- B. Inspect components for proper installation, wiring and piping.
- C. Operate all components and check for proper operation. Make necessary adjustments.

PART 4 - CLARIFICATIONS

- 4.01 Unless specifically mentioned in this proposal for inclusion with the proposed agreement, the aforementioned price DOES NOT INCLUDE:

Spare Parts:

- 1. Electrical motors, devices, controls, wiring (other than outlined)
- 2. Piping, valves, fittings, hangers, or supports (other than outlined)
- 3. Equipment erection or field welding
- 4. Concrete work, grout, or sealant
- 5. Lubricating oil or grease

- 4.02 Seller shall use reasonable efforts to meet specified drawing schedules and shipment dates, but such dates are estimates provided only to serve as a guide to the Contractor, and not guaranteed. No liability, direct or indirect, is assumed by manufacturer for failure to ship on such dates. Contractor agrees to expedite issuance of the written purchase order and approval of drawings.
- 4.03 Seller retains the title and right of repossession to the equipment until the full purchase price has been paid. Purchaser will not encumber nor permit other to encumber said equipment by any liens or security instruments until the full purchase price has been paid.
- 4.04 Contractor agrees not to back charge for labor, materials or other such costs unless previously approved in writing by an authorized employee of seller.

END OF SECTION

**SECTION 15561
STEEL TANK TERTIARY FILTER
PILE CLOTH**

PART 1 - GENERAL

1.01 SPECIFICATION PRECEDENCE

- A. The specifications for equipment and controls under this section supersede specifications for equipment and controls specified elsewhere in the contract documents and drawings. Purchased components such as gear reducers, pumps, motors, valves, and actuators shall be provided with standard recommended manufacturers paint, unless otherwise specified within this section.

1.02 SERVICE

- A. The equipment manufacturer shall furnish the services of a factory trained representative for a maximum of three (3) trips and eleven (11), eight-hour days at the jobsite to inspect the installing contractor's equipment installation, supervise the initial operation of the equipment, instruct the plant operating personnel in proper operation and maintenance, and provide process assistance. The equipment manufacturer shall furnish the services of a factory trained representative for 1 trip and 3 eight hour days at the jobsite for performance testing.
- B. If additional service is required due to the mechanisms not being fully operational at the time of service requested by the contractor, the additional service days will be at the contractor's expense.

1.03 WARRANTY

- A. The Manufacturer shall provide a written warranty against defects in materials and workmanship. Manufacturer shall warrant the goods provided by the Manufacturer to be free from defects in materials and workmanship under normal conditions and use for a period of one (1) year from the date the goods are put into service, or eighteen (18) months from shipment of equipment, whichever first shall occur. This warranty shall not apply to any goods or parts which have been altered, applied, operated, or installed contrary to the Manufacturer's instructions or subject to misuse, chemical attack/degradation, negligence, or accident.

1.04 MANUFACTURING QUALIFICATIONS

- A. The filter supplier shall have experience in the design and manufacture of cloth media filters for a minimum of ten (10) years and shall be able to demonstrate a

minimum of fifty (50) installations within the United States in municipal wastewater applications with cloth media.

PART 2 - PRODUCTS

2.01 DISK TERTIARY FILTER

- A. There shall be two Model ADFsP54x4EPC Aquadisk filters with OptiFiber PES-13® media cloth type or approved equal. Contractor shall furnish all labor, materials, equipment and incidentals required for installation of the disk filter as shown on the drawings and as specified herein. Through the wall spool piping and all external piping shall be provided by the installation contractor. Effluent weir assembly shall be provided by the installation contractor.

Each unit will include:

1. Basin Mounting Brackets and Hardware
 2. Drive Assembly
 3. Centertube Assembly with Cloth Media Disks
 4. Backwash System
 5. Backwash/Waste Pump Assembly
 6. Valves
 7. Influent Weir
 8. Pressure Transducer Assembly
 9. Float Switch
 10. Vacuum Transmitter
 11. Electrical Controls with Internal Components
- B. All motors, pumps, and bearings shall be designed for continuous duty and long operating life in a high humidity atmosphere. All motors and pumps shall be 460 volt, 60 hertz, 3 phase.

2.02 PERFORMANCE AND DESIGN PARAMETERS

- A. The Disk filter shall be capable of filtering effluent from an SBR process. Design shall be able to treat for the below design conditions with one unit offline:
- 0.65 MGD Average Daily Flow
1.30 MGD Maximum Daily Flow
- B. Filter influent total suspended solids (TSS) concentration shall be 5 mg/l daily average and 10 mg/l maximum at average daily flow rate.

- C. Filter effluent total suspended solids concentration shall not be greater than 5 mg/l based on a monthly average.
- D. Filter effluent turbidity shall not be greater than 3 NTU based on a daily average.
- E. The cloth media filter area classification shall be non-rated.

2.03 FILTER DISK TANK

- A. Each tank assembly shall be painted steel. Each tank drain shall be provided with a manually operated ball valve. Valve shall be provided loose for installation by the installing contractor. Tank interior shall be blasted per SSPC-10 and coated with one epoxy basecoat and one epoxy topcoat for a total DFT of 8-12 mils. Tank exterior shall be blasted per SSPC-6 and coated with two epoxy basecoats and one polyurethane topcoat for a total DFT of 8-12 mils. Coating shall be the color "safety blue", manufactured by Sherwin Williams or Tnemec.

2.04 DRIVE ASSEMBLY

- A. Each filter shall include an adjustable drive assembly with a gearbox, nylon drive sprocket, acetal drive chain with 304 stainless steel link pins, a 304 stainless steel chain guard, warning labels, adjustable drive bracket weldment(s), stationary motor bracket weldment, and drive sprockets. The gearbox shall be parallel in-line helical type, AGMA Class 1 with a 3/4 HP drive motor rated for 460 volt, 3 phase, 60 Hz. Gear reducer shall be Nord or approved equal. Drive motor shall be Nord, Weg, Baldor, or approved equal.
- B. To reduce energy demand, the drive assembly shall rotate the disks only during backwash. Systems requiring constantly rotating disks during filtration will not be approved. Belt drive systems or systems with multiple drive units per filter will not be approved.
- C. If motors and gearboxes require routine maintenance and are not accessible from the outside tank side walls, the equipment manufacturer shall provide an internal access platform between the tank side walls and motors and gearboxes.

2.05 CENTERTUBE ASSEMBLY

- A. Each centertube assembly shall include a minimum 3/16" thick 304 stainless steel centertube weldment, driven sprocket centertube carrier assembly, centertube position maintainer, centertube end support bearing kit(s), effluent centertube lip

seal(s), media sealing gaskets, wheel assemblies, 304 stainless steel disk segment rods, and frame and cloth assemblies. Each centertube assembly shall also include a Viton v-ring effluent port seal which provides superior chlorine resistance. Materials other than Viton are not approved for seal materials. The driven sprocket shall be multi segment made of UHMW polyethylene. All fasteners shall be stainless steel.

2.06 FILTER CLOTH ASSEMBLIES

- A. Each basin shall include four (4) cloth disk assemblies. Each consisting of a cloth media sock supported by an injection molded polypropylene co-polymer frame with corrosion resistant assembly hardware. Cloth/frame assemblies shall be constructed such that each segment is easily removable from the centertube, without special tools, to allow for removal and replacement of the cloth at the point of installation. Systems requiring special tools and/or the return of media segments to the factory for replacement will not be considered.
- B. Cloths shall be of fiber pile construction having a nominal filtration rating of 10 microns. Granular media and screens having structured identical openings shall not be allowed. The cloth media shall have an active filter depth of 3 to 5 mm to provide additional collisions between solids particles and the media within the media depth, resulting in capture of solids across a broader particle range. The cloth depth shall also provide storage of captured solids, reducing backwash volumes while maintaining an operational head loss. Woven mesh or microscreen type media with no filtration depth will not be approved.
- C. Each filter unit shall have a total of 53.8 square feet of minimum effective submerged filtration area.
- D. Each cloth disk assembly shall have a minimum of 8.97 square feet of effective submerged filtration area. Effective submerged filtration area is defined as only the portion of the disk that is submerged during filtration. Any disk area that is not submerged shall not be considered as an effective area. Each disk shall be divided into no more than six (6) segments and shall be easily removable for service.
- E. If the wet weight of the filter disk segment is greater than 50 pounds, a lifting mechanism shall be provided.
- F. Individual pile fibers shall be held in place by a support backing integral to the media. To facilitate proper flow of backwash water through the cloth, the medium's back side shall be of open construction consisting of 10% open area at least 50 times larger than the nominal filtration media in any direction. Media that

uses sewn in support structures, which have the potential to prevent free flow through the media, shall not be allowed.

- G. Cloth strength is critical to ensure long term performance of the media. Cloth media breaking strength and elongation shall be tested in accordance with ASTM Standard D5035 2R-E method by an ISO certified laboratory specializing in textile testing. Breaking strength shall be in excess of 200 lbf (890 N) in the warp and the weft direction. Elongation shall be less than 10% at 60 lbf (270 N) in the warp and the weft direction. Test reports shall be provided with submittals to demonstrate compliance with this requirement.
- H. To avoid excessive media movement, deformation and folding during backwash, the maximum distance between cloth restraints must not exceed 36 inches.

2.07 FILTER HYDRAULICS

- A. During filtration, the filter unit shall operate in a static condition with no moving parts. The filter system shall provide for the collection of filtered solids on the outside of the cloth media surface to allow for the direct contact of cleaning systems. Filtered effluent shall be used for backwashing. The filter flow path shall be from the outside of the disk to the inside. Systems with flow paths from the inside to the outside of the disk that collect filtered solids and debris on the interior surfaces of the disk will not be approved.
- B. Only media area below the effluent weir elevation will be considered in the filtration area calculation since this is the only area that is submerged and available for filtration 100% of the time.
- C. Submittal information shall include calculations that verify the effective filtration surface area. Media surface fused directly to support structure such that water cannot pass through the media shall not be included in these calculations.
- D. The operator shall be able to bring a drained filter online by simply opening the influent isolation device. If the filter design is such that it must be filled with water before the influent isolation device is opened to prevent damage to the filter media, an automated process that sequentially brings the filter back online with a single switch shall be provided to prevent accidental media damage. The automated process shall activate a minimum 6" diameter motorized valve to fill the filter with effluent or other clean water source in not more than five minutes, verify that the filter is full, and open the motorized influent isolation device.

- E. Because of the frequency of the backwash and misting associated with spray systems, designs that utilize high pressure spray or a moving vacuum head as the sole means of solids removal will not be approved.
- F. Submittals shall include a hydraulic profile through the filter showing the following:
 - Influent weir length
 - Influent weir elevation
 - Influent weir nappe at design and peak flow
 - Effluent weir length
 - Effluent weir elevation
 - Effluent weir nappe at design and peak flow

2.08 BACKWASH SYSTEM

- A. The backwash function shall incorporate a pump that draws filter effluent through the cloth as the media rotates past the fixed backwash shoe, thereby removing accumulated solids from the cloth surface. Each disk shall be cleaned by a minimum of two (2) backwash shoes, one on each side. The backwash shoes shall remain in a fixed position. Springs shall be used to maintain the proper tensioning of the backwash shoe against the media surface.
- B. The backwash system shall include 304 stainless steel backwash shoe supports with 316 stainless steel springs, UHMW backwash shoes, reinforced PVC flexible hose with stainless steel hose clamps, 304 stainless steel backwash manifold, and PVC sludge collection manifold.
- C. The backwash shoe shall be in direct contact with the cloth to ensure effective media cleaning. Systems utilizing media cleaning mechanisms that do not contact the filter media will not be approved. Neither the cloth / support assemblies nor the backwash shoes shall include any gridwork overlays or other interferences that would prevent direct contact of the backwash shoes with the cloth fibers.

2.09 BACKWASH/WASTE PUMP ASSEMBLIES

- A. Each backwash/waste pump assembly shall include one (1) backwash/waste pump, valves, and gauges. In the external piping shall be backwash and solids waste valves, 3" recirculation ball valves, 3" manually operated flow control gate valve for each pump, vacuum gauges, and pressure gauges.

- B. The backwash/waste pumps shall be shipped loose for field installation by the installation contractor. Backwash piping between the filter basin and pumps as well as piping following the pumps shall be supplied by the installation contractor. The installing contractor shall supply unions or flanges for service, and interconnecting wiring.
- C. The backwash/waste pumps shall be a Gorman Rupp model 12B20-B or approved equal, externally mounted centrifugal pump. Pump shall be provided with a 2 HP, 460 volt, 3 phase, 60 Hz motor and operate at 1750 RPM. Pump shall be rated for 130 gpm at 23.2 ft TDH with 12.2 ft allowable discharge head after losses in internal filter piping have been accounted for. Motor shall be Baldor, Teco, Weg or approved equal. Each pump shall be provided with a painted 304 stainless steel support stand with wedge anchors. Backwashing shall be initiated by tank water level, timer, or manually through the operator interface. Operator shall have the ability to specify backwash time interval elapses through the operator interface. The backwash water shall be pressurized by the filter's backwash/waste pump for discharging from the filter system. Systems utilizing non-pressurized backwash flow will not be accepted. Backwash pumps using a belt drive shall not be acceptable due to routine tensioning and other maintenance requirements.
- D. Pump manually operated threaded gate valve shall be class 125 bronze with screw in bonnet, non-rising stem, and solid wedge. Valve shall conform to MSS SP-80 and shall be Nibco or approved equal. The 2 inch threaded three-way ball valves shall be a two-piece, full port, with a brass body. Valves and shall be Nibco or approved equal.
- E. The vacuum gauges shall have a minimum 2.5" dial with all stainless-steel welded construction, 0-30" Hg vacuum range, liquid filled, 1/4" NPT process connection, 316 stainless steel bourdon tube and tip material, and bronze socket material, Ashcroft or approved equal.
- F. The pressure gauges shall have a 2.5" dial with a black painted steel case, 0-15 psi, heat resistant polycarbonate window, 1/4" NPT process connection, "C" shaped bronze bourdon tube, and brass socket material, Ashcroft or approved equal.
- G. Filtering shall not be interrupted during normal backwashing and solids waste discharge.

2.10 VALVES

- A. Each pair of filters shall include two 2" backwash valve. Valves shall be 3-piece, grooved end, ASTM A351 Grade CF8M stainless steel body, 316 stainless steel ball

and stem, fullport, with a 115 volt, single phase, 60 Hz, open / close service electric actuator. Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork), Nibco, or approved equal. Valve actuator shall include a compartment heater and limit switch feedback to the microprocessor in both the open and closed positions.

- B. Because of fouling that can be caused by stringy material, non-full port valves such as butterfly valves or plastic valves will not be approved.
- C. Each filter shall include one (1), 2" solids waste valve. Valve shall be 3-piece, grooved end, ASTM A351 Grade CF8M stainless steel body, 316 stainless steel ball and stem, fullport, with a 115 volt, single phase, 60 Hz, open / close service electric actuator. Valve / actuator combination shall be TCI / RCI (RCI, a division of Rotork), Nibco, or approved equal. Valve actuator shall include a compartment heater and limit switch feedback to the microprocessor in both the open and closed positions.
- D. Each filter shall include one (1) 12" influent valve. The valve shall be a butterfly valve with a single-phase electric actuator. The valve/actuator combination shall be manufactured by Del-Tech, Nibco, RCI, or approved equal.
- E. Each filter shall include a solids waste removal system consisting of perforated manifold, mounted on the floor of the filter basin. The manifold shall be designed to siphon settled solids for waste discharge through the backwash/waste pump. The operation of the solids waste removal system shall be automatic with user adjustable intervals and duration through the operator interface. Filters that are designed without a solids waste removal system will not be approved.

2.11 INFLUENT VALVE

- A. Each filter shall include one influent valve. Valve shall be 12" lugged style influent butterfly valve with a ductile iron body, aluminum bronze disk, stainless steel shaft and Viton seat. Valve shall be Nibco, Del-Tech, ABZ, or approved equal and to be provided by the manufacturer.
- B. Each valve shall be provided assembled and tested with an RCI (RCI, a division of Rotork), 115 volt, single phase, open/close service electric actuator. Valve actuator shall include a compartment heater and limit switch feedback to the microprocessor in both the open and closed positions.

2.12 EFFLUENT WEIR BOX

- A. Each filter shall include a 304 stainless steel effluent weir box. Filter systems without effluent weir box will not be accepted.

2.13 PRESSURE TRANSDUCER

- A. Furnish submersible pressure transducer unit(s) constructed of stainless-steel for each basin as specified herein. Transducer shall utilize a diffused silicone semiconductor sensor protected by an integral stainless-steel diaphragm with seal fluid. Transducer output shall be a 4-20 mA signal. Electrical connection shall be 2-wire, loop powered through a shielded integral cable comprised of 22 AWG conductors and separate drain wire.

Quantity:	1 per basin (2 total)
Model:	Keller Levelrat or approved equal

Mounting Materials of Construction

Support Pipe:	304 SS
Supports:	304 SS
Anchors:	304 SS
Tank Connection:	304 SS Adhesive Anchors

- B. Transducers shall be suspended on a removable mounting pipe assembly. Pipe, supports, and anchors shall be provided. Field attachment of the pipe and supports to the basin shall be the responsibility of the installing contractor. A moisture excluding aneroid bellows shall be supplied loose for installation in the junction box/ disconnect. Attachment and supply of the junction box/disconnect at the basin wall shall be the responsibility of the installing contractor.
- C. Field attachment of the pressure transducer mounting brackets to the tank shall be the responsibility of the installing contractor.

2.14 FLOAT SWITCH

- A. A float switch shall be furnished to indicate emerging overflow level. The float switch shall be Anchor Scientific Model GSI 40NONC-STO or approved equal. The float shall contain a non-mercury switch, chemical resistant polypropylene casing hermetically sealed and a PVC #18 AWG three conductor cable. Switch rating shall be minimum 4.5 amps non-inductive at 120 VAC.

2.15 VACUUM TRANSMITTER

- A. The vacuum transmitter shall have stainless steel wetted parts and provide a 4-20 mA signal over a range of 1 standard atmosphere to full vacuum. Transmitter shall be an IFM Effector PX series or approved equal.

2.16 DISK MISC/SPARE PARTS

- Frame and cloth assemblies (2)
- Backwash/solids waste valve and actuator (1)
- Viton V-ring effluent port/center tube seal (1)

2.17 TURBIDITY MONITORING SYSTEM INSTALLATION

- A. Provide a total of 4 turbidity meter system(s), one common influent, one dedicated effluent (per filter), and one common effluent.
- B. One (1) Turbidity meter assembly shall consist of a turbidity sensor, a Hach SC4500 controller or approved equal and display module, a calibration start-up kit, and a turbidity mounting plate.
- C. The additional two (2) turbidity meter assemblies shall consist of NEMA 4X fiberglass enclosures, turbidity sensors, Hach SC4500 controller or approved equal and display modules, calibration start-up kits, and sensor feed pumps.
- D. The system shall also include a remote display that can be used for continuous readout of measurement values from the sensor. Turbidimeter and display shall be Hach or approved equal.
- E. System range of operation shall be 0 to 1000 NTU with an accuracy of +/- 2% of reading from 0-40 NTU and +/- 10% of reading from 40-1000 NTU. Operating temperature shall be 32°F to 122°F and the sampling temperature shall be 35°F to 140°F. Sample inlet and outlet connection shall be 1/4" OD tubing.

2.18 CONTROL SYSTEM

- A. There shall be two (2) control panels provided for this project.
- B. The automatic and manual controls for operation of the filtration system shall be furnished fully assembled, wired, and pre-programmed in a UL 508A Certified Industrial Control Panel. Controls shall be provided to control or monitor equipment as described in the contract drawings. The control system shall include the following control components and practices.

2.19 CONTROL PANEL WIRING AND ASSEMBLY

- A. All control enclosures shall be custom assembled and wired in an Underwriters Laboratories (UL) certified cabinet shop using quality materials and labor. Short circuit rating of control enclosure shall be 5 kA RMS symmetrical @ 480VAC maximum.
- B. All two (2) control panels shall consist of NEMA 4X 304 stainless steel enclosures, air conditioners, control panel sun shields, circuit breakers with handles, transformers, fuses and fuse blocks, line filters, GFI convenience outlets, control relays, selector switches, indicating pilot lights, push buttons, MicroLogix 1400 PLCs, ethernet switches, operator interfaces, operator interface sun shields, power supplies, motor starters, terminal blocks, and UL labels.
- C. All control panel single conductor wire shall be 16 AWG multi-strand machine tool wire (MTW) minimum, with PVC insulation.
- D. Wire colors are as follows:
- | | | |
|-----------------------------|---|--------------------------|
| 208 VAC or higher | - | Black |
| 120 VAC control power | - | Red |
| Neutral | - | White |
| Ground | - | Green |
| AC Power from remote source | - | Yellow |
| Neutral from remote source | - | White with Yellow Stripe |
| 24 VDC (+) | - | Blue |
| 24 VDC (-) | - | White with Blue Stripe |
| VDC (+) from remote source | - | Orange |
| VDC (-) from remote source | - | White with Orange Stripe |
| Intrinsically Safe | - | Light Blue |
- E. All wires shall be clearly marked with an identification number consistent with the wiring schematic drawing. Wire markers shall be a thermal transfer printable type. The material shall be self-laminating vinyl. Labels shall be Brady THT-9-427-10 or approved equal.
- F. Wiring inside the control panel shall be run in PVC wiring duct rated for continuous temperatures up to 122° F (50°C). Devices mounted in the enclosure door shall have wires run in spiral wrap to avoid pinch points when opening and closing the door.

- G. Control components mounted internal and external to the enclosure shall be mounted with stainless steel hardware and clearly labeled with a plastic identification nametag. The tag shall be white with black lettering.

2.20 CONTROL PANEL QUALITY ASSURANCE

- A. All Control panels shall be UL certified. Testing by manufacturer's electrical engineer prior to releasing for shipment shall be completed. Testing shall consist of the following:
 - 1. Point to point testing of all wiring prior to application of power.
 - 2. Intended supply voltage shall be applied to the enclosure.
 - 3. All components shall be tested for proper operation and calibration.
 - 4. The PLC and operator interface program shall be loaded and functionally checked.
 - 5. All components shall be checked to confirm proper mounting specifications have been followed.
 - 6. Enclosure shall be inspected for defects and repaired if necessary.
 - 7. All labeling of wires and devices are correct, properly installed, and clean.
- B. The manufacturer shall finalize the factory checkout by completing a control panel checklist to document all testing completed above. This document must be signed by Engineering, prior to release for shipment.
- C. Upon the successful completion of the control testing of the enclosure assembly, all applicable documentation (i.e., finalized drawing set, signed control checklist cover page, device data sheets, etc.) shall be placed in the drawing pocket of the enclosure.

2.21 PVC NON-METALLIC CONDUIT

- A. All wiring of pre-assembled and mounted external electrical components to control panels or junction boxes shall be protected with rigid PVC nonmetallic schedule 40 conduit and fittings. Conduit shall be sized for adequate spare capacity. All conduit unions and fittings shall be solvent cemented in accordance with instructions from the manufacturer. All conduits shall be supported at maximum 3-foot intervals.
- B. Conduit shall be impact, corrosion, and sunlight resistant and be rated for a maximum ambient temperature of 122°F (50°C). It shall be rated for use with 194°F (90°C) conductors and shall be UL Listed for exposed or outdoor usage. Conduit shall be manufactured by Carlon or approved equal.

2.22 CONTROL ENCLOSURE

- A. The automatic controls shall be provided in a UL listed, NEMA Type 4X 304 stainless steel (14 gauge) wall mounted enclosure that provides insulation and protection for electrical controls and components from highly corrosive environments indoors and outdoors. Enclosure shall include a seamless foam-in-place gasket to assure watertight and dust-tight seal. An internal 3-point latch and 316SS padlocking POWERGLIDE® handle shall be provided. Enclosures shall be unpainted, with a smooth #4 brushed finish. Enclosure shall include a painted white mild steel (12 gauge) sub-panel mounted with collar studs. Enclosure shall be manufactured by Hoffman or approved equal.
- B. The control enclosure shall be mounted remotely.

2.23 ENCLOSURE SUN SHIELD

- A. A 304 10 gauge stainless steel sun shield shall be included. A sunshield shall overhang the front of the panel a minimum of 10".
- B. The control panel will be factory installed, wired, tested then removed for shipping. The installing contractor shall mount the control panel and re-connect the wiring.

2.24 CORROSION INHIBITOR

- A. Each control enclosure assembly shall be provided with corrosion inhibitors to protect interior electrical components from damage caused by high humidity. The corrosion inhibitors shall be installed prior to shipment to provide protection during shipment and storage of the enclosure.
- B. The corrosion inhibitor shall be Hoffman AHCI5E or approved equal.

2.25 AIR CONDITIONER

- A. A thermostat-controlled air conditioner with noise suppression shall be supplied to protect control components mounted inside the enclosure from high temperatures, humidity, and ambient air contaminants. The air conditioner shall be constructed of brushed finish stainless steel 304 material and provide NEMA 4X Type protection from outdoor and hose-down applications. The air conditioner unit shall use CFC-free or environmentally safe refrigerant that is universally

accepted. The air conditioner shall be manufactured by Hoffman or approved equal.

2.26 MAIN DISCONNECT CIRCUIT BREAKER

- A. A UL listed; automatic molded case 3-pole disconnect breaker shall be provided in the control enclosure(s). The primary function of the disconnect switch shall be to provide a means to manually open a circuit and automatically open a circuit under overload or short circuit conditions. The disconnect breaker shall have a door mounted operating mechanism with trip indication. Power distribution connectors shall be mounted integrally to the circuit breaker for multiple load connections. Integral connectors shall be provided. The disconnect circuit breaker shall be a Square D/FAL, HDL, JDL, LAL, MGL, PGL or approved equal.

2.27 MOTOR STARTER

- A. A full voltage non-reversing Integrated Motor Starter-Controller shall be provided for motor applications up to 15 kW. Each starter shall provide control, protection, and monitoring functions for the motor. The starter shall be IEC rated and shall have certifications according to UL and CSA standards and shall bear the CE marking. The starter shall have a maximum rated operational voltage of 690V and provide a 42kA @ 480 VAC rated breaking capacity on short circuit. The starter shall have a mechanical durability of 15 million operations. The starter shall provide short circuit trip, thermal overload trip with selectable tripping class, under current trip and phase imbalance trip.
- B. A full voltage non-reversing IEC Style motor starter shall be provided for motor applications over 15 kW. Each starter shall consist of a circuit breaker, contactor, and overload relay. The starter shall be IEC rated and shall have certifications according to UL and CSA standards and shall bear the CE marking. The starter shall have a maximum rated operational voltage of 690V and provide a minimum 18 kA @ 480VAC and 25 kA @ 240 VAC interrupt rating on short circuit when used in combination with a PowerPact circuit breaker. The starter shall have a mechanical durability of 15 million operations. The solid-state overload relay shall have class 10 tripping characteristics with trip current adjustment, phase loss and unbalance protection.

2.28 TRANSFORMER

- A. A step-down multi-tap transformer shall be supplied when there is a necessity to reduce incoming 3-phase power to 120 VAC single-phase. The transformer power wire connections (incoming and outgoing) shall be protected with a finger-safe

cover to protect against accidental contact. Primary and secondary fuse protection shall be provided. Transformer shall be UL listed and of continuous wound construction with vacuum impregnated with non-hygroscopic thermosetting varnish. Transformer shall be Square D 9070T or approved equal.

2.29 TRANSFORMER PRIMARY AND SECONDARY FUSE

- A. Properly rated fuses and fuse blocks shall be provided for primary and secondary protection of the transformer. Each fuse shall be equipped with a thermoplastic cover to protect against accidental contact. Clip style fuse block shall be rated up to 600 VAC and 100 amps, dual element, time delay fuses shall be rated up to 600 VAC. Fuse blocks and fuses shall be UL listed. Fuses shall be Littelfuse Class CC or approved equal. Fuse blocks and fuse covers shall be manufactured by Marathon or approved equal.

2.30 CIRCUIT BREAKER

- A. All single-phase branch or supplementary circuits shall be protected with a single-pole, C-Curve rated circuit breaker. Circuit breakers shall be rated for 240 VAC maximum, 50/60 Hz and UL 489 listed. Supplementary and branch protection circuit breakers shall be Merlin Gerin Multi 9 or approved equal.

2.31 FUSE

- A. Properly rated fuses and fuse holders shall be provided for protection of individual control devices (discrete and analog signals) mounted outside of the enclosure. Each fuse shall be housed in a hinged type fuse block to protect against contact with the fuse. Fuses shall be rated up to 250 VAC and be Littelfuse or approved equal. Fuse holders for discrete devices shall be rated to 600 VAC and 30 Amps. Fuse holders for analog devices shall be rated to 300 VAC and 15 Amps. Fuse holders shall be Allen Bradley 1492 or approved equal.

2.32 OPERATOR DEVICE

- A. Operator devices (pushbuttons and selector switches) shall be mounted through the control enclosure door for manual operation of the filter. Transformer type push-to-test pilot lights and illuminated pushbuttons shall be provided for indication of an operation status. Lights shall be a 6 VAC incandescent type lamp. Color coding shall be applied as required and is as follows:

Amber	-	Alarm active, caution
Green	-	Valve open, motor running

Red	-	Valve closed
White	-	Information

- B. All operator devices shall be UL Listed, 30.5mm style, NEMA Type 4X rated, oil and watertight with finger safeguards located on the contact blocks to prevent accidental contact with wire connections. Operator device function shall be identified with an engraved white Gravoply nameplate with black letters. Operator devices shall be Allen-Bradley 800H, Square D 9001, or approved equal.

2.33 HIGH FREQUENCY NOISE FILTER

- A. A UL listed active tracking filter shall be provided to protect the PLC and HMI power feeds from high-frequency noise and low-energy transients. It shall be designed for a single-phase input voltage of 120/240VAC operating at 47 to 63 Hz. The unit shall reduce normal mode transients to plus or minus 2 volts, provide surge capacity of 45,000 amps and protect in all modes (Line to neutral, line to ground and neutral to ground). The noise filter shall be an Islatrol IC+ or approved equal.

2.34 GROUND FAULT DUPLEX RECEPTACLE

- A. A UL listed ground fault circuit interrupter (GFCI) duplex receptacle shall be provided within the panel for instrument (e.g., programming terminal, modem, etc.) use only. The receptacle shall be protected with a 5 Amp circuit breaker. The receptacle shall carry a 20A / 120VAC rating. The electro-mechanical circuit interrupter shall be double-pole and trip free (GFCI protection and shall not be overridden by holding reset button). Built-in transient suppression shall protect GFCI's internal circuitry from voltage transients. Receptacle shall be Hubbell DRUBGFI20 or approved equal.

2.35 24 VOLT DC POWER SUPPLY

- A. A UL listed, industrial grade, compact power supply shall be supplied to provide 24 VDC power to such rated components. The power supply shall be DIN rail mounted and functional with input voltage of 100 to 240 VAC (single-phase) incoming control power. The power supply shall have a green LED which shall be illuminated when output voltage is "OK". The power supply shall be an Allen Bradley 1606 or approved equal.

2.36 CONTROL RELAY

- A. UL listed control relays for general control purposes shall be supplied with a pilot light to indicate when the coil is in an energized state. The relay socket shall be panel or DIN rail mounted inside the enclosure. The relays shall provide the following ratings: 120VAC coil, 10A contact rating (thermal), 250 VAC insulation rating, and 5 million mechanical life cycles. Relays shall be Allen Bradley 700-HK, Square D, or approved equal.

2.37 TERMINAL BLOCK

- A. Standard feed-through screw terminal blocks, DIN rail mounted, shall be supplied for all point-to-point wiring connections. All terminals shall be numbered per the wiring schematic with printed markers. Terminals shall carry a 600V AC/DC voltage rating. Terminal blocks shall be Allen-Bradley 1492-J4 (35A max) and 1492-J16 (85A max) or approved equal.

2.38 PROGRAMMABLE LOGIC CONTROLLER

- A. Automatic operation of the Filter shall be controlled through a programmable logic controller (PLC) mounted inside the main control panel. The PLC components shall consist of a power supply, CPU, discrete input and output modules and analog input and output modules. The processor unit shall include built-in USB and two (2) Ethernet IP communication ports. All input and output points supplied (including unused) shall be wired to terminal blocks. Processor design characteristics shall include: 1.0MB user memory size, real-time clock and calendar, battery backed RAM and an operating temperature range between 32 °F and 140°F. The PLC processor shall be an Allen-Bradley CompactLogix 1769-L30ER or approved equal.

2.39 BASE UNIT

- A. The base unit shall house embedded inputs, outputs, power supply, and communication (Ethernet, RS-232, RS-485) ports. The base unit shall also provide the interface to expansion I/O when required by an application.
- B. The power supply input range shall have an input voltage range of 85-265 / 170-265 VAC, 47-63 Hz, maximum inrush current of 30 amps, backplane output current of 4 amps @ 5V or 2 amps @ 24V, internal fuse protection, ambient operating temperature of 32°F to 140°F, Class I, Division 2 hazardous location certified, UL Listed
- C. The embedded discrete inputs shall have an operating voltage of 79 to 132 VAC at 47 to 63 Hz, backplane current draw at 5VDC = 115mA , off-state current 2.5mA

maximum, maximum inrush current 250mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

- D. The discrete outputs shall have an operating voltage of 5 to 265 VAC at 47 to 63 Hz / 5 to 125 VDC, backplane current draw at 5 VDC = 205mA , at 24VDC = 180mA, off-state current leakage is 1.0mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.
- E. The analog inputs shall have backplane current draw at 5 VDC = 120mA, at 24VDC = 70mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.
- F. The analog outputs shall have backplane current draw at 5 VDC = 120mA, at 24VDC = 170mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.
- G. The base unit shall have one (1) RS-232-C serial port, one (1) RS-485 serial port, and one (1) RJ-45 port which supports 10/100 Mbps Ethernet/IP. These ports shall be capable of local and remote programming, troubleshooting, and data manipulation.

2.40 DIGITAL EXPANSION INPUT MODULE

- A. The expansion digital input module shall have an operating voltage of 79 to 132V AC at 47 to 63 Hz. The module shall have an LED status indication of each point. The digital expansion input module shall be an Allen Bradley 1762-IA8 or approved equal.

2.41 MEMORY MODULE

- A. The controller shall be shipped with a memory module for user program and data backup. The memory module shall be an Allen Bradley 1766-MM1 or approved equal.

2.42 ETHERNET SWITCH

- A. An Ethernet switch shall be provided inside the control enclosure to provide connectivity between the PLC, operator interface, and plant networking. The switch shall support both 10 and 100 Mbit/s operation and provide for store and forward switching mode. The switch shall have five (5) 10/100Base-T ports with RJ-45 sockets and shall support auto-crossing, auto-negotiation, and auto-polarity. Maximum distance for twisted pair cable shall be 100m.

- B. The unit shall be DIN rail mounted and require 24VDC/100mA power. Diagnostic LEDs for power, link status, data, and data rate shall be provided. The Ethernet switch shall be UL listed and manufactured by Hirschmann/Spider 5TX or approved equal.

2.43 HUMAN MACHINE INTERFACE OVERVIEW

- A. The control system shall be equipped with a UL listed operator interface that provides control display screens. These screens shall be used by the operator to monitor and control filter status, setpoint and alarm information.
- B. The Interface shall allow the Operator access to adjust the following operating parameters:
 - Backwash interval, Backwash duration, Solids Waste interval, Solids Waste duration Number of Backwashes between Solids Waste intervals.
- C. The operator interface shall provide information to assist the Operator in assessing the status of the filter system. The interface screen shall display, at minimum, the following parameters:
 - Water level in the filter, Time since last Backwash, Time since last Solids Waste withdrawal, Elapsed time on the Drive Motor, Elapsed time on the Backwash Pump(s), Total Backwash time and cycles, Total Solids Waste withdrawal time and cycles.
- D. The operator interface shall allow the Operator to:
 - Initiate Backwash
 - Control all electric actuated valves
- E. The interface shall display the alarm history. The alarm history shall include the time and date of the most recent 25 alarms along with the description of the alarm.
- F. The interface shall also display current alarms, including the date, time, and a description of the alarm.
- G. As a diagnostic aid to the Operator, the interface shall display the time between Backwashes for the most recent 40 Backwashes.

2.44 HUMAN MACHINE INTERFACE

- A. The operator interface shall be a NEMA Type 12, 13, 4X rated, 6.5" diagonal, color touchscreen display with Ethernet and serial communications. The interface shall be a liquid crystal display (LCD). The display type shall be color active matrix thin-film transistor (TFT) with 640 x 480 pixel resolution. The rated operating temperature shall be 32° to 131° F (0° to 55° C). The operator interface shall be an Allen Bradley PanelView Plus 7 Performance 7".

2.45 HUMAN MACHINE INTERFACE SUN SHIELD

- A. A sun shield constructed of 304 stainless steel shall be mounted over the operator interface to provide protection and visibility of operator screens in outdoor applications.

PART 3 – INSTALLATION

3.01 PERFORMANCE TESTING

- A. The Engineer will select one of the Filters for performance testing. The filter shall meet the following performance criteria:
 - 1. Flow
 - a. Average Daily Flow 0.65 MGD per filter
 - 2. Maximum Daily Flow
 - a. 1.3 MGD per filter
 - 3. Influent Total Suspended Solids (TSS) Concentration
 - a. 10 mg/l, Average Daily.
 - b. 15 mg/l, Maximum Daily.
 - 4. Effluent TSS Concentration,
 - a. 5 mg/l at Average Daily Flow and Average Daily TSS.
 - 5. Maximum Solids Loading Rate
 - a. Maximum Solids Loading Rate, 0.87 #/day/sf,
 - b. At no time during the testing should the solids loading to the filter exceed the Maximum Solids Loading Rate.
 - 6. The Performance Test shall include three conditions:
 - a. Two, 24 hour periods at Average Daily Flow, no solids addition.

- i. Within each 24 hour period, one three hour test at Maximum Daily Flow conditions, no solids addition.
- b. One, 3 hour test at Maximum Solids Loading Rate at the Average Daily Flow rate.

3.02 TEST PROTOCOL

- A. The actual plant flow at the time of the testing may not be available to achieve each of the test conditions. Flow to other filters in the system may be throttled to increase the flow to the filter being tested. The Owner shall be responsible for maintaining the flow rate required during the test periods.
- B. Flow through the filter will be calculated using the nappe over the effluent weir. The nappe will be measured using a calibrated pressure transmitter mounted in the effluent chamber. The flow will be logged throughout the test period.
- C. The flow will be calculated using the following formula:

$$\text{Flow (MGD)} = 2.15 * \text{Weir Length (feet)} * \text{Weir Nappe}^{3/2} \text{ (feet)}$$
- D. For conditions requiring solids addition to achieve a specific influent solids concentration, stabilized activated solids waste shall be added to the influent.
- E. Owner shall provide an estimate of the influent and activated solids waste suspended solids concentration the day prior to the performance testing.
- F. The Manufacturer shall use the estimated activated solids waste concentration and influent TSS concentrations to calculate the required activated solids waste feed flow rate to achieve the desired Maximum Solids Loading.
- G. Each Maximum Flow test condition shall be run for a three hour period.
- H. For the Maximum Solids Loading Rate test:
 - Actual flow and load conditions should be recorded at the beginning of the test.
 - Add solids as necessary until Maximum Solids Loading Rate is achieved.
 - Operate at Maximum Solids Loading Rate for 3 hour duration.
 - Record flow and load during testing.
 - For solids addition, activated solids waste samples shall be taken at 10 minute intervals and analyzed for TSS.

- I. Composite samples consisting of a minimum of 4 samples per hour during the test period shall be taken. Samples will be taken upstream of the influent weir (mid-depth) and from the effluent chamber (mid-depth). Composite samples shall be tested for TSS according to the latest edition of Standard Methods for the Examination of Water and Solids Wastewater. Sample analysis shall be conducted by a local certified laboratory facility using personnel and equipment provided by the lab.
- J. The Owner shall furnish all labor, materials, power, water, equipment, lab services, instrumentation, and any other equipment and services necessary for conducting the field performance testing.
- K. The influent flow and influent and effluent TSS data shall be collected and presented by the Manufacturer in a report. The data shall be presented to clearly verify performance compliance.
- L. At a minimum, the report must include:

Average Daily Flow Test (for each day of testing)

- 24 hour flow total
- Influent TSS composite sample concentration
- Effluent TSS composite sample concentration

Maximum Daily Flow Test (for each of the two three hour test periods)

- 3 hour flow total
- Monitor and record any flow bypassing

Maximum Solids Loading Rate (for the one, 3 hour test)

- 3 hour flow total (upon achieving solids concentration necessary for Maximum Solids Loading Rate)
- Calculated Influent Solids concentration based on activated solids waste samples
- Calculated Solids Loading Rate

3.03 ACCEPTANCE

- A. For the Average Daily Flow test conditions,
 - If the influent concentration is below the specified value and the effluent concentration is below the specified value, the test is successful.
 - If the influent concentration is above the specified value and the effluent concentration is below the specified value, the test is successful.

- If the influent concentration is above the specified value and the effluent concentration is above the specified value, no conclusion can be reached, and the test must be re-run.
 - If the influent concentration is below the specified value and the effluent concentration exceeds the specified value, the test is unsuccessful.
 - If either of the two 24 hour tests are unsuccessful, the overall Average Daily Flow test is unsuccessful.
- B. For the Maximum Daily Flow test conditions,
- If the Maximum Daily Flow is passed through the filter without bypassing and the Influent Solids concentration is at or below the Maximum Daily concentration, the test is successful.
 - If the Maximum Daily flow is passed through the filter without bypassing and the Influent Solids concentration is above the Maximum Daily concentration, the test is successful.
 - If the Maximum Daily Flow is not passed through the filter without bypassing and the Influent Solids concentration is at or below the Maximum Daily concentration, the test is unsuccessful.
 - If either of the two (3) hour tests are unsuccessful, the overall Maximum Daily Flow test is unsuccessful.
- C. For the Maximum Solids Loading Rate test conditions, the actual solids concentration results shall be used to calculate the actual solids loading rate.
- If the solids' loading rate is greater than or equal to the specified Maximum Solids Loading and flow does not bypass the filter at any time during the test, the test is successful.
 - If the solids' loading rate is greater than the specified Maximum Solids Loading and any portion of the flow bypasses the filter during the test, the test results are disregarded since the solids loading rate exceeded the design.
 - If the solids' loading rate is less than or equal to the specified Maximum Solids Loading and any portion of the flow bypasses the filter during the test, the test is unsuccessful.
- D. The bypassing of flow during any of the test conditions is not permitted. If bypassing occurs during testing, the test must be restarted. Three by-passing events during the formal test period will constitute an unsuccessful test.
- E. In the event the performance testing is deemed unsuccessful, the Manufacturer shall have the option to modify the filter(s) as necessary to achieve the guaranteed performance. The maximum cumulative liability to the Manufacturer for the modification or supply of additional equipment shall be limited to 100% of the purchase price of the equipment supplied.

END OF SECTION

**SECTION 15570
SBR EQUIPMENT**

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section shall include unloading at the job site, handling, storage and installing of four AquaSBR System including digester and post equalization equipment manufactured by Aqua-Aerobic Systems, Inc., of Rockford, Illinois or approved equal. Contractor shall furnish all labor, materials, equipment, and incidentals required for installation of the system as shown on the drawings and as specified herein. Through the wall spool piping and all external piping shall be provided by the installation contractor.

The system shall include:

1. SBR EQUIPMENT

- 2 10 HP Mixers with Moorings
- 2 2.4 HP Sludge Wasting Pumps
- 3 25 HP Blowers
- 2 Influent Electronically Operated Butterfly Valves
- 2 Decanter Assembly
- 2 6" Air Control Valves
- 2 4-20 mA D.O. signals
- 2 4-20 mA Pressure Transducers
- 2 Level Sensors
- 1 Discharge Pressure Gauge
- 1 Common Alarm
- 4 Retrievable Fine Bubble Diffusers

2. DIGESTER EQUIPMENT

- 2 20 HP Blowers
- 1 7.5 HP Mixers with Moorings
- 2 2.4 HP Sludge Wasting Pumps
- 1 4-20 mA Pressure Transducers
- 1 Level Sensors Assembly
- 1 Fixed Coarse Bubble Diffuser System
- 1 Discharge Pressure Gauge

3. POST SBR EQUIPMENT

- 3 5 HP Transfer Pump
- 1 10 HP Blower
- 1 4-20 mA Pressure Transducer
- 1 Level Sensor
- 1 Discharge Pressure Gauge
- 1 Fixed Coarse Bubble Diffuser System

All motors, pumps, and bearings shall be designed for continuous duty and long operating life in a high humidity atmosphere. All motors and pumps shall be 460 volt, 60 hertz, 3 phase.

- B. Equipment installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the engineer.

1.02 MOTOR COMPLIANCE

- A. Motors shall be in compliance with the Energy Independence and Security Act of 2007 (EISA 2007).
 - 1. All three phase motors and components shall be 460 volt, 60 hertz.
 - 2. All single-phase components shall be 115 volt, 60 hertz.

1.03 INSTALLATION

- A. The installation of the equipment furnished by the manufacturer shall be the responsibility of the installing contractor in accordance with all requirements of the contract documents.

1.04 SPECIFICATION PRECEDENCE

- A. The specifications for equipment and controls under this section supersede specifications for equipment and controls specified elsewhere in the contract documents and drawings. Purchased components such as gear reducers, pumps, motors, valves, and actuators shall be provided with standard recommended manufacturers paint, unless otherwise specified within this section.
- B. The SBR area electrical classification shall be non-classified. Motors within the basin shall be rated for a temperature code T2A (280 Deg.C).

1.05 ACCEPTABLE MANUFACTURERS

- A. These specifications and accompanying drawings are based upon the use of the AquaSBR® System and AquaDisk® System manufactured by Aqua-Aerobic Systems, Inc., 6306 North Alpine Road, Loves Park, IL, 61111, phone no. 815/654-2501, fax no. 815/654-2508.

1.06 SERVICE

- A. The equipment manufacturer shall furnish the services of a factory trained representative for a maximum of 3 trip(s) and 12 eight-hour days at the jobsite to inspect the installing contractor's equipment installation, supervise the initial operation of the equipment, instruct the plant operating personnel in proper operation and maintenance, and provide process assistance.
- B. The equipment manufacturer shall furnish the services of a factory trained representative for the Cloth Media Filter a maximum of 1 trip and 4 eight-hour days at the jobsite to inspect the installing contractor's equipment installation, supervise the initial operation of the equipment, instruct the plant operating personnel in proper operation and maintenance, and provide process assistance.
- C. If additional service is required due to the mechanisms not being fully operational at the time of service requested by the contractor, the additional service days will be at the contractor's expense.
- D. The selected SBR manufacturer shall have a free troubleshooting help line available 24 hours a day, 365 days per year for the life of the plant. The line shall connect to a live service technician who shall have the capability of connecting to the control panel via internet, with the operator's permission.

1.07 PERFORMANCE GUARANTEE

- A. The single source supplier of the SBR and Cloth Media Filter System equipment shall provide a written Process Performance Guarantee to guarantee the SBR and Cloth Media Filter System will meet the effluent criteria specified under Section TBD of this specification section. The guarantee period shall commence at time of plant start-up, once the system has reached stable operation (or within six months of equipment shipment whichever first shall occur), and shall be in force for a period of one year. The Process Performance Guarantee shall be submitted as part of the engineer's submittal data.

1.08 SUBMITTAL REQUIREMENTS

A. Complete shop and installation drawings of all materials and equipment furnished by the City under this Section shall be submitted to the Contractor for approval in accordance with the bid document. Submittals shall include, but not be limited to, the following:

1. Detailed drawings showing all of the details of construction pertaining to the filter screen system. This shall include installation details of all equipment associated with this system.
2. Detailed schematic and layout drawings and a description/narrative explaining the operation of all control panels.
3. All interconnections and interface requirements, dimensions, and locations of all major elements of the filter system including critical clearance requirements.
4. Basis of design, including background data, calculations, operational plant data and other information showing the development of the proposed design.
5. The startup/performance testing report and manufacturer's certification as required in Part 3.

1.09 CODES AND STANDARDS

A. Equipment specified herein shall meet or exceed the applicable sections of the following codes and standards authorities.

1. AGMA, American Gear Manufacturers Association.
2. ASME, American Society of Mechanical Engineers.
3. ASTM, American Society of Testing and Materials.
4. ANSI, American National Standards Institute.
5. IEEE, Institute of Electrical and Electronics Engineers
6. NEC, National Electrical Code.
7. U.L., Underwriters Laboratories.
8. AWS, American Welding Society

1.10 SYSTEM STARTUP

- A. It is the responsibility of the contractor to coordinate with the filter system supplier/manufacture for startup services upon completion of the system's installation. The following activities shall be provided by the manufacturer.
- B. Manufacturer's Representative
 - 1. The manufacturer's representative shall inspect the construction plans and the installation, and recommend any required modifications, additions, or other changes required to allow the manufacturer to certify that the complete installation is appropriate and will operate as expected and intended.
 - 2. The manufacturer's representative shall instruct the Owner's and Engineer's personnel on the operation and maintenance of the filter system. The instruction shall include both classroom and field training on proper operation and maintenance procedures, accompanied by complete demonstrations.
 - 3. The manufacturer's representative shall supervise the performance testing of the installation.
 - 4. The equipment manufacturer shall furnish the services of a factory trained representative for a maximum of 3 trips and 12 eight-hour days at the jobsite to inspect the installing contractor's equipment installation, supervise the initial operation of the equipment, instruct the plant operating personnel in proper operation and maintenance, and provide process assistance.
 - 5. If additional service is required due to the mechanisms not being fully operational at the time of service requested by the contractor, the additional service days will be at the contractor's expense.
 - 6. The selected manufacturer shall have a free troubleshooting help line available 24 hours a day, 365 days per year for the life cycle of the plant. The line shall connect to a live service technician who shall have the capability of connecting to the control panel via internet, with the operator's permission.

1.11 SBR FUNCTIONAL REQUIREMENT

- A. The SBR shall be capable of treating influent from an in-plant pump station. Design shall be for the following parameters further described in the project description:

0.65 MGD Average Daily Flow
1.30 MGD Maximum Daily Flow
2.0 MGD Peak Hourly Flow

<u>Design Loadings</u>	<u>Influent</u>	<u>Effluent</u>
BOD	200	5
TSS	240	5
NH ₃ -N	20	0.5
Phosphorus	5	1.5

1.12 SYSTEM SOURCE & QUALITY ASSURANCE

- A. The SBR System shall be supplied by a company of good reputation that is regularly engaged in the manufacture and fabrication of SBR wastewater treatment systems. The manufacturer's experience shall include a minimum of ten (10) installations where equipment of similar size and design has been in operation successfully in a similar process for a minimum of five (5) years. As a minimum, the supplier shall be the manufacturer of the following components: mixers, decanters, diffusers, and controls.
- B. The Contractor shall assign full responsibility for the functional operation of all SBR System components to a Single Source Supplier. This Supplier shall be responsible for all engineering necessary in order to select, furnish, inspect the installing contractor's equipment installation and connections, calibrate, and place into operation the SBR System along with all other equipment and accessories as specified herein.

1.13 ELECTRICALLY ACTUATED VALVE QUALITY ASSURANCE

- A. Actuated valves shall be tested to Aqua-Aerobic Systems test protocol or approved equal
- B. prior to shipment. Testing shall consist of the following:
 - 1. Project and nameplate data verification per assembly documentation
 - 2. Limit switch and torque switch setup and cycle test
 - 3. Hydrostatic test (two pressurization cycles) for all plug and butterfly valves

1.14 MIXER QUALITY ASSURANCE

- A. The floating mixer(s) shall be shop inspected and tested prior to shipment. Testing shall consist of the following:

1. Project and nameplate data verification per assembly documentation.
2. Dynamic balancing
3. Final Inspection

1.15 CONTROL PANEL QUALITY ASSURANCE

- A. All Control panels shall be UL certified. Testing by manufacturer's electrical engineer prior to releasing for shipment shall be completed. Testing shall consist of the following:
1. Point to point testing of all wiring prior to application of power.
 2. Intended supply voltage shall be applied to the enclosure.
 3. All components shall be tested for proper operation and calibration.
 4. The PLC and operator interface program shall be loaded and functionally checked.
 5. All components shall be checked to confirm proper mounting specifications have been followed.
 6. Enclosure shall be inspected for defects and repaired if necessary.
 7. All labeling of wires and devices are correct, properly installed and clean.
- B. The manufacturer shall finalize the factory panel checkout by completing a controls checklist to document all testing completed above. This document must be signed by a Professional Electrical Engineer.

PART 2 - PRODUCTS

2.01 SBR STRUCTURE

- A. The system shall be field erected in two basins as shown on the contract drawings:

Basin Quantity 2 (new basins)

Inside Dimensions:

Basin Width:	38 ft.
Basin Length:	56.5 ft.
Volume at HWL:	0.334 MG
Volume at LWL:	0.204 MG

Side Water Depth:

Minimum Operating Level:	12.8 ft. SWD
Maximum Operating Level:	21 ft. SWD
Top of Wall:	26 ft.
Centerline of discharge:	1.0 ft. from LWL

No hydraulic profile modifications shall be permitted.

2.02 INFLUENT PLUG VALVE

- A. Furnish one (1) electrically operated flanged plug valve(s) for each basin to control the influent flow. Due to the risk of effluent violations, systems not including influent valves are not acceptable.

Valve Quantity	1 per SBR basin (2 total)
Valve Size	10 inch
Valve Model	Milliken 601 or approved equal

Actuator	Auma or approved equal
Actuator Power	Three phase
Actuator Type	Open/Close service
Compartment Heater	Yes

Valve Extension	
Extension Material	304 SS Steel

- B. Valves shall be a 125# flanged end connection, ASTM A-126 Class B cast iron body with welded in nickel seat, Viton coated ductile iron plug with 80% port opening, assembled and tested with an SA14.5, 460-volt, three phase, 60 cycle open/close service electric actuator. Valve actuator shall include motor winding protection, manual override, and limit switch feedback in the open and closed position. Actuator(s) include local controls consisting of pushbutton(s), selector switch(es), and light(s). Field wiring and junction/box disconnect shall be provided by the installation contractor.
- C. Each valve shall include a manual override with limited switch feedback to the microprocessor in both the open and closed positions. Field wiring and junction/box disconnect shall be provided by the installation contractor.
- D. Provisions for valve access shall be provided by the installing contractor.

2.03 MIXER (ENDURA® SERIES DDM MIXER OR APPROVED EQUAL)

- A. Furnish one (1) mechanical floating mixer(s) and related equipment accessories as described herein for each basin. Each mixer shall consist of a motor, direct-drive

impeller driven at a constant speed, an integral flotation unit, and impeller volute. The mixer shall incorporate design enhancements that provide for three (3) years without routine maintenance (greasing).

Mixer Quantity	1 per basin (2 total)

Mixer Properties

Zone of Complete Mix	65 ft.
Direct Pumping Rate	7680 GPM
Recirculation Rate	253,000 GPM
MLSS	4500 mg/l or less

Motor

Size	10 HP
RPM	900 RPM
Efficiency	Standard
Mounting Base Materials	304 Stainless-steel

Float

Diameter (Minimum)	84 inches
Shell Material	Fiber Reinforced Polyester Skin (FRP)

Impeller Volute Material	304 Stainless-steel

- B. Each mixer shall meet the requirements summarized above. Complete mix shall be defined as maintaining biological suspension of all mixed liquor suspended solids with the specified MLSS concentration without the introduction of air.

2.04 MIXER DRIVE MOTOR (SBR)

- A. The motor shall be vertical P base design, totally enclosed fan cooled TEFC, and generally rated for severe duty. The motor shall in all cases equal or exceed standard NEMA specifications. A minimum service factor of 1.15 shall be furnished.
- B. The motor winding shall be non-hygroscopic, and insulation shall equal or exceed NEMA Class "F" and rated for a temperature code T2A (280°C). A lip seal shall be provided below the bottom bearing to prevent moisture from penetrating around the motor shaft. A condensate drain shall be located at the lowest point in the lower-end bell housing. Unit shall have a one-piece motor shaft continuous from the top motor bearing, through the lower bearing and down to and through the propeller. The shaft shall be manufactured from 17-4 PH stainless-steel.

- C. Motor bearings shall be regreasable. Sealed bearings are not acceptable. Top bearing shall be shielded on the bottom side only. Bottom bearing shall be open. The top and bottom motor bearings shall be of combined radial and axial thrust type. The lower motor bearing inner brace shall be locked to the motor shaft via a special washer and locking nut arrangement. The shaft shall be threaded just below the lower bearing and shall have a keyway cut into the motor shaft. This key shall accept a tab from the inner diameter of the locking washer, and the locking nut shall have recesses to accept a tab from the outer diameter of the locking washer to prevent the nut from backing off. Snap ring type bearing retainers will not be acceptable.
- D. Submerged motors, jet pumps, submerged gear motors or gearboxes shall not be acceptable.

2.05 MOTOR MOUNTING BASE (SBR)

- A. The motor shall be securely mounted onto a solid base which is integral with the motor base extension. All submersed wetted motor mounting base components shall be constructed of 304 stainless-steel.
- B. The upper portion of the motor mounting base, immediately below the lower motor bearing, shall include two independent acting air seals. The two seals shall be capable of sealing off the flow of air from the suction action of the pumped flow and prevent backflow of liquid during impeller reversal. The lower end of the motor base extension shall be provided with a rotating backflow seal that will prevent grit from being introduced into the anti-deflection insert reservoir but shall allow liquid to contact the shaft. The backflow seal shall not require scheduled lubrication or maintenance.

2.06 FLOATATION (SBR)

- A. Each unit shall be equipped with a modular float with a central float passage of a size to allow installation and removal of the pump impeller. The float shall be foamed full of polyurethane foam of the closed cell type and shall be totally sealed to prevent the foam from being in contact with the external environment.

2.07 IMPELLER (SBR)

- A. The impeller shall be designed to pump the liquid from near the surface and direct it down toward the vessel/basin bottom. The impeller shall be a two-blade marine

type precision casting of 316 or 15/5 stainless-steel and shall be specifically designed for the application intended. It shall be dynamically and hydraulically balanced. The propeller must be attached to the motor shaft with a hardened stainless-steel pin and set screw. Impeller shall be capable of being reversed to cause back flow liquid movement without causing damage to the mixer chassis and without causing up flow liquid damage to the motor bearing and windings. No liquid spray or other liquid leakage upward onto the surface of the motor support surface or flotation chassis will be allowed.

2.08 INTAKE VOLUTE ASSEMBLY

- A. The impeller shall operate in a volute made of 304 stainless-steel plate, minimum 3/16 inch thick.

2.09 VIBRATION

- A. The entire rotating assembly, including the motor rotor, shaft, shaft accessories, and impeller, shall be dynamically balanced within 2.0 mils peak-to-peak horizontal displacement measured at the upper and lower motor bearing. Measurements shall be taken at a frequency equivalent to the motor RPM. Measurements shall be taken with the motor in a vertical, shaft down, position with the entire power section mounted on resilient pads.

2.10 MOORING SYSTEM

- A. The mooring system shall be supplied for each unit consisting of a mooring arm extending from the basin sidewall to the unit. Each unit shall be provided with a mooring system as described below:

Mooring type:	Pivotal
Mooring Point Quantity:	Three (3) per mixer
Cable Mooring	
Cable Material	304 SS
Anchoring Supply	Adhesive Anchors by System Manufacturer
Anchor Material	304 SS
Power Cable Size	
Unit	#12-four Conductor
Space Heater	#12-three Conductor

Thermostat

#12-three Conductor

- B. Field attachment of the mooring assembly to the tank wall shall be the responsibility of the installation contractor.

2.11 MOORING ELECTRICAL POWER CABLE

- A. Each unit shall include power cable wired into the motor conduit box and terminating at the basin wall. Electrical cable shall be supplied with kellems grips at the motor and basin wall terminations. Electrical cable(s) shall be attached with cable ties provided by the equipment supplier. Attachment of the cable and supply of junction box/disconnect at the basin wall shall be the responsibility of the installing contractor.

2.12 DECANTER ASSEMBLY

- A. Furnish floating decanter(s) and related equipment accessories as described herein for each basin. Each decanter shall consist of an integral flotation unit, a stainless-steel movable weir assembly, and an electric motor-driven actuator to open and close the weir. Due to the risk of ragging, spring loaded valves are not an acceptable means to deal the decanter.

Quantity	1 per basin (2 total)
Unit Size	8x7
Performance Requirements	
Maximum allowable water level (HWL)	21 ft.
Minimum allowable water level (LWL)	12.8 ft.
Decant pipe centerline	1 ft. below LWL
Decant rate, as average from HWL to LWL	2,407 GPM
Linear wear actuator	Single phase
Weir actuator closing force	1500 lbs.
Power section material	Painted steel
Junction box rating	NEMA 4X
Power cable(s) required	#14 AWG ten-conductor
Shape	Circular
Material	304 SSDecanter Flo
Reserve Buoyancy	1833 lbs.
Material	Fiberglass
Type	Pipe
Diameter	12 inches
Pylon Quantity	3 per unit
Pylon Diameter	3 inches

Support Quantity	1 per unit
Support Diameter	4 inches
Pylon/Support Material	Galvanized steel schedule 40
Base plate material	Galvanized steel 304 adhesive anchors
Floor Connection	Galvanized steel
Mooring Frame Material	
Discharge Pipe	
Elbow material	304 SS
Pipe Material	304 SS
Flex Joint/Hinge Material	304L SS
Decant Valve	
Valve Size	12 inches
Valve Model	Milliken Fig. 511A or approved equal
Decant Valve Actuator	
Actuator Power	Auma or approved equal
Actuator Type	Single phase
Compartment Heater	Open/close service
Valve Extension	
Extension Material	Yes
	304 SS

- B. Each decanter shall be capable of withdrawing decant fluid from 4-6 inches beneath the liquid surface, regardless of liquid depth, down to the minimum allowable water level specified below. The decant liquid shall be drawn through an adjustable weir opening of 2-6 inches. The weir shall be circular in shape and permit liquid to enter the decanter from the entire 360 degrees without obstruction.

2.13 WEIR ACTUATOR

- A. Weir actuator shall include a reversible electric motor operated linear actuator. The actuator shall be capable of operating with a closing force of 1500 lbs. and shall operate from a 115-volt, single phase, 60 hertz source. Adjustable limit switches shall be included to permit adjustment of the weir opening. A spring shall be included to provide for travel after the weir has closed and provide desired closure pressure. A corrosion resistant removable cover shall be included to provide protection to the actuator and motor during normal operation. The power section is painted steel. #14 AWG ten-conductor power cable shall be provided from the NEMA 4X junction box of the unit to the basin wall. Supply of junction

box/disconnect at the basin wall shall be the responsibility of the installing contractor.

2.14 WEIR

- A. The weir shall be constructed of 304 stainless-steel, be circular in shape, and shall include vortex control baffles permanently affixed to the weir. The weir shall be attached to the actuator through a removable single shaft or linkage which shall also function as the torque restraint.

2.15 FLOTATION (DECANTER)

- A. Each unit shall be equipped with a modular float constructed of fiberglass filled with closed cell polyurethane foam having a minimum 2.0 lbs./ft³ density. Float shall be completely sealed to prevent the foam from being in contact with the external environment. Float shall have 1833 lbs. reserve buoyancy to ensure stability and to provide support flotation required during decanter servicing. A urethane type seal shall be molded into the bottom of the float assembly to receive the decanter weir.

2.16 DECANTER DISCHARGE PIPE

- A. Each decanter shall include a stainless-steel elbow with schedule 10 stainless-steel discharge pipe. Decanters with FRP or PVC discharge pipe are not acceptable. The installing contractor shall provide a 12" valve with hose bib connection on the decant line between the decanter and the decant valve.
- B. Each decanter shall include two stainless-steel flex joints. Flex joints shall be constructed of stainless-steel flanges and 321 stainless-steel bellows. Flex joints shall utilize heavy-duty stainless-steel hinges with over-travel stops and full perimeter welds. Flex joints shall carry a minimum rating per EJMA calculations, the Elastic Joint Manufacturer's Association. Flex joints shall be full port diameter, and not reduce flow area of the nominal pipe size. Flex joints shall be fully crated and provided with shipping bars that immobilize and protect the flex joint prior to final installation. Flex joints constructed of plastic or rubber material are not acceptable.
- C. All piping, supports, gaskets, and hardware beyond the terminating flange of the decant pipe flexible joint shall be supplied by the installing contractor.

2.17 DECANTER RESTRAINED MOORING SYSTEM

- A. Furnished as part of the decanter assembly shall be a mooring frame, which shall permit the assembly to move up and down following the change in liquid level while restrained within the vertical pylons.
- B. Each decanter shall be moored with a restrained mooring system consisting of vertical pylon(s) with base plate and/or supports as specified above. Each pylon/support with base plate shall be attached to the basin floor and filled with concrete by the installing contractor.
- C. Mooring post supports shall be provided for attachment to the basin wall by the installing contractor.

2.18 DECANT FLOW CONTROL VALVE

- A. Furnish one (1) electrically operated butterfly valves for each basin to control the decant rate. Systems not including decant valves are not acceptable.
- B. Valves shall be an AWWA C-504 Class 150B electrically operated decant valves with ANSI Class 125# flanged end ASTM ductile or cast-iron body and disk with a 316 stainless-steel edge, fully lined Viton seat, 304 stainless-steel shaft assembled and tested with an electric actuator as specified above. Valve actuator shall include motor winding protection, manual override, and limit switch feedback in the open and closed position. Actuator(s) include local controls consisting of pushbutton(s), selector switch(es), and light(s). Field wiring and junction/box disconnect shall be provided by the installation contractor.
- C. Provisions for valve access shall be provided by the installation contractor.
- D. Each valve shall include valve stem extension. Intermediate valve supports and hardware required for mounting of the extension shall be provided by the installing contractor.

2.19 RETRIEVABLE FINE BUBBLE AIR DIFFUSER ASSEMBLIES (SBR)

- A. The aeration system shall be a fine bubble diffused air system and shall be a retrievable configuration as shown on the contract drawings. Systems with fixed diffuser configuration or jet aeration are not acceptable. The aeration system shall be as described below:

Airflow per Basin:	599 SCFM
Assembly Quantity:	2 per SBR basin (4 in Total)
Diffuser Rack Size:	25 Duplex tubes

Materials of Construction:

Manifold	304 Stainless-steel
Vertical Air Column	Galvanized steel
Threaded Flange	Galvanized steel
Quick Disconnect Adaptor	316 SS
Track/Beam Assembly	Galvanized steel.
Diffuser Hoist Assembly	Galvanized steel
Valve seat	Viton
End fittings	316 SS
Cam lock adaptor	316 SS

Tank Connection	304 SS adhesive anchors
Valve	3" Manual isolation butterfly

Valve Material:

Body	Cast iron
Seat	Viton
Disk	Stainless-steel
Shaft	One-piece steel

- B. Furnish retrievable air diffuser assemblies for each basin. Each assembly shall consist of membrane diffusers, frame assembly, manifold weldment, vertical air column, track/beam, flexible airline, isolation valve, and lifting mechanism. Duplex diffuser tubes shall be provided for each diffuser rack. The 6" diffuser manifold weldment shall be constructed of stainless-steel. The entire assembly shall be located such that each diffuser centerline is twenty-four (24) inches above the basin floor.
- C. Air diffuser assemblies shall be of tubular, non-clog, fine bubble type with a flexible perforated air release membrane. Disc and panel diffuser designs are not acceptable. The diffuser membrane shall be constructed of Viton rubber and be suitable for continuous or intermittent aeration. Each membrane shall be held in place by two 304 stainless-steel band clamps. The membrane shall include two sheaths of UV inhibitor and compounds designed for resistance to chemical attack, weathering, fatigue, and aging. The diffuser assemblies shall have double backflow prevention to prevent liquid from passing into the aeration header. Backflow prevention shall consist of self-sealing slits and membrane clamping over the circumference of the diffuser support pipe. The membrane exterior surface shall

be smooth as to inhibit biological film growth. The membrane shall be cleanable in place with water from a high-pressure wash. Each diffuser membrane shall be supported over its full length and circumference by a support tube. The tube diffuser shall be of non-buoyant design. Diffusers which are of buoyant design are not acceptable.

- D. Each diffuser shall be fixed to the stainless-steel air distribution manifold via one connection coupling. Each diffuser length shall require one air manifold boring and shall be secured by a mounting saddle/grommet fitting. Each meter of diffuser membrane shall have a minimum effective aeration area of 0.16 square meters. The diffuser design gassing rate shall not exceed 12.0 SCFM per diffuser assembly. The head loss through an individual diffuser shall not exceed 20" @ 6 SCFM. Upon the loss of air pressure, the perforations shall close, and the membrane shall seat tightly over the air supply working as a check valve.
- E. Each diffuser assembly shall include a 3" diameter wire reinforced Viton flexible air line with quick disconnect end fittings, elbow, and quick disconnect adapters as specified above. All air distribution piping, gaskets, and hardware beyond the threaded flange shall be supplied by the installing contractor. The vertical track/beam shall support the lifting mechanism assembly during operation and servicing.
- F. Each assembly shall include a diffuser hoist assembly with base socket to receive a portable electric winch. A total of one (1) portable electric winch shall be provided for the diffuser assemblies. The winch mechanism shall be of sufficient design capacity to raise the diffuser rack assembly to the servicing position. The portable electric winch shall operate from a single phase, electrical supply rated for 12.6 full load amps. The winch shall be provided with a total of 8 feet of electrical cable. Supply of electrical power supply, wiring and junction box for winch shall be the responsibility of the installing contractor.
- G. Each diffuser assembly shall include a 3" diameter manually operated isolation butterfly valve for connection to the main air distribution piping by the installing contractor. Valve gaskets and hardware are to be provided by the installing contractor.
- H. Valve shall be a butterfly valve with cast iron body, seat as specified above, disk and one-piece stainless-steel shaft.
- I. Anchoring the diffuser assemblies to the basin shall be the responsibility of the installation contractor.

2.20 BLOWERS (SBR)

- A. Three phase rotary lobe type, positive displacement blowers as described below with premium efficient, T.E.F.C., Class F insulation, Teco, Siemens, or equal motor shall be furnished. The blowers shall be manifolded for individual and/or combined operation.

Blower Quantity	3
Motor Size	25 HP
Manufacturer	Aerzen
Model Number	GM 10 S DN 80
Airflow Rate	288 SCFM per blower
Maximum Discharge Gauge Pressure	10.7 PSIG
Enclosure:	Painted Steel Acoustic Hood
Discharge Isolation Valve	
Diameter	3" inches
Seat Material	Viton

- B. Each blower assembly shall be complete and mounted on a base weldment with four-corner anti-vibration mountings, designed for direct application on a concrete slab or other solid foundation. Each assembly shall be suitable for shipment as a complete unit, factory assembled (less discharge pipe fittings) as much as possible to facilitate shipping and handling.
- C. Equipment shall include a blower, electric motor, direct drive coupling, inlet package, discharge silencer, discharge check valve, rubber inlet sleeve and discharge connection, pressure relief valve, butterfly discharge isolation valve, and rubber expansion joint.

2.21 DISCHARGE PRESSURE GAUGE (SBR)

- A. Provide a discharge liquid filled pressure gauge to be equivalent to U.S. Gauge, Ashcroft, or approved equal.

Range: 0-15 psig.

Dial: 2 ½", 270 degree scale.

Case: 300 Series stainless-steel.

Accuracy: ±3-2-3% of span (Grade B)

The installing contractor shall provide all air piping from the diffuser termination(s) at the basin(s) to the blowers as shown on the contract drawings. Supply of

electrical wiring and junction box/disconnects shall be the responsibility of the installing contractor.

2.22 AIR CONTROL VALVES

- A. Furnish electrically operated butterfly valves to control the air flow as outlined herein.

Valve Quantity	2 (Shared for all SBR basins)
Valve Size	6 inches
Valve Model	ABZ or approved equal
Connection Type	Lug style
Materials of Construction	
Valve Seat	Viton
Disk	Stainless-steel
Valve actuator	Auma or approved equal
Actuator Power	Single phase
Actuator Type	Open/close service
Compartment Heater	Yes

- B. Furnish electrically operated butterfly valve(s) as specified above to direct the airflow. Valve actuator shall include motor winding protection, manual override, and limit switch feedback in the open and closed position. Actuator(s) include local controls consisting of pushbutton(s), selector switch(es), and light(s). Field wiring and junction/box disconnect shall be provided by the installation contractor.
- C. Provision for valve access shall be provided by the installation contractor.

2.23 SLUDGE WASTING PUMP (SBR)

- A. Furnish submersible non-clog sludge pump(s) for each basin as specified herein. Each pump shall be equipped with a submersible electrical motor connected for three phase operation. Pump housing shall be painted cast iron. Pump shall include an adequate length of multi-conductor chloroprene jacketed type SPC cable suitable for submersible pump applications. The power cable shall also be sized according to NEC and ICEA standards. The pump shall be supplied with a mating cast iron discharge elbow. Each unit shall be fitted with an adequate length of galvanized steel lifting chain of adequate strength to permit raising and lowering the pump.

Pump Quantity:	1 per basin (2 in total)
Pump Function:	Sludge
Motor Size:	2.4 HP
Pump Flow Rate and Required Total Dynamic Head (TDH):	65 GPM at 26 ft. TDH
Discharge Valve Actuator Type:	Manual
Manufacturer:	Milliken or approved equal
Diameters Discharge Connection Elbow:	3 inches
Discharge Pipe:	3 inches
Valve(s):	3 inches
Materials of Construction Lifting Chain:	304 SS
Upper Guide Bars and Brackets:	Galvanized
System Manufacturer Termination Point: Tank Connection	Pump discharge connection elbow 304 SS adhesive anchors

- B. The pump shall be capable of handling raw, unscreened sewage. The discharge connection elbow shall be permanently installed with the discharge piping. The pump shall be automatically connected to the discharge connection elbow when lowered into place and shall be easily removed for inspection or service. There shall be no need for personnel to enter the basin or pump well. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple linear downward motion of the pump.
- C. The upper guide bar bracket shall be provided with each pump. The entire weight of the pumping unit shall follow guide bars into the operating position and pressed tightly against the discharge connection elbow with metal-to-metal contact. No sealing of the discharge interface by means of a diaphragm, O-ring, or other devices shall be acceptable. The pump, with its appurtenances and cable, shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 ft.

- D. Supply of all discharge piping, supports, gaskets, and hardware beyond the flanged connection of the pump discharge connection elbow shall be the responsibility of the installing contractor.
- E. Each pump shall include a "Seal Failure" and "Over Temperature" warning system.
- F. Each pump shall include a discharge valve to control the design transfer flow rate.
- G. Valve shall have a 125# flanged end connection, ASTM A-126 Class B cast iron body with welded in nickel seat, Viton or neoprene coated ductile iron plug. The valve shall be a non-lubricated type with a port area of at least 80% of full pipe size.
- H. Each pump shall include a Nibco F-918-B check valve with cast iron body and bronze disk to prevent backflow.

2.24 PRESSURE TRANSDUCER (SBR AND ANCILLARY BASINS)

- A. Furnish submersible pressure transducer unit(s) constructed of stainless-steel for each basin as specified herein. Transducer shall utilize a diffused silicone semiconductor sensor protected by an integral stainless-steel diaphragm with seal fluid. Transducer output shall be a 4-20 mA signal. Electrical connection shall be 2-wire, loop powered through a shielded integral cable comprised of 22 AWG conductors and separate drain wire.

Quantity:	1 per basin (2 total)
Model:	Keller Levelrat or approved equal
Mounting Materials of Construction	
Support Pipe:	PVC
Supports:	304 SS
Anchors:	304 SS
Tank Connection:	304 SS Adhesive Anchors

- B. Transducers shall be suspended on a removable mounting pipe assembly. Pipe, supports, and anchors shall be provided. Field attachment of the pipe and supports to the basin shall be the responsibility of the installing contractor. A moisture excluding aneroid bellows shall be supplied loose for installation in the junction box/ disconnect. Attachment and supply of the junction box/disconnect at the basin wall shall be the responsibility of the installing contractor.
- C. Field attachment of the pressure transducer mounting brackets to the tank shall be the responsibility of the installing contractor.

2.25 LEVEL SENSORS (SBR)

- A. Furnish one (1) level sensor assembly consisting of a float switch with a smooth, chemical resistant polypropylene casing, and 316 stainless-steel mounting brackets for each basin. Each float switch shall be provided with a three-conductor electrical cable. Electrical cable shall terminate at a junction box/disconnect located at the basin wall. Field wiring and junction box/disconnect shall be provided by the installation contractor.
- B. Field attachment of the level sensor assembly to the tank shall be the responsibility of the installing contractor.

2.26 PROCESS CONTROL INSTRUMENTATION (SBR)

Manufacturer:	ABB or approved equal
Controller	
Quantity:	1 per basin
Model:	AWT440 or approved equal
Maximum Inputs per controller:	2 per controller
Probes:	
DO	
Quantity:	1 per basin
Model:	Aztec ADS420 or approved equal
pH	
Quantity:	1 per basin
Model:	Aztec AP522 or approved equal
Probe Mounting	
Materials of Construction:	304 Stainless-steel

2.27 CONTROLLER (SBR)

- A. The controller will communicate with the main PLC via 4-20 mA signals. The controller will have a NEMA 4X enclosure with corrosion-resistant finish and shall be AC powered from a 100-230VAC power source. Each probe module shall include a sun shield.

2.28 SENSORS (SBR)

- A. Furnish one sensor of each type specified above per basin. Sensors shall be suspended on a removable mounting pipe assembly. Stainless-steel pipes, stainless-steel supports, and stainless-steel anchors shall be provided. Field

attachment of the pipe and supports to the basin shall be the responsibility of the installing contractor. Field wiring, conduit, and installation of cable shall be the responsibility of the installing contractor.

2.29 POST-EQUALIZATION BASIN STRUCTURE

- A. The Post-Equalization/Holding basin shall be field erected in one basin as shown on the contract drawings:

Basin Quantity:	1
Inside Dimensions	
Basin Width:	34 ft.
Basin Length:	27.25 ft.
Side Water Depth	
Minimum Operating Level:	0 ft. SWD
Maximum Operating Level:	11.7 ft. SWD
Top of Wall:	26 ft.

2.30 FIXED PVC COARSE BUBBLE DIFFUSERS (POST EQ BASIN)

- A. The aeration system for the Post Equalization basin shall be a coarse bubble diffused air system and shall be a fixed configuration as shown on the contract drawings.

Airflow per basin	177 SCFM
Riser Pipe Diameter	4 in.
Materials of construction	
Diffuser:	Schedule 40 PVC
Manifold:	Schedule 40 PVC
Supports:	Schedule 40 Galvanized Steel
Riser Pipe:	Schedule 40 Galvanized Steel
Tank connection:	304 SS adhesive anchors

- B. Furnish one (1) fixed coarse bubble diffuser system for each basin. The diffuser system shall consist of diffusers, supports, manifold, and riser pipe. Diffuser pipes shall be not less than a four-inch nominal diameter. Each diffuser section shall be supplied with uniformly spaced machined orifices located on the top of each section. Size and number of orifices shall be provided to ensure a uniform air distribution.
- C. Each diffuser section (and manifold pipe) shall be supported at span lengths not greater than 6 feet by supports. No unsupported end shall be longer than 2 ft.

Diffuser sections shall be secured to the supports with a corrosion resistant retainer. Support brackets shall be adjustable to provide header leveling within $\pm 1/4$ inch of a fixed elevation for each aeration basin.

- D. Diffuser system shall be field assembled by the installing contractor. All submerged PVC joints 8" and smaller shall be socket welded joints. Expansion joints shall be included to compensate for thermal expansion for PVC manifold runs longer than 40 feet. Pipe sizing, location and supports shall be as shown in the drawings. Diffuser sections and internal manifold piping shall have flange connections for disassembly.
- E. The riser pipe shall terminate in a flanged connection at the top of the basin wall. All piping, gaskets, and hardware beyond the riser pipe's flanged connection shall be provided by the installing contractor.
- F. Attachment to the basin shall be the responsibility of the installation contractor.

2.31 PIPE SUPPORTS

- A. Provide each section of air distribution header with a minimum of two supports. Support spacing to be limited to a maximum of 18 feet. Design all supports to allow for thermal expansion and contraction forces over a temperature range of 125° F and to minimize stress build up in the piping system. Design supports to be adjustable without removing the air distribution header from the support. Design supports to include hold down guide straps, support structure and two anchor bolts. Design guide straps with a 2-inch minimum width to eliminate point load on piping and minimize binding. Design support for a total of 1-inch lateral adjustment and 4-inch vertical adjustment for leveling within 3/8 inch of a common plane. Attach supports to tank floor with stainless-steel anchor bolts.

2.32 AIR DIFFUSER

- A. Design diffuser with cast stainless-steel alloy equivalent to 316L stainless-steel schedule 80 – $\frac{3}{4}$ inch NPT threaded nozzle, air reservoir, air exit ports and bottom deflector. Design diffuser with a minimum air release perimeter of 48 inches. Locate exit ports discharging air into liquid on horizontal planes at two levels. Provide deflector below each diffuser for its full length and width. Design deflector to direct the liquid being aerated along the diffuser reservoir walls so that the air exits through the ports and is sheared into small bubbles and distributed into the liquid.

2.33 DIFFUSER CONNECTORS

- A. Design diffuser connector for two diffusers. Furnish PVC plugs for all unused diffuser connectors. Design diffuser connector with cast stainless-steel alloy equivalent to 316L stainless-steel. Provide connector so that air exiting the diffusers does not interfere with the air distribution header. Factory weld connector to the invert centerline of the air distribution header with a full penetration butt weld. Reinforce the connector header weld joint by providing and continuously welding gussets between the vertical side wall of the header and the connector ends to limit long term flexure failure. Minimum gusset thickness to be 1/8 inch. Design connector to resist a vertical dead load applied to the threaded end of the connector that results in a bending moment of 1000 inch-lbs without exceeding 24,000 psi design stress in any part of the air distribution header wall or connector.

2.34 MATERIALS AND FABRICATION

- A. Fabricate all welded parts and assemblies from sheets and plates of 304L stainless-steel with a 2D finish conforming to ASTM A240, 554, 774, 778. Fabricate non-welded parts and flanges from sheets, plates, or bars of 304 stainless-steel conforming to ASTM A240 or ASTM A276. Weld in the factory with ER 316L filler wire using MIG, TIG or plasma-arc inert gas welding processes. Provide a cross section equal to or greater than the parent metal. Clean all welded stainless-steel surfaces and welds after fabrication to remove weld splatter and finish clean all interior and exterior welds by full immersion pickling and rinse with water to remove all carbon deposits and contaminants to regenerate a uniform corrosion resistant chromium oxide film per ASTM A380 Section 6.2.11, Table A2.1 Annex A2 and Section 8.3.

2.35 DROP PIPES

- A. Provide a minimum 12 ga. stainless-steel drop pipe from the air main connection to a point 3 feet above the air distribution header. Provide a stainless-steel flange with a 150-pound drilling at the top connection. Provide a stainless-steel gasketed coupling for connection to the air distribution header.

2.36 AIR DISTRIBUTION HEADERS

- A. Provide minimum 12 ga. stainless-steel air distribution headers for connection to the drop pipe. Fabricate air distribution headers with flanged joints or expansion

joints. Design piping with eccentric reducers for changes in diameter to maintain constant invert elevation. Provide piping with removable or welded end caps. Design piping, pipe joints and supports to resist expansion/contraction thrust forces of the air distribution headers over a temperature range of 125° F.

2.37 BLOWERS (POST EQ BASIN)

- A. Three phase rotary lobe type, positive displacement blowers as described below with premium efficient, T.E.F.C., Class F insulation, Teco, Siemens, or equal motor shall be furnished. The blowers shall be manifolded for individual and/or combined operation.

Blower Quantity	1
Motor Size	10 HP
Manufacturer	Aerzen
Model Number	GM 4S DN 80
Airflow Rate	177 SCFM per blower
Maximum Discharge Gauge Pressure	10.7 PSIG
Enclosure:	Painted Steel Acoustic Hood
Discharge Isolation Valve	
Diameter	3 inches
Seat Material	Viton

- B. Each blow shall consist of the Positive Displacement Blower Package with a common base, V-belt drive, enclosed drive guard, pressure gauge, pressure relief valve, and vibration pad.
- C. Each blower assembly shall be complete and mounted on a base weldment with four-corner anti-vibration mountings, designed for direct application on a concrete slab or other solid foundation. Each assembly shall be suitable for shipment as a complete unit, factory assembled (less discharge pipe fittings) as much as possible to facilitate shipping and handling.
- D. Equipment shall include a blower, electric motor, direct drive coupling, inlet package (filter and silencer), discharge silencer, discharge check valve, rubber inlet sleeve and flexible discharge connection, pressure relief valve, manual butterfly discharge isolation valve, and rubber expansion joint.

2.38 DISCHARGE PRESSURE GAUGE (POST EQ BASIN)

- A. Provide a discharge liquid filled pressure gauge to be equivalent to U.S. Gauge, Ashcroft, or approved equal.

Range: 0-15 psig.
Dial: 2 ½", 270 degree scale.
Case: 300 Series stainless-steel.
Accuracy: ±3-2-3% of span (Grade B)

- B. The installing contractor shall provide all air piping from the diffuser termination(s) at the basin(s) to the blowers as shown on the contract drawings. Supply of electrical wiring and junction box/disconnects shall be the responsibility of the installing contractor.

2.39 POST-EQ TRANSFER PUMP

- A. Furnish submersible non-clog sludge pump(s) for each basin as specified herein. Each pump shall be equipped with a submersible electrical motor connected for three phase operation. Pump housing shall be painted cast iron. Pump shall include an adequate length of multi-conductor chloroprene jacketed type SPC cable suitable for submersible pump applications. The power cable shall also be sized according to NEC and ICEA standards. The pump shall be supplied with a mating cast iron discharge elbow. Each unit shall be fitted with an adequate length of galvanized steel lifting chain of adequate strength to permit raising and lowering the pump.

Pump Quantity:	3
Pump Function:	Transfer
Motor Size:	5 HP
Pump Flow Rate and Required Total Dynamic Head (TDH):	450 GPM at 31 ft. TDH
Pump Material:	Painted cast iron pump housing
Discharge Valve Actuator Type:	Manual
Manufacturer:	Milliken or approved equal
Diameters Discharge Connection Elbow:	6 inches
Discharge Pipe:	6 inches
Valve(s):	6 inches
Materials of Construction	

Lifting Chain:	304 SS
Upper Guide Bars and Brackets:	Galvanized

System Manufacturer Termination Point:	Pump discharge connection elbow
Tank Connection	304 SS adhesive anchors

- B. The pump shall be capable of handling raw, unscreened sewage. The discharge connection elbow shall be permanently installed with the discharge piping. The pump shall be automatically connected to the discharge connection elbow when lowered into place and shall be easily removed for inspection or service. There shall be no need for personnel to enter the basin or pump well. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple linear downward motion of the pump.
- C. The upper guide bar bracket shall be provided with each pump. The entire weight of the pumping unit shall follow guide bars into the operating position and pressed tightly against the discharge connection elbow with metal-to-metal contact. No sealing of the discharge interface by means of a diaphragm, O-ring, or other devices shall be acceptable. The pump, with its appurtenances and cable, shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 ft.
- D. Supply of all discharge piping, supports, gaskets, and hardware beyond the flanged connection of the pump discharge connection elbow shall be the responsibility of the installing contractor.
- E. Each pump shall include a “Seal Failure” and “Over Temperature” warning system.
- F. Each pump shall include a discharge valve to control the design transfer flow rate.
- G. Valve shall have a 125# flanged end connection, ASTM A-126 Class B cast iron body with welded in nickel seat, Viton or neoprene coated ductile iron plug. The valve shall be a non-lubricated type with a port area of at least 80% of full pipe size.
- H. Each pump shall include a Nibco F-918-B check valve with cast iron body and bronze disk to prevent backflow or approved equal.

2.40 PRESSURE TRANSDUCER (POST EQ BASIN)

- A. Manufacturer shall furnish and install submersible pressure transducer unit(s) constructed of stainless-steel for each basin as specified herein. Transducer shall utilize a diffused silicone semiconductor sensor protected by an integral stainless-

steel diaphragm with seal fluid. Transducer output shall be a 4-20 mA signal. Electrical connection shall be 2-wire, loop powered through a shielded integral cable comprised of 22 AWG conductors and separate drain wire.

Quantity:	1 per basin
Model:	Keller Levelrat or approved equal
Mounting Materials of Construction	
Support Pipe:	PVC SS
Supports:	304 SS
Anchors:	304 SS
Tank Connection:	304 SS Adhesive Anchors

- B. Transducers shall be suspended on a removable mounting pipe assembly. Pipe, supports, stainless-steel sensor guide rail weldments, and anchors shall be provided. Field attachment of the pipe and supports to the basin shall be the responsibility of the installing contractor. A moisture excluding aneroid bellows shall be supplied loose for installation in the junction box/ disconnect. Attachment and supply of the junction box/disconnect at the basin wall shall be the responsibility of the installing contractor.
- C. Field attachment of the pressure transducer mounting brackets to the tank shall be the responsibility of the installing contractor.

2.41 LEVEL SENSORS (POST EQ BASIN)

- A. Provide one (1) level sensor assembly consisting of an Anchor Scientific model GSI 40NONC float switch with a smooth, chemical resistant polypropylene casing, and 316 stainless-steel mounting brackets for each basin or approved equal. Each float switch shall be provided with a three-conductor electrical cable. Electrical cable shall terminate at a junction box/disconnect located at the basin wall. Field wiring and junction box/disconnect shall be provided by the installation contractor.
- B. Field attachment of the level sensor assembly to the tank shall be the responsibility of the installing contractor.

2.42 PROCESS CONTROL INSTRUMENTATION

Manufacturer:	ABB or approved equal
Controller	
Quantity:	1 per basin
Model:	AWT440 or approved equal
Maximum Inputs per controller:	2 per controller

Probes:

DO

Quantity:

1 per basin

Model:

Aztec ADS420 or approved equal

Mounting

Materials:

304 Stainless-steel

2.43 CONTROLLER

- A. The controller will communicate with the main PLC via 4-20 mA signals. The controller will have a NEMA 4X enclosure with corrosion-resistant finish and shall be AC powered from a 100-230VAC power source. Each probe module shall include a sun shield.

2.44 SENSORS

- A. Furnish one sensor of each type specified above per basin. Sensors shall be suspended on a removable mounting pipe assembly. Stainless-steel pipes, stainless-steel supports, and stainless-steel anchors shall be provided. Field attachment of the pipe and supports to the basin shall be the responsibility of the installing contractor. Field wiring, conduit, and installation of cable shall be the responsibility of the installing contractor.

2.45 AEROBIC DIGESTER/SLUDGE HOLDING BASIN STRUCTURE

- A. The Aerobic Digester/Sludge Holding basin shall be field erected in two basins as shown on the contract drawings:

Basin Quantity:

1

Inside Dimensions

Basin Width:

34 ft.

Basin Length:

27.58 ft.

Side Water Depth

Maximum Operating Level:

21 ft. SWD

Minimum Operating level:

14.7 ft.

Top of Wall:

26 ft.

2.46 FIXED STAINLESS STEEL COARSE BUBBLE DIFFUSERS (DIGESTER)

- A. The aeration system for the Post Equalization basin shall be a coarse bubble diffused air system and shall be a fixed configuration as shown on the contract drawings.

Airflow per basin	263 SCFM
Riser Pipe Diameter	4 in.
Materials of construction	
Diffuser:	Stainless Steel
Manifold:	Stainless Steel
Supports:	Galvanized
Riser Pipe:	Galvanized
Tank connection:	304 SS adhesive anchors

- B. Furnish one (1) fixed coarse bubble diffuser capable of 263 SCM for each basin. The diffuser system shall consist of diffusers, supports, manifold, and riser pipe. Diffuser pipes shall be not less than a six-inch nominal diameter. Each diffuser section shall be supplied with uniformly spaced machined orifices located on the top of each section. Size and number of orifices shall be provided to ensure a uniform air distribution.
- C. Each diffuser section (and manifold pipe) shall be supported at span lengths not greater than 6 feet by supports. No unsupported end shall be longer than 2 ft. Diffuser sections shall be secured to the supports with a corrosion resistant retainer. Support brackets shall be adjustable to provide header leveling within $\pm 1/4$ inch of a fixed elevation for each aeration basin.
- D. Diffuser system shall be field assembled by the installing contractor. All submerged PVC joints 8" and smaller shall be socket welded joints. Expansion joints shall be included to compensate for thermal expansion for SS manifold runs longer than 40 feet. Pipe sizing, location and supports shall be as shown on the drawings. Diffuser sections and internal manifold piping shall have flange connections for disassembly.
- E. The riser pipe shall terminate in a flanged connection at the top of the basin wall. All piping, gaskets, and hardware beyond the riser pipe's flanged connection shall be provided by the installing contractor.
- F. Attachment to the basin shall be the responsibility of the installation contractor.

2.47 PIPE SUPPORTS

- B. Provide each section of air distribution header with a minimum of two supports. Support spacing to be limited to a maximum of 18 feet. Design all supports to allow for thermal expansion and contraction forces over a temperature range of 125° F and to minimize stress build up in the piping system. Design supports to be adjustable without removing the air distribution header from the support. Design supports to include hold down guide straps, support structure and two anchor bolts. Design guide straps with a 2-inch minimum width to eliminate point load on piping and minimize binding. Design support for a total of 1-inch lateral adjustment and 4-inch vertical adjustment for leveling within 3/8 inch of a common plane. Attach supports to tank floor with stainless-steel anchor bolts.

2.48 AIR DIFFUSER

- B. Design diffuser with cast stainless-steel alloy equivalent to 316L stainless-steel schedule 80 – ¾ inch NPT threaded nozzle, air reservoir, air exit ports and bottom deflector. Design diffuser with a minimum air release perimeter of 48 inches. Locate exit ports discharging air into liquid on horizontal planes at two levels. Provide deflector below each diffuser for its full length and width. Design deflector to direct the liquid being aerated along the diffuser reservoir walls so that the air exits through the ports and is sheared into small bubbles and distributed into the liquid.

2.49 DIFFUSER CONNECTORS

- B. Design diffuser connector for two diffusers. Furnish PVC plugs for all unused diffuser connectors. Design diffuser connector with cast stainless-steel alloy equivalent to 316L stainless-steel. Provide connector so that air exiting the diffusers does not interfere with the air distribution header. Factory weld connector to the invert centerline of the air distribution header with a full penetration butt weld. Reinforce the connector header weld joint by providing and continuously welding gussets between the vertical side wall of the header and the connector ends to limit long term flexure failure. Minimum gusset thickness to be 1/8 inch. Design connector to resist a vertical dead load applied to the threaded end of the connector that results in a bending moment of 1000 inch-lbs without exceeding 24,000 psi design stress in any part of the air distribution header wall or connector.

2.50 MATERIALS AND FABRICATION

- B. Fabricate all welded parts and assemblies from sheets and plates of 304L stainless-steel with a 2D finish conforming to ASTM A240, 554, 774, 778. Fabricate non-welded parts and flanges from sheets, plates, or bars of 304 stainless-steel conforming to ASTM A240 or ASTM A276. Weld in the factory with ER 316L filler wire using MIG, TIG or plasma-arc inert gas welding processes. Provide a cross section equal to or greater than the parent metal. Clean all welded stainless-steel surfaces and welds after fabrication to remove weld splatter and finish clean all interior and exterior welds by full immersion pickling and rinse with water to remove all carbon deposits and contaminants to regenerate a uniform corrosion resistant chromium oxide film per ASTM A380 Section 6.2.11, Table A2.1 Annex A2 and Section 8.3.

2.51 DROP PIPES

- B. Provide a minimum 12 ga. stainless-steel drop pipe from the air main connection to a point 3 feet above the air distribution header. Provide a stainless-steel flange with a 150-pound drilling at the top connection. Provide a stainless-steel gasketed coupling for connection to the air distribution header.

2.52 AIR DISTRIBUTION HEADERS

- A. Provide minimum 12 ga. stainless-steel air distribution headers for connection to the drop pipe. Fabricate air distribution headers with flanged joints or expansion joints. Design piping with eccentric reducers for changes in diameter to maintain constant invert elevation. Provide piping with removable or welded end caps. Design piping, pipe joints and supports to resist expansion/contraction thrust forces of the air distribution headers over a temperature range of 125° F.

2.53 BLOWERS (DIGESTER)

- A. Three phase rotary lobe type, positive displacement blowers as described below with premium efficient, T.E.F.C., Class F insulation, Teco, Siemens, or equal motor shall be furnished. The blowers shall be manifolded for individual and/or combined operation.

Blower Quantity:	2
Motor Size:	20 HP
Manufacturer:	Aerzen
Model Number:	GM 10 S DN 80
Airflow Rate:	263 SCFM per blower
Maximum discharge gauge pressure:	10.7 PSIG
Enclosure:	Painted Steel Acoustic Hood

Discharge Isolation Valve

Diameter:	3 inches
Seat Material:	Viton

- B. Each blower assembly shall be complete and mounted on a base weldment with four corner anti-vibration mountings, designed for direct application on a concrete slab or other solid foundation. Each assembly shall be suitable for shipment as a complete unit, factory assembled (less discharge pipe fittings) as much as possible to facilitate shipping and handling.
- C. Equipment shall include a blower, electric motor, direct drive coupling, inlet package, discharge silencer, discharge check valve, rubber inlet sleeve and discharge connection, pressure relief valve, butterfly discharge isolation valve, and rubber expansion joint.

2.54 DISCHARGE PRESSURE GAUGE (DIGESTER)

- A. Provide a discharge liquid filled pressure gauge to be equivalent to U.S. Gauge, Ashcroft, or approved equal.

Range: 0-15 psig.

Dial: 2 ½", 270 degree scale.

Case: 300 Series stainless-steel.

Accuracy: ±3-2-3% of span (Grade B)

- B. The installing contractor shall provide all air piping from the diffuser termination(s) at the basin(s) to the blowers as shown on the contract drawings. Supply of electrical wiring and junction box/disconnects shall be the responsibility of the installing contractor.

2.55 SLUDGE TRANSFER PUMP (DIGESTER)

- A. Furnish submersible non-clog sludge pump(s) for each basin as specified herein. Each pump shall be equipped with a submersible electrical motor connected for three phase operation. Pump housing shall be painted cast iron. Pump shall include an adequate length of multi-conductor chloroprene jacketed type SPC cable suitable for submersible pump applications. The power cable shall also be sized according to NEC and ICEA standards. The pump shall be supplied with a mating cast iron discharge elbow. Each unit shall be fitted with an adequate length of galvanized steel lifting chain of adequate strength to permit raising and lowering the pump.

Pump Quantity:	1
Motor Size :	2.4 HP
Pump Function:	Sludge
Pump Flow rate:	65 GPM
Required Total Dynamic Head:	26 TDH
Discharge Valve:	
Actuator type:	Manual
Manufacturer:	Milliken or approved equal
Diameters:	
Discharge connection elbow:	4 inches
Discharge pipe:	4 inches
Valve(s):	4 inches
Materials of Construction:	
Lifting Chain:	304 SS
Upper Guide bars and bracket:	Galvanized
System Manufacturer termination point:	Pump discharge connection elbow
Tank connection:	304 SS adhesive anchors

- B. The pump shall be capable of handling raw, unscreened sewage. The discharge connection elbow shall be permanently installed with the discharge piping. The pump shall be automatically connected to the discharge connection elbow when lowered into place and shall be easily removed for inspection or service. There shall be no need for personnel to enter the basin or pump well. Sealing of the pumping unit to the discharge connection elbow shall be accomplished by a simple linear downward motion of the pump.
- C. The upper guide bar bracket shall be provided with each pump. The entire weight of the pumping unit shall follow guide bars into the operating position and pressed tightly against the discharge connection elbow with metal-to-metal contact. No sealing of the discharge interface by means of a diaphragm, O-ring, or other devices shall be acceptable. The pump, with its appurtenances and cable, shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 ft.
- D. Supply of all discharge piping, supports, gaskets, and hardware beyond the flanged connection of the pump discharge connection elbow shall be the responsibility of the installing contractor.
- E. Each pump shall include a “Seal Failure” and “Over Temperature” warning system.
- F. Each pump shall include a discharge valve to control the design transfer flow rate.

- G. Valve shall have a 125# flanged end connection, ASTM A-126 Class B cast iron body with welded in nickel seat, Viton or neoprene coated ductile iron plug. The valve shall be a non-lubricated type with a port area of at least 80% of full pipe size.
- H. Each pump shall include a Nibco F-918-B check valve with cast iron body and bronze disk to prevent backflow or approved equal.
- I. Valves shall be provided loose for installation within the discharge piping by the installing contractor. Valve gaskets and hardware shall be supplied by the installation contractor.
- J. Adhesive anchors of 304 stainless-steel shall be provided for anchoring the pump.

2.56 PRESSURE TRANSDUCER (DIGESTER)

- A. Furnish submersible pressure transducer unit(s) constructed of stainless-steel for each basin as specified herein. Transducer shall utilize a diffused silicone semiconductor sensor protected by an integral stainless-steel diaphragm with seal fluid. Transducer output shall be a 4-20 mA signal. Electrical connection shall be 2-wire, loop powered through a shielded integral cable comprised of 22 AWG conductors and separate drain wire.

Quantity:	1 per basin (2 total)
Model:	Keller Levelrat or approved equal
Mounting Materials of Construction	
Support Pipe:	PVC
Supports:	304 SS
Anchors:	304 SS
Tank Connection:	304 SS Adhesive Anchors

- B. Transducers shall be suspended on a removable mounting pipe assembly. Pipe, supports, and anchors shall be provided. Field attachment of the pipe and supports to the basin shall be the responsibility of the installing contractor. A moisture excluding aneroid bellows shall be supplied loose for installation in the junction box/ disconnect. Attachment and supply of the junction box/disconnect at the basin wall shall be the responsibility of the installing contractor.
- C. Field attachment of the pressure transducer mounting brackets to the tank shall be the responsibility of the installing contractor.

2.57 LEVEL SENSORS (DIGESTER)

- A. Furnish one (1) level sensor assembly consisting of an Anchor Scientific model GSI 40NONC float switch with a smooth, chemical resistant polypropylene casing, and 316 stainless-steel mounting brackets for each basin or approved equal. Each float switch shall be provided with a three-conductor electrical cable. Electrical cable shall terminate at a junction box/disconnect located at the basin wall. Field wiring and junction box/disconnect shall be provided by the installation contractor.
- B. Field attachment of the level sensor assembly to the tank shall be the responsibility of the installing contractor.

2.58 PROCESS CONTROL INSTRUMENTATION

Manufacturer:	ABB or approved equal
Controller	
Quantity:	1 per basin
Model:	AWT440 or approved equal
Maximum Inputs per controller:	2 per controller
Probes:	
DO	
Quantity:	1 per basin
Model:	Aztec ADS420 or approved equal
Mounting	
Materials:	304 Stainless-steel

2.59 CONTROLLER

- A. The controller will communicate with the main PLC via 4-20 mA signals. The controller will have a NEMA 4X enclosure with corrosion-resistant finish and shall be AC powered from a 100-230VAC power source. Each probe module shall include a sun shield.

2.60 SENSORS

- A. Furnish one sensor of each type specified above per basin. Sensors shall be suspended on a removable mounting pipe assembly. Stainless-steel pipes, stainless-steel supports, and stainless-steel anchors shall be provided. Field attachment of the pipe and supports to the basin shall be the responsibility of the installing contractor. Field wiring, conduit, and installation of cable shall be the responsibility of the installing contractor.

2.61 MIXER (ENDURA® SERIES DDM MIXER OR APPROVED EQUAL)

- A. Furnish one (1) mechanical floating mixer(s) and related equipment accessories as described herein for each basin. Each mixer shall consist of a motor, direct-drive impeller driven at a constant speed, an integral flotation unit, and impeller volute. The mixer shall incorporate design enhancements that provide for three (3) years without routine maintenance (greasing).

Mixer Quantity	1 per basin (2 total)
Motor	
Size	7.5 HP
RPM	900 RPM
Efficiency	Standard
Mounting Base Materials	304 Stainless-steel
Float	
Diameter (Minimum)	84 inches
Shell Material	Fiber Reinforced Polyester Skin (FRP)
Impeller Volute Material	304 Stainless-steel

- B. Each mixer shall meet the requirements summarized above. Complete mix shall be defined as maintaining biological suspension of all mixed liquor suspended solids with the specified MLSS concentration without the introduction of air.

2.62 MIXER DRIVE MOTOR (DIGESTER)

- A. The motor shall be rated for 7.5 horsepower at 900 RPM and wired for 460-volt, 60 hertz, three-phase service. The motor shall be standard efficiency, vertical P base design, totally enclosed fan cooled TEFC, and generally rated for severe duty. The motor shall in all cases equal or exceed standard NEMA specifications. A minimum service factor of 1.15 shall be furnished.
- B. The motor winding shall be non-hygroscopic, and insulation shall equal or exceed NEMA Class "F". A labyrinth seal shall be provided below the bottom bearing to prevent moisture from penetrating around the motor shaft. A condensate drain shall be located at the lowest point in the lower-end bell housing. Unit shall have a one-piece motor shaft continuous from the top motor bearing, through the lower bearing and down to and through the propeller. The shaft shall be manufactured from 17-4 PH stainless-steel.
- C. Motor bearings shall be re-greaseable. Sealed bearings are not acceptable. Top bearing shall be shielded on the bottom side only. Bottom bearing shall be open.

The top and bottom motor bearings shall be of combined radial and axial thrust type. The lower motor bearing inner brace shall be locked to the motor shaft via a special washer and locking nut arrangement. The shaft shall be threaded just below the lower bearing and shall have a keyway cut into the motor shaft. This key shall accept a tab from the inner diameter of the locking washer, and the locking nut shall have recesses to accept a tab from the outer diameter of the locking washer to prevent the nut from backing off. Snap ring type bearing retainers will not be acceptable.

- D. Submerged motors, jet pumps, submerged gear motors or gearboxes shall not be acceptable.

2.63 MOTOR MOUNTING BASE (DIGESTER)

- A. The motor shall be securely mounted onto a solid base which is integral with the motor base extension. All submerged wetted mounting base components shall be constructed of 304 stainless-steel.
- B. The upper portion of the motor mounting base, immediately below the lower motor bearing, shall include two independent acting air seals. The two seals shall be capable of sealing off the flow of air from the suction action of the pumped flow and prevent backflow of liquid during impeller reversal. The lower end of the motor base extension shall be provided with a rotating backflow seal that will prevent grit from being introduced into the anti-deflection insert reservoir but shall allow liquid to contact the shaft. The backflow seal shall not require scheduled lubrication or maintenance.

2.64 IMPELLER (DIGESTER)

- A. The impeller shall be designed to pump the liquid from near the surface and direct it down toward the vessel/basin bottom. The impeller shall be a two-blade marine type precision casting of 316 or 15/5 stainless-steel and shall be specifically designed for the application intended. It shall be dynamically and hydraulically balanced. The propeller must be attached to the motor shaft with a hardened stainless-steel pin and set screw. Impeller shall be capable of being reversed to cause back flow liquid movement without causing damage to the mixer chassis and without causing upflow liquid damage to the motor bearing and windings. No liquid spray or other liquid leakage upward onto the surface of the motor support surface or flotation chassis will be allowed.

2.65 RESTRAINED MOORING SYSTEM

A. Shall be provided with a mooring system as described below:

Mooring Post Quantity:	Two(2)
Mooring Post Diameter:	4 inch
Pylon Material:	Schedule 40
Base Plate Material:	Galvanized Steel
Floor Connection:	Stainless Steel Anchor
Electrical Cable:	#12-four conductor
Space Heater:	#12-four conductor
Thermostat Cable:	#12-four conductor

The system shall consist of vertical pylons with base plate. Each pylon shall be filled with concrete by the installation contractor.

Furnished, as part of the unit, shall be a triangular mooring frame. The frame shall permit the assembly to move up and down following the change in liquid level while restrained within the vertical pylons. Removable 304 stainless-steel U-bolts shall be attached to each frame and fit around the pylons.

B. Field attachment of the mooring assembly to the tank wall shall be the responsibility of the installation contractor.

2.66 MOORING ELECTRICAL POWER CABLE

A. Shall include power cable wired into the motor conduit box and terminating at the basin wall. Electrical cable shall be supplied with kellems grips at the motor and basin wall terminations. Electrical cable(s) shall be attached with cable ties provided by the equipment supplier. Attachment of the cable and supply of junction box/disconnect at the basin wall shall be the responsibility of the installing contractor.

2.67 CHEMICAL FEED SYSTEM

Chemical feed will be controlled by the panel specified above. The operator will have the option of turning the chemical feed to "Auto" or "Off" if desired. The chemical feed pumps, piping, valve, storage tanks, and yard piping will be supplied by others.

2.68 SPARE PARTS

The following spare parts shall be supplied by the equipment manufacturer:

<u>Component</u>	<u>Quantity</u>
Decanter Linear Actuator with Capacitor:	1
Decanter Limit Switch with Arm:	1
Input Card:	1
Output Card:	1
Analog Input Card:	1
Analog Output Card:	1
Membrane Kits:	70
Crimping tool(s):	1
25 HP Blower V-Belts:	4 sets
7.5 HP Blower V-Belts:	1 sets
Blower Inlet Filters:	2 per blower
Blower Direct Drive Coupling:	1 per blower

2.69 SBR CONTROL PANEL WITH MOTOR STARTERS

- A. The control system shall be designed to optimize the SBR process while minimizing operator attention and to accommodate the continuous maximum daily flow without adjusting cycle structures. The control software program shall be factory tested prior to installation at the jobsite.
- B. The control system shall be a timer-based system with level overrides and shall provide control, sequence, monitoring, and alarm annunciation capabilities. The operator shall be able to access the timer values and set points through the operator interface panel to allow for adjustment of cycle times and system flexibility. The control system shall be designed to automatically accommodate the plant's full range of loads and flows.
- C. A complete control system shall be provided as described in the following and as shown on the contract drawings:
The control system shall include a circuit breaker disconnect, control transformer, branch protection, motor starters, microprocessor control, indicator lights, HAND-OFF-AUTOMATIC selector switches.
- D. The control system shall consist of two (2) panels; (1) 460V power panel and (1) 115V PLC panel.
- E. The incoming service of the control system shall be 460 volt, 60 hertz, three-phase. Motor starters for the equipment listed below shall be provided within the SBR control panel. Elapsed time indication shall be provided through the operator interface of the SBR control panel for equipment indicated by an asterisk (*).

- F. The provided control package will include:
 - 1. NEMA 12 panel enclosure suitable for indoor installation and constructed of painted steel.
 - 2. Fuse(s) and fuse block(s)
 - 3. Compactlogix Processor
 - 4. Operator interface(s)
 - 5. Ethernet switch(es)
 - 6. Remote access ethernet modem(s)

- G. The provided power panel will include:
 - 1. NEMA 12 painted steel enclosure
 - 2. Circuit breaker with handle
 - 3. Heat exchanger
 - 4. Transformer 3 KVA
 - 5. Fuses and fuse blocks
 - 6. GFI convenience outlet(s)
 - 7. Size 0 motor starter(s)
 - 8. Size 1 motor starter(s)
 - 9. 25 HP VFD(s)
 - 10. 10 HP VFD(s)
 - 11. 7.5 HP VFD(s)
 - 12. Terminal blocks
 - 13. UL labels

2.70 ANCILLARY EQUIPMENT DESCRIPTION

Coagulant Pump(s)	(Pumps supplied by others)
Caustic Pump(s)	(Pumps supplied by others)
Polymer Pump(s)	(Pumps supplied by others)
Grit Chamber Blower(s)	(Blowers supplied by others)
Grit Chamber Motor(s)	(Grit Chamber Equipment supplied by others)
Grit Chamber Classifier Motor	(Grit Chamber Equipment supplied by others)

2.71 CONTROL PANEL WIRING AND ASSEMBLY

- A. All control enclosures shall be custom assembled and wired in an Underwriters Laboratories (UL) certified cabinet shop using quality materials and labor. Short circuit rating of control enclosure shall be 5 kA RMS symmetrical @ 480VAC maximum.

B. All control panel single conductor wire shall be 16 AWG multi-strand machine tool wire (MTW) minimum, with PVC insulation.

C. Wire colors are as follows:

208 VAC or higher	-	Black
120 VAC control power	-	Red
Neutral	-	White
Ground	-	Green
AC Power from remote source	-	Yellow
Neutral from remote source	-	White with Yellow Stripe
24 VDC (+)	-	Blue
24 VDC (-)	-	White with Blue Stripe
VDC (+) from remote source	-	Orange
VDC (-) from remote source	-	White with Orange Stripe
Intrinsically Safe	-	Light Blue

D. All wires shall be clearly marked with an identification number consistent with the wiring schematic drawing. Wire markers shall be a thermal transfer printable type. The material shall be self-laminating vinyl. Labels shall be Brady THT-9-427-10 or approved equal.

E. Wiring inside the control panel shall be run in PVC wiring duct rated for continuous temperatures up to 122° F (50°C). Devices mounted in the enclosure door shall have wires run in spiral wrap to avoid pinch points when opening and closing the door.

F. Control components mounted internal and external to the enclosure shall be mounted with stainless-steel hardware and clearly labeled with a plastic identification nametag. The tag shall be white with black lettering.

2.72 CONTROL ENCLOSURE

A. The automatic controls shall be provided in a UL listed, NEMA Type 12 mild steel (12 gauge) floor mount enclosure that provides a degree of protection for electrical controls and components from dust, dripping water and external condensation of non-corrosive liquids. The enclosure is intended for indoor installation. Enclosure shall include gasketed overlapping doors with a 3-point latch mechanism operated by an oil tight key-lock handle. The enclosure shall have white polyester powder paint inside with ANSI 61 gray polyester powder paint outside over phosphatized surfaces. The enclosure shall include a painted white

mild steel (10 gauge) sub-panel mounted with collar studs. Enclosure shall be manufactured by Hoffman or approved equal.

B. The control enclosure shall be mounted remotely.

2.73 CORROSION INHIBITOR

A. Each control enclosure assembly shall be provided with corrosion inhibitors to protect interior electrical components from damage caused by high humidity. The corrosion inhibitors shall be installed prior to shipment to provide protection during shipment and storage of the enclosure.

B. The corrosion inhibitor shall be Hoffman AHCI5E or approved equal.

2.74 MAIN DISCONNECT CIRCUIT BREAKER

A. A UL listed, automatic molded case, 3-pole disconnect breaker shall be provided in the control enclosure(s). The primary function of the disconnect switch shall be to provide a means to manually open a circuit and automatically open a circuit under overload or short circuit conditions. The disconnect breaker shall have a door mounted operating mechanism with trip indication. Power distribution connectors shall be mounted integrally to the circuit breaker for multiple load connections. Integral connectors shall be provided. The disconnect circuit breaker shall be a Square D/FAL, HDL, JDL, LAL, MGL, PGL or approved equal.

2.75 MOTOR STARTER

A. A full voltage non-reversing Integrated Motor Starter-Controller shall be provided for motor applications up to 15 kW. Each starter shall provide control, protection, and monitoring functions for the motor. The starter shall be NEMA rated IEC form factor and shall have certifications according to UL and CSA standards and shall bear the CE marking. The starter shall have a maximum rated operational voltage of 690V and provide a 42kA @ 480 VAC rated breaking capacity on short circuit. The starter shall have a mechanical durability of 15 million operations. The starter shall provide short circuit trip, thermal overload trip with selectable tripping class, under current trip and phase imbalance trip.

B. A full voltage non-reversing NEMA Style motor starter shall be provided for motor applications over 15 kW. Each starter shall consist of a circuit breaker, contactor, and overload relay. The starter shall be NEMA rated and shall have certifications according to UL and CSA standards and shall bear the CE marking. The starter shall have a maximum rated operational voltage of 600V and provide a minimum 18 kA

@ 480VAC and 25 kA @ 240 VAC interrupt rating on short circuit when used in combination with a PowerPact circuit breaker. The starter shall have a mechanical durability of 2 million operations. The solid-state overload relay shall have class 10/20 (selectable) tripping characteristics with trip current adjustment, phase loss and unbalance protection.

2.76 VARIABLE FREQUENCY DRIVE

- A. UL Listed Variable Frequency Drives (VFD) shall be provided to control pumps and/or blowers. The VFD's shall control pump and/or blower speed via an analog signal from the PLC. The VFD output frequency shall be programmable. The VFD shall be provided in a NEMA Type 20 panel mount package and rated for an operating temperature of -4° to 122°F (-20° to 50°C). The VFD shall have a 65 kA maximum short circuit rating when protected with an Allen Bradley 140M motor circuit protector or Class CC/J fuse. The VFD shall be Allen-Bradley PowerFlex or approved equal.

2.77 TRANSFORMER

- A. A step-down multi-tap transformer shall be supplied when there is a necessity to reduce incoming 3-phase power to 120 VAC single-phase. The transformer power wire connections (incoming and outgoing) shall be protected with a finger-safe cover to protect against accidental contact. Primary and secondary fuse protection shall be provided. Transformer shall be UL listed and of continuous wound construction with vacuum impregnated with non-hygroscopic thermosetting varnish. Transformer shall be Square D 9070T or approved equal.

2.78 TRANSFORMER PRIMARY AND SECONDARY FUSE

- A. Properly rated fuses and fuse blocks shall be provided for primary and secondary protection of the transformer. Each fuse shall be equipped with a thermoplastic cover to protect against accidental contact. Clip style fuse block shall be rated up to 600 VAC and 100 amps, dual element, time delay fuses shall be rated up to 600 VAC. Fuse blocks and fuses shall be UL listed. Fuses shall be Littelfuse Class CC or approved equal. Fuse blocks and fuse covers shall be manufactured by Marathon or approved equal.

2.79 CIRCUIT BREAKER

- A. All single-phase branch or supplementary circuits shall be protected with a single-pole, C-Curve rated circuit breaker. Circuit breakers shall be rated for 240 VAC

maximum, 50/60 Hz and UL 489 listed. Supplementary and branch protection circuit breakers shall be Merlin Gerin Multi 9 or approved equal.

2.80 FUSE

- A. Properly rated fuses and fuse holders shall be provided for protection of individual control devices (discrete and analog signals) mounted outside of the enclosure. Each fuse shall be housed in a hinged type fuse block to protect against contact with the fuse. Fuses shall be rated up to 250 VAC and be Littelfuse or approved equal. Fuse holders for discrete devices shall be rated to 600 VAC and 30 Amps. Fuse holders for analog devices shall be rated to 300 VAC and 15 Amps. Fuse holders shall be Allen Bradley 1492 or approved equal.

2.81 OPERATOR DEVICE

- A. Operator devices (pushbuttons and selector switches) shall be mounted through the control enclosure door for manual operation of the filter. Transformer type push-to-test pilot lights and illuminated pushbuttons shall be provided for indication of an operation status. Lights shall be a 6 VAC incandescent type lamp. Color coding shall be applied as required and is as follows:

Amber	-	Alarm active, caution
Green	-	Valve open, motor running
Red	-	Valve closed
White	-	Information

- B. All operator devices shall be UL Listed, 30.5mm style, NEMA Type 4X rated, oil and watertight with finger safeguards located on the contact blocks to prevent accidental contact with wire connections. Operator device function shall be identified with an engraved white Gravoply nameplate with black letters. Operator devices shall be Allen-Bradley 800H, Square D 9001, or approved equal.

2.82 HIGH FREQUENCY NOISE FILTER

- A. A UL listed active tracking filter shall be provided to protect the PLC and HMI power feeds from high-frequency noise and low-energy transients. It shall be designed for a single-phase input voltage of 120/240VAC operating at 47 to 63 Hz. The unit shall reduce normal mode transients to plus or minus 2 volts, provide surge capacity of 45,000 amps and protect in all modes (Line to neutral, line to ground and neutral to ground). The noise filter shall be an Islatrol IC+ or approved equal.

2.83 UNINTERRUPTIBLE POWER SUPPLY

- A. A UL listed uninterruptible power supply suitable for location in a UL 508 panel shall be provided to protect the HMI and PLC from short power outages by switching to an emergency battery backup without data loss or downtime. Nominal input voltage and output voltage shall be 120VAC with an autosensing input frequency of 47 to 63 Hz. The output power capacity shall be 650W / 1000VA. The UPS shall be provided with an audible alarm and LED status indicators and operate from 32° to 122°F (0° to 50°C). The UPS shall be an Allen Bradley 1609-B1000N or approved equal.

2.84 GROUND FAULT DUPLEX RECEPTACLE

- A. A UL listed ground fault circuit interrupter (GFCI) duplex receptacle shall be provided within the panel for instrument (e.g., programming terminal, modem, etc.) use only. The receptacle shall be protected with a 5 Amp circuit breaker. The receptacle shall carry a 20A / 120VAC rating. The electro-mechanical circuit interrupter shall be double-pole and trip free (GFCI protection and shall not be overridden by holding reset button). Built-in transient suppression shall protect GFCI's internal circuitry from voltage transients. Receptacle shall be Hubbell DRUBGFI20 or approved equal.

2.85 24 VOLT DC POWER SUPPLY

- A. A UL listed, industrial grade, compact power supply shall be supplied to provide 24 VDC power to such rated components. The power supply shall be DIN rail mounted and functional with input voltage of 100 to 240 VAC (single-phase) incoming control power. The power supply shall have a green LED which shall be illuminated when output voltage is "OK". The power supply shall be an Allen Bradley 1606 or approved equal.

2.86 CONTROL RELAY

- A. UL listed control relays for general control purposes shall be supplied with a pilot light to indicate when the coil is in an energized state. The relay socket shall be panel or DIN rail mounted inside the enclosure. The relays shall provide the following ratings: 120VAC coil, 10A contact rating (thermal), 250 VAC insulation rating and 5 million mechanical life cycles. Relays shall be Allen Bradley 700-HK, Square D, or approved equal.

2.87 TERMINAL BLOCK

- A. Standard feed-through screw terminal blocks, DIN rail mounted, shall be supplied for all point-to-point wiring connections. All terminals shall be numbered per the wiring schematic with printed markers. Terminals shall carry a 600V AC/DC voltage rating. Terminal blocks shall be Allen-Bradley 1492-J4 (35A max) and 1492-J16 (85A max) or approved equal.

2.88 PROGRAMMABLE LOGIC CONTROLLER

- A. Automatic operation of the SBR shall be controlled through a programmable logic controller (PLC) mounted inside the main control panel. The PLC components shall consist of a power supply, CPU, discrete input and output modules and analog input and output modules. The processor unit shall include built-in USB and two (2) Ethernet IP communication ports. All input and output points supplied (including unused) shall be wired to terminal blocks. Processor design characteristics shall include: 1.0MB user memory size, real-time clock and calendar, battery backed RAM and an operating temperature range between 32 °F and 140°F. The PLC processor shall be an Allen-Bradley CompactLogix 1769-L33ER or approved equal.
- B. Modular equipment shall be provided to complete the PLC system. These Allen-Bradley components include: 1769-PA4 – Power Supply, 1769-IA16 – Discrete input (16 point) modules, 1769-OW16 – Discrete output (16 point) modules and 1769-IF8 – Analog input (8 point) modules, 1769-OF4 – Analog output (4 point) modules.

2.89 PLC POWER SUPPLY

- A. Input voltage range of 85-265 / 170-265 VAC, 47-63 Hz, maximum inrush current of 30 amps, backplane output current of 4 amps @ 5V or 2 amps @ 24V, internal fuse protection, ambient operating temperature of 32°F to 140°F, Class I, Division 2 hazardous location certified, UL Listed.

2.90 DISCRETE INPUT MODULE

- A. Operating voltage of 79 to 132 VAC at 47 to 63 Hz, backplane current draw at 5VDC = 115mA , off-state current 2.5mA maximum, maximum inrush current 250mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

2.91 DISCRETE OUTPUT MODULE

- A. Operating voltage of 5 to 265 VAC at 47 to 63 Hz / 5 to 125 VDC, backplane current draw at 5 VDC = 205mA , at 24VDC = 180mA, off-state current leakage is 1.0mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

2.92 ANALOG INPUT MODULE

- A. Backplane current draw at 5 VDC = 120mA, at 24VDC = 70mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

2.93 ANALOG OUTPUT MODULE

- A. Backplane current draw at 5 VDC = 120mA, at 24VDC = 170mA, LED status indication of each point, ambient operating temperature of 32°F to 140°F, UL Listed.

2.94 ETHERNET SWITCH

- A. An Ethernet switch shall be provided inside the control enclosure to provide connectivity between the PLC, operator interface and plant networking. The switch shall support both 10 and 100 Mbit/s operation and provide for store and forward switching mode. The switch shall have five (5) 10/100Base-T ports with RJ-45 sockets and shall support auto-crossing, auto-negotiation, and auto-polarity. Maximum distance between devices shall be 100m.
- B. The unit shall be DIN rail mounted and require 24VDC/100mA power. Diagnostic LEDs for power, link status, data, and data rate shall be provided. The Ethernet switch shall be UL listed and manufactured by Hirschmann/Spider 5TX or approved equal.

2.95 REMOTE ACCESS ETHERNET MODEM

- A. A UL listed remote access Ethernet modem shall be supplied to provide connection capability between the Ethernet PLC network to a standard analog phone line. The device shall be complete with 4 RJ-45 10/100 full/half duplex network ports with one RJ-12 modem port capable of line rates (V90) of 56K thru 28K bps. The unit shall meet compliance with FCC Part 68, Part 15-Class b, UL/CSA Certified, CTR 21, CE. Mounting shall be on 35 mm-din rail with an operating input of 8 to 48V DC.

The remote access Ethernet modem shall be a Rockwell Automation Model 9300-RADES or approved equal.

2.96 HUMAN MACHINE INTERFACE

- A. The operator interface shall be a NEMA Type 12, 13, 4X rated, 10.4" diagonal, color touchscreen display with Ethernet and serial communications. The interface shall be a liquid crystal display (LCD). The display type shall be color active matrix thin-film transistor (TFT) with 800 x 600-pixel resolution. The rated operating temperature shall be 32° to 131° F (0° to 55° C). The operator interface shall be an Allen Bradley PanelView Plus 7 Performance 10" or approved equal.

PART 3- EXECUTION

3.01 SYSTEM OPERATION AND MAINTENANCE MANUALS

- A. Complete system operation and maintenance manuals shall be available in hardcopy and electric form. The electronic form shall be provided in .pdf format and be fully bookmarked. Manuals shall address:
 - 1. General project information;
 - 2. Installation and start-up;
 - 3. Process Design and operational control descriptions;
 - 4. Maintenance and troubleshooting;
 - 5. Mechanical, electrical, and field instrumentation component descriptions; and
 - 6. Mechanical and electrical drawings.

3.02 INSTALLATION OF EQUIPMENT

- A. Supervision by a representative of the manufacturer shall be provided with regard to all mechanical equipment at the time of installation and initial operation.

3.03 OPERATING EQUIPMENT

- A. The following shall be provided for plant operation:
 - 1. a complete outfit of tools and accessories;
 - 2. necessary laboratory equipment; and
 - 3. adequate piping with suitable sampling taps so located as to permit the collection of samples of water from critical portions of the units. Sampling taps should be located at the sludge withdrawal level and preferably spaced at two-foot intervals from the basin bottom to two feet below the effluent level. This shall be provided by the contractor.

3.04 CHEMICAL FEED

- A. Chemicals shall be applied at such points and by such means as to ensure satisfactory mixing of the chemicals with the water. Interference between treatment chemicals and optimum locations and sequences for feeding different chemicals shall be considered. This system shall be provided by the contractor.

3.05 SLUDGE CONCENTRATORS

- A. The equipment should provide either internal or external concentrators in order to obtain a concentrated sludge with a minimum of wastewater. This equipment shall be provided by the contractor.

3.06 SLUDGE REMOVAL

- A. Sludge removal design shall provide that:
 - 1. sludge pipes shall be not less than three (3) inches in diameter and so arranged as to facilitate cleaning;
 - 2. entrance to sludge withdrawal piping shall prevent clogging;
 - 3. valves shall be located outside the tank for accessibility;
 - 4. operator may observe, and sample sludge being withdrawn from the unit;
 - 5. backflow from sanitary sewer systems be impossible; and
 - 6. provide permanent fittings to allow flushing or unplugging of the blow-off lines.

END OF SECTION

SECTION 15880
DAVIT CRANE

PART 1 - GENERAL

1.01 SCOPE

- A. This work shall consist of furnishing, assembling, and installing portable or fixed, adjustable davit cranes as indicated, with electric cable hoists. Multiple bases shall be provided to allow the davit crane to be used at multiple locations.

1.02 SUBMITTAL OF INFORMATION

- A. Submit manufacturers data showing dimensional information and materials of construction including accessories.
- B. Submit shop drawings showing equipment installation, layout, and dimensions.
- C. Submit Operation and Maintenance Manuals, which include specific instructions for receiving and handling, assembly, wiring, installation, repair and service troubleshooting, and full parts list.

1.03 WARRANTY:

- A. The Contractor shall warrant the listed equipment being supplied to the Owner, including installation, against defects in workmanship and material for a period of one year commencing upon approval and acceptance of a fully functioning system.

1.04 FIELD CONDITIONS

- B. Field Measurements: Verify actual locations of walls, equipment to be removed and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by Thern Winches & Cranes model 5PT10-E2 or approved equal.

2.2 DESCRIPTION

- A. Contractor shall supply the number of Davit Cranes indicated below, along with the appropriate bases, hoists/winches, cable, hooks and any other standard equipment and hardware required for installation and operation.

Crane Location/Use

Portable Davit Crane w/mount base for SBR

Portable Davit Crane w/mount base for UV System

Portable Davit Crane w/mount base Influent Pump Station

- B. Requirements:

1. Rated for a minimum of 1,200 lbs at 60-inch hook reach and 100-inch hook height
2. Adjustable reach from 24 inches to 66 inches
3. Adjustable hook height. Maximum hook height of 100 inches
4. Pendant control: 6 ft
4. Steel Finish: Enamel
5. 115VAC Electric winch operation with pendant control. Winch speed of greater than 8 feet per minute.
6. Stainless Steel wire rope 1/4" Diameter and 60 ft wire rope length

2.3 BASES

- A. Provide pedestal/flush bases as required in drawings.
- B. Bases shall be epoxy paint finish.

2.4 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Contractor shall assemble the davit crane and install the bases at the locations shown on the drawings. Assembly and installation shall comply with manufacturer's instructions and recommended installation practices. Contractor shall advise of any conflict between field conditions and manufacturers recommended installation procedures prior to installation.
- B. Contractor shall lubricate all operating parts as recommended by manufacturer.

END OF SECTION

SECTION 15900
LABORATORY EQUIPMENT

PART 1 - GENERAL

1.01 SCOPE

- A. This work shall consist of installing the equipment specified in this section of the specifications in the laboratory.
- B. Required plumbing will be specified under Section 15150.
- C. Electrical work as specified under Section 16010

1.02 SUBMITTAL OF INFORMATION

- A. Submit manufacturers data showing dimensional information and materials of construction including accessories.
- B. Operation and maintenance manuals shall be submitted in accordance with Section 01001, Paragraph 1.18 of these specifications.

1.03 WARRANTY:

- A. The Contractor shall warrant the listed equipment being supplied to the Owner, including installation, against defects and material for a period of at least one year commencing upon approval and acceptance of a fully functioning system.

PART 2 - PRODUCTS

2.01 DUCTED FUME HOOD

- A. The Ducted Fume Hood shall be Basic 47 Series as manufactured by LABCONCO or approved equal, installed as shown on the plan.
- B. Dimensions
 - a) Overall Width: 48 in
 - b) Overall Depth: 31.7 in
 - c) Overall Height: 66 in

- C. By-Pass Air Flow with Blower Included
- D. 75 dBA of Maximum Sound Level
- E. Digital Display Type
- F. Powder Coated Housing Finish
- G. Incandescent Lighting Type
- H. Equipment shall be 100-115V AC / 60 Hz / 10 A / 1 phase

2.02 STERILIZER

- A. The Sterilizer shall be BioClave B4000-28-120 as manufactured by Benchmark Scientific or approved equal, installed as shown on the plan.
- B. Dimensions
 - a) Overall Width: 25 in
 - b) Overall Depth: 25 in
 - c) Overall Height: 22 in
- C. 209 lbs of Weight.
- D. Equipment shall be 100 or 230V AC / 60 Hz / 2300 W

2.03 INCUBATOR

- A. The Refrigerated Forced Air Incubator shall be SRI6P as manufactured by SHEL LAB or approved equal, installed as shown on the plan.
- B. 6.5 cu ft of Capacity
- C. Dimensions
 - a) Overall Width: 30 in
 - b) Overall Depth: 31-1/2 in
 - c) Overall Height: 33-1/2 in

- D. By-Pass Air Flow with Blower Included
- E. 125 lbs of Weight.
- F. Equipment shall be 100 – 120 V AC / 60 Hz / 360 W
- G. Temperature Settings:
 - a) Maximum Temperature Setting: 40 °C
 - b) Minimum Temperature Setting: Ambient + 15°C
 - c) Temperature Accuracy Tolerance: +/-0.5°C @ 20°C
- H. Digital Display Type
- I. Minimum 2 Shelves
- J. 80% Maximum Humidity
- K. Shelf Capacity: 75 lb
- L. Steel Housing and Door
- M. Aluminum Interior

2.04 CONVECTION OVEN

- A. The Forced Air Convection Oven shall be SMO3 as manufactured by SHEL LAB or approved equal, installed as shown on the plan.
- B. 3 cu ft of capacity.
- C. Horizontal Forced Airflow.
- D. Dimensions
 - a) Overall Width: 26-7/8 in
 - b) Overall Depth: 28-5/8 in
 - c) Overall Height: 34 in
- E. Equipment shall be 100 – 120 V AC / 60 Hz / 650 W

- F. Maximum Temperature: 306 °C
- G. Temperature Accuracy Tolerance +/-2.0°C @ 150°C
- H. Temperature Uniformity 1.8°C
- I. Preheat Time: 20 min to 150°C
- J. Plug Type: 5-15P
- K. Digital Single Screen Control
- L. Number of Shelves: 7
- M. Interior Material: Stainless Steel
- N. Painted Steel Housing
- O. Stainless Steel Door
- P. Embedded Microprocessor Control

2.05 REFRIGERATOR

- A. The Upright Style Refrigerator shall be ABT-HC-RFP-20 as manufactured by AMERICAN BIOTECH SUPPLY or approved equal, installed as shown on the plan.
- B. 20 cu ft of capacity.
- C. Dimensions
 - a) Overall Width: 30-3/4 in
 - b) Overall Depth: 29 in
 - c) Overall Height: 6-1/4 ft
- D. Swing Solid Door Type
- E. Digital Temperature Display
- F. Temperature Range

- a) Minimum Refrigerator Temperature: 1 °C
- b) Maximum Refrigerator Temperature: 10 °C
- c) Temperature Accuracy Tolerance: +/-1°C
- G. Refrigerant Type: R-600a
- H. Equipment shall be 115V / 2.5 A / 60 Hz
- I. NEMA 5-15 Plug Type
- J. 3,500 RPM Compressor Speed
- K. Number of Shelves: 5
- L. 235 lb of weight

PART 3 - EXECUTION

3.1 INSTALLATION

- M. Contractor shall install the equipment at the locations shown on the plans. Installation shall comply with manufacturer's instructions and recommended installation practices. Contractor shall advise of any conflict between field conditions and manufacturers recommended installation procedures prior to installation.

END OF SECTION

D. CONTROL SPECIFICATIONS

SECTION 13300
INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS
GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

- A. The Contractor shall provide, through the services of a process control system subcontractor (PCSS), all components, system installation services and specified ancillary services in connection with the instrumentation, control and information system. The system includes all materials, labor, tools, fees, charges and documentation required to furnish, install, test and place in operation a complete and operable instrumentation, control and information system as shown and/or specified. The system shall include all measuring elements, signal converters, transmitters, local control panels, digital hardware and software, operator workstations, signal and data transmission systems, interconnecting wiring and such accessories as shown, specified, and/or required to provide the functions indicated.
- B. The scope of the work to be performed by the instrumentation and control system supplier includes but is not limited to the following:
1. The Contractor shall retain overall responsibility for the instrumentation and control system as specified herein.
 2. Furnish process instrumentation and associated taps and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.
 3. Furnish SCADA control panels as shown on the drawings.
 4. Furnish digital control system hardware and software.
 5. Furnish and terminate control system fiber optic communication network cables.
 6. Furnish and install surge protection devices for all digital equipment, local control panels, and instrumentation provided under this Division.
 7. Coordinate grounding requirements with the electrical subcontractor for all digital equipment, local control panels and instrumentation provided under this Division. Terminate grounding system cables at all equipment provided under this Division.
 8. Furnish and install surge protection devices for all digital equipment, local control panels, remote telemetry units, and instrumentation provided under this Division.
 9. Provide system testing, calibration, training and startup services as specified herein and as required to make all systems fully operational.
- C. It is the intent of the Contract documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

1.02 RELATED ITEMS

- A. Field mounted switches, torque switches, limit switches, gauges, valve and gate operator position transmitters and other instrumentation and controls furnished with mechanical or electrical equipment not listed in the instrument schedule shall be furnished, installed, tested and calibrated as specified under other Divisions.
- B. Additional and related work performed under Electrical includes the following:
 - 1. Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, and A.C. power supplies for all equipment, control panels and accessories furnished under instrumentation and control sections.
 - 2. Conduit and raceways for all instrumentation and control system signal wiring, grounding systems, special cables, and data highway cables.
 - 3. Instrumentation and control system signal wiring.
 - 4. Install data highway network cables (non-fiber).
 - 5. Furnish and install grounding systems for all digital equipment, local control panels, remote telemetry units, and instrumentation provided.
 - 6. Termination of all instrumentation and control system signal wiring at all equipment furnished under other divisions of the Specifications.
 - 7. Final wiring and termination to A.C. grounding systems and to A.C. power sources (e.g. panelboards, motor control centers, and other sources of electrical power).

1.03 GENERAL INFORMATION AND DESCRIPTION

- A. Where manufacturers are named for a particular item of equipment, it is intended as a guide to acceptable quality and performance and does not exempt such equipment from the requirements of these Specifications or Drawings.
- B. In order to centralize responsibility, it is required that all equipment (including field instrumentation and control system hardware and software) offered under instrumentation and controls shall be furnished by the instrumentation subcontractor, or under the supervision of the PCSS. The PCSS shall assume complete responsibility for proper operation of the instrumentation and control system equipment, including that of coordinating all signals, and furnishing all appurtenant equipment.
- C. The Contractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and control system as well as equipment and controls furnished under other Divisions of the Specifications. The Contractor shall be responsible for the delivery of all detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment and/or systems and shall provide for the services of a qualified installation engineer to supervise all activities required to place the completed facility in stable operation

under full digital control.

- D. The instrumentation and control system shall be capable of simultaneously implementing all real-time control and information system functions, and servicing all operator service requests as specified, without degrading the data handling and processing capability of any system component. It shall also be possible to simultaneously generate displays on all workstations without degradation of system performance.
- E. The process and instrumentation diagrams, and electrical control schematics, describes the real-time monitoring and control functions to be performed. In addition, the system shall provide various man/machine interface and data reporting functions as specified in the software sections of this Specification.
- F. The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field-mounted equipment provided by others. The PCSS shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this contract. The PCSS shall inspect all equipment, panels, instrumentation, controls and appurtenances furnished under other divisions of the specifications to determine all requirements to interface with the control and information system. The contractor shall coordinate the completion of any required modifications with the associated supplier of the item furnished.
- G. The PCSS shall review and approve the size and routing of all instrumentation and control cable and conduit systems furnished by the electrical subcontractor for suitability for use with the associated cable system.
- H. The contractor shall coordinate the efforts of each supplier to aid in interfacing all systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the electrical subcontractor and to the PCSS furnishing the equipment under this Division.
- I. The contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.
- J. The owner and/or construction manager shall have the right of access to the subcontractor's facility and the facilities of his equipment suppliers to inspect materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records and certifications during any stage of design, fabrication and tests. The PCSS and his equipment suppliers shall furnish office space, supplies and services required for these surveillance activities.
- K. The terms "Instrumentation", "Instrumentation and Control System", "Instrumentation, Control and Information System" and "Process Control System" shall hereinafter be defined as all equipment, labor, services and documents necessary to meet the intent of the specifications.

1.04 INSTRUMENTATION AND CONTROL SYSTEM SUBCONTRACTOR

- A. The instrumentation and control system subcontractor shall be Control Instruments Inc. Smyrna, Georgia (404) 351-1085.

1.05 DEFINITIONS

- A. Solid State: Wherever the term solid state is used to describe circuitry or components in the Specifications, it is intended that the circuitry or components shall be of the type that convey electrons by means of solid materials such as crystals or that work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, mechanical relays, stepping motors or other devices will not be considered as satisfying the requirements for solid state components of circuitry.
- B. Bit or Data Bit: Whenever the terms bit or data bit are used in the Specification, it is intended that one bit shall be equivalent to one binary digit of information. In specifying data transmission rate, the bit rate or data bit rate shall be the number of binary digits transmitted per second and shall not necessarily be equal to either the maximum pulse rate or average pulse rate.
- C. Integrated Circuit: Integrated circuit shall mean the physical realization of a number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.
- D. Mean Time Between Failures (MTBF): The MTBF shall be calculated by taking the number of system operating hours logged during an arbitrary period of not less than six months and divided by the number of failures experienced during this period plus one.
- E. Mean Time to Repair (MTTR): The MTTR shall be calculated by taking the total system down time for repair over an arbitrary period of not less than six months coinciding with that used for calculation of MTBF and dividing by the number of failures causing down time during the period.
- F. Availability: The availability of a nonredundant device or system shall be related to its MTBF and MTTR by the following formula:

$$A = 100 \times (\text{MTBF} / (\text{MTBF} + \text{MTTR})) \text{ Percent}$$

The availability of a device or system provided with an automatically switched backup device or system shall be determined by the following formula:

$$A = A_2 + 1 - ((1-A_1) \times (1-A_1))$$

where

$\hat{A}_1$ = availability of nonredundant device or system

A_2 = availability of device or system provided with an automatically switched backup device or system

- G. Abbreviations: Specification abbreviations include the following:

A Availability

ADC	Analog to Digital Converter
AI	Analog Input
AO	Analog Output
AVAIL	Available
BCD	Binary Coded Decimal
CSMA/	Carrier Sense Multiple Access/Collision
̂CPU	̂Central Processing Unit
CRC	Cyclic Redundancy Check
CRT	Cathode Ray Tube
CS	Control Strategy
DAC	Digital to Analog Converter
DBMS	Data Base Management System
DI	Discrete Input
DMA	Direct Memory Access
DO	Discrete Output
DPDT	Double Pole, Double Throw
DVE	Digital to Video Electronics
EPROM	Erasable, Programmable Read Only
FDM	̂Frequency Division Multiplexing
FSK	Frequency Shift Keyed
HMI	Human Machine Interface (Software)
I/O	Input/Output
LAN	Local Area Network
LDFW	Lead-Follow
MCC	Motor Control Center
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
OS	Operating System
PCB	Printed Circuit Board
PID	Proportional Integral and Derivative
PLC	̂Programmable Logic Controller
PROM	Programmable Read Only Memory
RAM	Random Access Memory
RDY	Ready
RMSS	Root Mean Square Summation
RNG	Running
ROM	Read Only Memory

RTU	Remote Telemetry Unit
SPDT	Single Pole, Double Throw
ST/SP	Start/Stop
TDM	Time Division Multiplexing
UPS	Uninterruptible Power Supply

- H. To minimize the number of characters in words used in textual descriptions on HMI displays, printouts and nameplates, abbreviations may be used subject to the construction manager's approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

1.06 ENVIRONMENTAL CONDITIONS

- A. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.
- B. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees C; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (i.e., for dust).
- C. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees C with relative humidity between 40 and 95 percent.
- D. Field equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 degrees C and relative humidity from 10 to 100 percent. All supports, brackets and interconnecting hardware shall be aluminum or 316 stainless steel as shown on the installation detail drawings.

1.07 SIGNAL COORDINATION REQUIREMENTS

- A. The contractor shall conform to the signal coordination requirements specified herein.
- B. The contractor shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, the electrical subcontractor, the HVAC subcontractor, and the instrumentation subcontractor.
- C. Analog signals shall be signals for transmitting process variables, etc. from instruments and to and from panels, equipment and control system PLCs.
- D. Discrete signals shall consist of contact closures or powered signals for transmitting status/alarm information and control commands between starters, panels, equipment PLCs, the Control System, etc.

E. ANALOG SIGNAL TRANSMISSION

1. Signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 milliamperes and shall operate at 24 volts D.C.
2. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.
3. All cable shields shall be grounded at one end only, at the control panel, with terminals bonded to the panel ground bus.
4. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels, and appurtenances.
5. Non-standard transmission systems such as pulse duration, pulse rate, and voltage regulated shall not be permitted except where specifically noted in the contract documents. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 mA signal.
6. The contractor shall provide 24 V power supplies for analog signals and instruments where applicable and as required inside panels, controls, etc.
7. Where two-wire instruments transmit directly to the control and information system, the instrumentation subcontractor shall provide power supplies at the PLC control panels for those instruments.
8. Where four-wire instruments with on-board loop power supplies transmit directly to the control and information system, the instrumentation subcontractor shall provide necessary signal isolators or shall otherwise isolate the input from the control and information system loop power supply. Similar provisions shall be made when a third element such as a recorder, indicator, or single loop controller with integral loop power supply is included in the loop.

F. DISCRETE INPUTS

1. All discrete inputs to equipment and control and information system PLC, from field devices, starters, panels, etc., shall be unpowered (dry) contacts in the field device or equipment, powered from the PLC, unless specified otherwise.
2. Sensing power (wetting voltage) supplied by the PLCs shall be 24 VDC.

G. DISCRETE OUTPUTS

1. All discrete outputs from local control panels and control and information system PLCs to field devices, starters, panels, etc., shall be dry contact relay outputs.
2. Where required or specified herein, discrete outputs from equipment and control and information system PLC to field devices, starters, panels, motor operated valves, etc., shall be dry contact or relay outputs.

H. OTHER DISCRETE SIGNALS

1. Where applicable, warning signs shall be affixed inside the starter, panel, etc. stating that the panel is energized from multiple sources.
2. Output contacts in the starter, panel, etc., that are powered from other locations shall be provided with special tags and/or color-coding. Disconnecting terminal strips shall be provided for such contacts.
3. The above requirements shall apply to all starters and panels, regardless of supplier.

PART 2 - PRODUCTS

2.01 NAMEPLATES

- A. All items of equipment listed in the instrument schedule, control panels, and all items of digital hardware shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number and description. Abbreviations of the description shall be subject to the construction manager's approval.
- B. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background.
- C. Nameplates shall be attached to metal equipment by stainless steel screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of stainless-steel wire.

3.01 FINAL ACCEPTANCE

- A. Final acceptance of the instrumentation, control and information system will be determined complete by the construction manager, and shall be based upon the following:
 1. Receipt of acceptable start-up completion and availability reports and other documentation as required by the contract documents.
 2. Completion of the Availability Demonstration
 3. Completion of all punch-list items that are significant.
- B. Final acceptance of the system shall mark the beginning of the extended warranty period. The warranty shall be one year from final acceptance.

END OF SECTION

SECTION 13302
CONTROL AND INFORMATION SYSTEM SUBMITTALS

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The contractor shall submit for review, complete shop drawings for all equipment in accordance with the General Conditions and Division 1 of the specifications. All submittal material shall be complete, legible, and reproducible, and shall apply specifically to this project.

1.02 DIGITAL HARDWARE SUBMITTALS

- A. Submit system block diagram(s) showing:
1. All equipment to be provided.
 2. All interconnecting cable.
 3. Equipment names, manufacturer, and model numbers.
 4. Equipment locations.
- B. Submit information for all digital equipment including, but not limited to, the following:
1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
 2. Catalog cuts.
 3. Complete technical, material and environmental specifications.
 4. Assembly drawings.
 5. Mounting requirements.
 6. Color samples.
 7. Nameplates.
 8. Environmental requirements during storage and operation.

1.03 SOFTWARE SUBMITTALS

- A. Software submittals shall include the following as a minimum:

1. Bill of materials with software names, vendors, and complete listings of included software modules.
 2. Standard manufacturer's literature describing the products.
 3. Description of function of software in Control and Information System.
 4. Limitations or constraints of software.
 5. Minimum system (processor and memory) requirements.
 6. Operation and maintenance requirements.
- B. Submit information on the following software:
1. Third-party software, including:
 - a. Operating system.
 - b. Programmable logic controller programming software (where applicable).
 2. Software configuration, including:
 - a. Graphic display organization.
 - b. Database configuration for operator workstations and database management system.
 - c. Trends.
 - d. System security.
 - e. Formats for all reports, including all required calculations.
 - f. Intercommunications between software products required to implement system functions.
 - g. Equipment backup configuration and requirements.
- C. Control Strategies
1. Provide control strategy documentation that includes control strategy diagrams (either block oriented logic or ladder logic diagrams, as appropriate) to describe the control of all processes. The written description shall follow the format of the functional control descriptions contained herein. The control strategy submittals shall contain the following as a minimum:
 - a. An overall description of the program structure and how it will meet the

specified control requirements.

- b. A listing of the program.
- c. Extensive comments in the listings to describe program steps.
- d. Equation and ladder program derivations for all specified control routines.
- e. Resource (processor and memory) requirements.
- f. A listing of inputs and outputs to the control strategy.

D. Application Software

- 1. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.
- 2. Application software includes all custom routines developed specifically for this project, or pre-written routines used for accomplishing specified functions for this project. This shall include VBASIC and C programs, and any other add-in custom software.

E. Graphic Displays

- 1. Submit all graphic displays required to perform the control and operator interface functions specified herein for the new operator interface panel.
- 2. Submit graphic displays for review by the Owner and the Engineer at least 60 days prior to commencement of factory testing.
- 3. The Contractor shall allow for one major cycle of revisions to the displays prior to factory testing and one minor cycle of revisions following factory test. A cycle of revisions shall be defined as all revisions necessary to complete a single set of changes marked by the Engineer. Additional corrections shall be performed during start-up as required to accommodate changes required by actual field conditions, at no additional cost to the Owner.
- 4. Two of the required submittals in each revision cycle shall be full color prints of the entire set of displays. Additional sets may be in black-and-white or grayscale.
- 5. Displays shall be printouts of actual process graphics implemented in the system.

1.04 CONTROL PANEL SUBMITTALS

- A. Submittals shall be provided for all control panels, and shall include:
 - 1. Exterior panel drawings with front and side views, to scale.
 - 2. Interior layout drawings showing the locations and sizes of all equipment and wiring mounted within the cabinet, to scale.
 - 3. Panel area reserved for cable access and conduit entry.
 - 4. Location plans showing each panel in its assigned location.
- B. Submit information for all exterior and interior panel mounted equipment including, but not limited to, the following:
 - 1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.
 - 2. Catalog cuts.
 - 3. Complete technical, material and environmental specifications.
 - 4. Assembly drawings.
 - 5. Mounting requirements.
 - 6. Color samples.
 - 7. Nameplates.
 - 8. Environmental requirements during storage and operation.
- C. Submit panel wiring diagrams showing power, signal, and control wiring, including surge protection, relays, courtesy receptacles, lighting, wire size and color coding, etc.

1.05 INSTRUMENT SUBMITTALS

- A. Submit information on all field instruments, including but not limited to the following:
 - 1. Product (item) name and tag number used herein and on the Contract Drawings.
 - 2. Catalog cuts.
 - 3. Manufacturer's complete model number.

4. Location of the device.
5. Input - output characteristics.
6. Range, size, and graduations.
7. Physical size with dimensions, NEMA enclosure classification and mounting details.
8. Materials of construction of all enclosures, wetted parts and major components.
9. Instrument or control device sizing calculations where applicable.
10. Certified calibration data on all flow metering devices.
11. Environmental requirements during storage and operation.
12. Associated surge protection devices.

1.06 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall deliver equipment operation and maintenance manuals. Operation in two basic parts:
 1. Manufacturer standard O&M manuals for all equipment and software furnished under this Division.
 2. Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.
- B. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.
- C. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include trouble shooting data and full preventive maintenance schedules. The instructions shall be bound in locking 3-D-ring binders with bindings no larger than 3.5 inches. The manuals shall include 15% spare space

for the addition of future material. The instructions shall include drawings reduced or folded and shall provide the following as a minimum.

1. A comprehensive index.
 2. A functional description of the entire system, with references to drawings and instructions.
 3. A complete "as-built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.
 4. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.
 5. Full specifications on each item.
 6. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.
 7. References to manufacturers' standard literature where applicable.
 8. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.
- D. The operating instructions shall clearly describe the step-by-step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.
- E. The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.
- F. The hardware maintenance documentation shall include, as a minimum, the following information:
1. Operation Information - This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.
 2. Preventive Maintenance Instructions - These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and

the adjustments necessary for periodic preventive maintenance of the System.

3. Corrective Maintenance Instructions - These instructions shall include guides for locating malfunctions down to the card-replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.
 4. Parts Information - This information shall include the identification of each replaceable or field-repairable component. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross-references between equipment numbers and manufacturer's part numbers shall be provided.
- G. Software documentation shall conform to a standard format and shall include, but not be limited to, the following:
1. A program abstract that includes:
 - a. Program Name - The symbolic alphanumeric program name.
 - b. Program Title - English text identification.
 - c. Program Synopsis - A brief text shall be provided that specifies the need for the program, states when it shall be used and functionally describes all inputs, outputs and functions performed. This descriptive text shall be written in a language that is understandable by non-software oriented readers.
 2. A program description that shall include, but not be limited to, the following:
 - a. Applicable Documents - List all documents (standard manufacturer's literature, other program descriptions, etc.) by section, if practical, that apply to the program. One complete copy of all applicable reference material shall be provided.
 - b. Input-Output - Identify each input and output parameter, variable, and software element used by the program. State the purpose of all inputs, outputs, and variables.
 - c. Processing - This section shall contain a description of the overall structure and function of the program. Describe the program run stream and present a detailed description of how the program operates. Describe the timing and sequencing of operations of the program relative to other programs. Describe all interactions with other programs. Processing logic that is not

readily described without considerable background information shall be handled as a special topic with references to an appendix or to control strategy document that details the necessary information. Reference shall also be made to an appendix or control strategy document for equation and program algorithm derivations.

- d. System Configuration - Describe in detail the system configuration or status required for program implementation, if appropriate.
- e. Limitation and Constraints - Summarize all known or anticipated limitations of the program, if appropriate.
- f. Storage - Define program storage requirements in terms of disk or RAM memory allocation.
- g. Verification - Describe, as a minimum, a test that can be used by the operator to assure proper program operation. Define the required system configuration, input requirements and criteria for successful test completion.
- h. Diagnostics - Describe all program diagnostics, where applicable. Descriptions shall list each error statement, indicate clearly what it means, and specify what appropriate actions should be taken.
- i. Malfunction Procedures - Specify procedures to follow for recovering from a malfunction due to either operator error or other sources.

1.07 FINAL SYSTEM DOCUMENTATION

- A. All documentation shall be delivered to the Owner/Construction Manager prior to final system acceptance in accordance with the contract documents. As a minimum, final documentation shall contain all information originally part of the control system submittals.
- B. If any documentation or other technical information submitted is considered proprietary, such information shall be designated. Documentation or technical information which is designated as being proprietary will be used only for the construction, operation, or maintenance of the system and, to the extent permitted by law, will not be published or otherwise disclosed.
- C. Provide a complete set of detailed electrical interconnection diagrams required to define the complete instrumentation and control system. All diagrams shall be 11 X 17-inch original reproducible prints. All diagrams shall be corrected so as to describe final "as-built" hardware configurations and to reflect the system

configuration and control methodology adopted to achieve final system acceptance.

- D. Provide system software documentation for the operation and maintenance of all system software programs provided as a part of the digital system. All system software documentation shall be amended as required to delineate all modifications and to accurately reflect the final as-built software configurations.
- E. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.
- F. Provide control strategy documentation which shall include control strategy (block oriented or ladder logic) diagrams to describe the control of all processes. Control strategy documentation shall reflect the system configuration and control methodology adopted to achieve final system acceptance. Control strategy documentation shall conform to the submittal requirements listed hereinabove.
- G. O&M documentation shall be amended with all final, adjusted values for all setpoints and other operating parameters for Owner reference.
- H. The Owner recognizes the fact that not all possible problems related to real-time events, software interlocks, flags, active tasks, and hardware maintenance and utilization can be discovered during the Acceptance Tests. Therefore, the instrumentation subcontractor through the contractor shall investigate, diagnose, repair, update, and distribute all pertaining documentation of the deficiencies that become evident during the warranty period. All such documentation shall be submitted in writing to the Owner/Construction Manager within 30 days of identifying and solving the problem.

1.08 PROGRAMS AND SOURCE LISTINGS

- A. Provide two copies of all standard, of-the-shelf system and application software (exclusive of firmware resident software) on tape or disk. One copy shall be the original tapes or disks from the manufacturer, with one additional copy for backup purposes.
- B. Provide two copies of source listings on tape or disk for all custom software written specifically for this facility, all database files configured for this facility, and all control strategies. All source listings shall include a program abstract, program linkage and input/output data. Comments describing the program flow shall be frequently interspersed throughout each listing.

END OF SECTION

SECTION 13303
CONTROL AND INFORMATION SYSTEM TRAINING REQUIREMENTS

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. To familiarize the Owner's personnel with the process control system and field instrumentation, training shall be provided as detailed hereunder.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 13300 – Instrumentation and Control for Process Systems - General Requirements

1.03 SUBMITTALS

- A. A minimum of 60 days prior to beginning training, submit a detailed training plan describing the following:
 - 1. A listing of all subjects to be covered.
 - 2. Course schedule.
 - 3. Documentation/lesson plans covering all subjects to be covered during the course instruction. Information shall be in a "how to" format, with sufficient background documentation and references to manufacturer literature to provide a thorough and clear understanding of the materials to be covered.
 - 4. Course schedules.
 - 5. Qualifications and experience of individual(s) providing training.

1.04 GENERAL REQUIREMENTS

- A. All costs of providing the training courses shall be borne by the Contractor.
- B. As used herein, the term "day" shall mean an eight-hour day, and the term "week" shall mean a five-day, 40-hour week.
- C. All training courses shall be conducted under the direction of a training director who shall design a detailed training plan that complements the experience and skill levels of the Owner's personnel.
- D. All training courses shall include lecture as well as "hands on" experience for each of the attending personnel. The Contractor shall provide sufficient equipment for this to be accomplished. For example, training in which the instructor uses the computer and the Owner's personnel passively observe as the instructor

demonstrates system functions shall not be acceptable.

- E. Unless otherwise specified, all training courses shall be conducted in the Owner's facilities.
- F. All training shall be completed prior to system acceptance.

1.05 OPERATOR TRAINING

- A. Provide three days of Operator training for staff to provide instruction in the use of the Control and Information System to monitor and control the facility.
- B. Operator training shall include refresher training covering the Control and Information System. Operators shall be instructed in the names, locations, functions, and basic operation of all items of digital equipment and associated software.
- C. Operator training shall cover process and equipment operation both individually and collectively as an operating system. Normal as well as abnormal operating conditions shall be covered, including the response to failure occurrences and system alarms. All operator/system interactions shall be described.
- D. Operators shall be trained to instruct other operators and shall be provided with all course materials.

1.06 MAINTENANCE TRAINING

- A. A one-day refresher-level course shall be conducted for at least six persons prior to the start-up of digital equipment at the pump station. Instruction shall be provided in the following:
 - 1. Operating all digital equipment, including system start-up and shutdown procedures.
 - 2. The use of hardware diagnostic routines, test equipment and test procedures as required to enable the Owner's personnel to detect and isolate system faults to the circuit board or module level and to implement repairs by replacing failed circuit boards or modules.
 - 3. Calibration and routine maintenance procedures for all analog and digital equipment.
- B. Step by step written procedures shall be provided for all preventive maintenance tasks and for identifying hardware faults to the circuit board or module level for all items of digital equipment.
- C. All digital equipment preventive and corrective maintenance training activities shall be limited to the use of commercially available off-the-shelf test equipment and to

the use of diagnostic routines and hardware items which are the same as those to be provided as part of the system.

1.07 INSTRUMENT TRAINING

- A. A one-day refresher-level course shall be provided at the Owner's facilities no more than three months prior to system start-up to instruct a minimum of five persons each in the calibration and preventive maintenance of the field instruments provided under this Contract.

END OF SECTION

SECTION 13304
CONTROL AND INFORMATION SYSTEM QUALITY ASSURANCE

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. It is the intent of these Specifications and Drawings to secure high quality in all materials, equipment and workmanship in order to facilitate operations and maintenance of the facility. The Contractor shall provide equipment and services to meet this intent.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. All work shall be installed in accordance with the National Electric Code, National Electric Safety Code, OSHA, State, local and other applicable codes.

1.03 QUALITY ASSURANCE - GENERAL

- A. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items.
- B. For uniformity, only one manufacturer will be accepted for each type of product.
- C. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses that may occur during fabrication, transportation, and erection as well as during continuous or intermittent operation. They shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.
- D. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, which shall be of sturdy and durable construction and be suitable for long, trouble-free service.
- E. Electronic equipment shall be all solid state construction, utilizing microprocessors, unless otherwise specified. Components shall be de-rated to assure dependability and long-term stability.
- F. Printed circuit boards in field mounted equipment shall be suitable for the specified environmental conditions.
- G. Alignment and adjustments shall be non-critical, stable with temperature changes or

aging and accomplished with premium grade potentiometers.

- H. Components of specially selected values shall not be inserted into standard electronic assemblies in order to meet the performance requirements of this specification.

1.05 OPTIONAL EQUIPMENT

- A. Optional or substituted equipment or both requiring changes in details or dimensions required to maintain all structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these Specifications and Drawings shall be made at no additional cost to the Owner. In the event that the changes are necessary, calculations and drawings showing the proposed revisions shall be submitted for approval. The Contractor shall coordinate all changes with other affected trades and contracts and pay all additional charges incurred.

1.06 SHIPPING HANDLING AND STORAGE

- A. In addition to shipping, handling and storage requirements specified elsewhere in the Contract documents, air conditioning/heating shall be provided for storage of all field instrumentation, panels, digital equipment and ancillary devices to maintain temperatures between 20 and 25 degrees C and relative humidity 40 to 60 percent without condensation. The air shall be filtered and free of corrosive contaminants and moisture.

1.07 FABRICATION

- A. Fabrication of all equipment shall conform to the codes and standards outlined in this Section, and other portions of the Contract documents.
- B. The Engineer may inspect the fabricated equipment at the factory before shipment to job site. The Contractor shall provide the Engineer with sufficient prior notice so that an inspection can be arranged at the factory. Inspection of the equipment at the factory by the Engineer will be made after the manufacturer has performed satisfactory checks, adjustments, tests and operations.
- C. Equipment approval at the factory only allows the equipment to be shipped to the project site. The Contractor shall provide for the proper storage, installation and satisfactory start-up and operation of the equipment to the satisfaction of the equipment manufacturer, the instrumentation subcontractor, and the Engineer.

1.08 INSTALLATION

- A. All instrumentation and control system installation work shall conform to the codes and standards outlined in this Section, and other portions of the Contract documents.

- B. The instrumentation subcontractor shall assign a competent representative who shall provide full time coordination and supervision of all on-site instrumentation and control system construction work from commencement of construction through completion and final acceptance.
- C. All labor shall be performed by qualified craftsmen in accordance with the standards of workmanship in their profession and shall have had a minimum of three years of documented experience on similar projects.
- D. All equipment and materials shall fit properly in their installations. Any required work to correct improperly fit installations shall be performed at no additional expense to the Owner.
- E. Sufficient common-mode and differential-mode noise rejection shall be provided to insure operation of the plant process control system to meet all specification requirements. General practice shall include:
 - 1. Maintaining crossings between noisy wires and signal wires at right angles.
 - 2. Maintaining separation between noisy wires and signal wires as wide as practical.
 - 3. Grounding all signals, shields and power supplies at the process control unit or local control panel.
 - 4. Providing passive filters on signals with time constant compatible with scan intervals and overvoltage protection.
 - 5. Eliminating cable splices. All splices in instrumentation and control system signal and network cables shall be approved in advance by the Engineer.
 - 6. Providing a floating output for transmitters that have their own power sources.
- F. Separate grounding systems shall be provided for the control system AC power and DC circuits within a control system cabinet containing programmable logic controller (PLC) equipment. The AC power system ground shall be connected to the AC power ground system in the associated building. The DC ground shall be a # 6 insulated conductor routed directly from a separate copper ground bus bar in the control system cabinet to a separate DC grounding electrode outside each associated building. DC grounding electrode shall be a separate ground rod driven as specified under Section 26 05 26. The DC ground bus bar inside the control system cabinet shall be isolated from the cabinet chassis using insulated stand-offs. The DC and AC power grounding systems shall be furnished and installed in accordance with the control system manufacturer's recommendations as well as all applicable code requirements.

- G. The case of each field instrument and control panel shall be grounded in compliance with the National Electric Code.
- H. Power wires shall be separated from parallel-running signal wires by the following minimum spacing:

CIRCUIT VOLTAGE (VAC)	MINIMUM SPACING (IN.)
120	12
240	18
480	18
2000 and above	24

- I. The Contractor shall provide all required cutting, drilling, inserts, supports, bolts, and anchors, and shall securely attach all equipment and materials to their supports. Embedded supports for equipment furnished under this Division shall be provided and installed as shown specified herein and shown on the Drawings.
- J. Following acceptance of the factory tests by the Engineer and in accordance with the construction schedule, the Contractor shall commence installation of the digital control system hardware. Digital system equipment items shall not be installed, however, until all architectural, mechanical, HVAC and electrical work has been completed in the equipment rooms, MCC's, control rooms and all structural and/or mechanical work has been completed within 50 feet of equipment locations.
- K. Upon completion of the above construction work, the Contractor shall request an inspection of the above-named areas. The Engineer will issue a written approval to proceed with delivery and installation only after being satisfied that all work described above has been properly performed. Digital equipment shall remain at the factory site or storage prior to approval for delivery to the project site. Partial shipments may be required to meet construction schedule requirements.

END OF SECTION

SECTION 13305
CONTROL AND INFORMATION SYSTEM TESTING - GENERAL

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor shall test the Control and Information System as specified herein to demonstrate compliance with the Contract documents.

1.02 SUBMITTALS

- A. For each of the specified tests, submit a test plan to the Construction Manager at least one month in advance of commencement of the tests. The test plan shall contain the following at a minimum:

1. A schedule of all testing to be conducted.
2. A brief description of the testing to be performed
3. Test objectives.
4. Testing criteria per the Specifications.
5. Check lists and procedures for performing each of the specified tests.
6. Sample test result documentation.
7. Requirements for other parties.

1.03 GENERAL REQUIREMENTS

- A. All system start-up and test activities shall follow detailed test procedures; check lists, etc., previously approved by the Engineer. The Engineer shall be notified at least 21 days in advance of any system tests and reserves the right to have his and/or the Owner's representatives in attendance.
- B. The Contractor shall provide the services of experienced factory trained technicians, tools and equipment to field calibrate, test, inspect, and adjust all equipment in accordance with manufacturer's specifications and instructions.
- C. The Engineer (or designee) shall maintain master logbooks for each phase of installation, startup and testing activities specified herein. Each logbook shall include signal, loop or control strategy tag number, equipment identification, description and space for sign-off dates, Contractor signature and Construction Manager

signature. Example test documentation specific to each phase of testing shall be approved prior to initiation of that testing, as specified hereinabove.

- D. All test data shall be recorded on test forms, previously approved by the Engineer. When each test has been successfully completed, a certified copy of all test results shall be furnished to the Construction Manager together with a clear and unequivocal statement that all specified test requirements have been met and that the system is operating in accordance with the Contract documents.
- E. The Engineer will review test documentation in accordance with the Contract documents and will give written notice of the acceptability of the tests within 10 days of receipt of the test results.

END OF SECTION

SECTION 13306
CONTROL AND INFORMATION SYSTEM FIELD TESTING

PART 1 - GENERAL

1.01 REQUIREMENTS:

- A. The Contractor shall perform field testing on the Control and Information System as specified herein to demonstrate compliance with the Contract documents.

1.02 GENERAL REQUIREMENTS:

- A. Control system start-up and testing shall be performed to ensure that all plant processes shall be systematically and safely placed under digital control in the following order:
 - 1. Primary elements such as transmitters and switch devices shall be calibrated and tested.
 - 2. Each final control element shall be individually tested as specified hereinafter.
 - 3. Each control loop shall be tested as specified hereinafter.
 - 4. Each control strategy shall be tested under automatic digital control as specified hereinafter.
 - 5. The entire control system shall be tested for overall monitoring, control, communications, and information management functions, and demonstrated for system availability as specified hereinafter.
 - B. System start-up and test activities shall include the use of water, if necessary, to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.
 - C. Each phase of testing shall be fully and successfully completed and all associated documentation submitted and approved prior to the next phase being started. Specific exceptions are allowed if written approval has been obtained in advance from the Engineer.
- 1.03 CONTRACTOR'S RESPONSIBILITIES:**
- A. The Contractor shall ensure that all mechanical equipment, equipment control panels, local control panels, field instrumentation, control system equipment and

related equipment and/or systems are tested for proper installation, adjusted and calibrated on a loop-by-loop basis prior to control system startup to verify that each is ready to function as specified. Each test shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

- B. The Contractor shall be responsible for coordination of meetings with all affected trades. A meeting shall be held each morning to review the day's test schedule with all affected trades. Similarly, a meeting shall be held each evening to review the day's test results and to review or revise the next day's test schedule as appropriate.
- C. The Contractor shall ensure that the electrical subcontractor conforms with the start-up, test and sign-off procedures specified herein to assure proper function and coordination of all motor control center control and interlock circuitry and the transmission of all discrete and/or analog signals between equipment furnished by the electrical subcontractor and the control system specified herein.

1.04 FINAL CONTROL ELEMENT TESTING:

- A. The proper control of all final control elements shall be verified by tests conducted in accordance with the requirements specified herein.
- B. All modulating final control elements shall be tested for appropriate speed or position response by applying power and input demand signals, and observing the equipment for proper direction and level of reaction. Each final control element shall be tested at 0, 25, 50, 75, and 100 percent of signal input level and the results checked against specified accuracy tolerances. Final control elements, such as VFD's, that require turndown limits shall be initially set during this test.
- C. All non-modulating final control elements shall be tested for appropriate position response by applying and simulating control signals, and observing the equipment for proper reaction.

1.05 LOOP CHECKOUT:

- A. Prior to control system startup and testing, each monitoring and control loop shall be tested on an individual basis from the primary element to the final element, including the operator workstation or loop controller level, for continuity and for proper operation and calibration.
- B. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written approval by the Engineer. All modes of control shall be exercised and checked for proper operation.

- C. The accuracy of all DAC's shall be verified by manually entering engineering unit data values at the operator workstation and then reading and recording the resulting analog output data.
- D. The accuracy of all ADC's shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the operator workstation.
- E. Each loop tested shall be witnessed, dated and signed off by both the Contractor and the Engineer upon satisfactory completion.

1.06 CONTROL SYSTEM STARTUP AND TESTING:

- A. Control system startup and testing shall be performed to demonstrate complete compliance with all specified functional and operational requirements. Testing activities shall include the simulation of both normal and abnormal operating conditions.
- B. All digital hardware shall be fully inspected and tested for function, operation and continuity of circuits. All diagnostic programs shall be run to verify the proper operation of all digital equipment.
- C. Final control elements and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits.
- D. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses for final control elements. Simulated input data signals may be used subject to prior written approval by the Engineer.
- E. Each control strategy shall be tested to verify the proper operation of all required functions. The control system start-up and test activities shall include procedures for tuning all control loops incorporating PID control modules, and for adjusting and testing all control loops as required to verify specified performance.
- F. The control system start-up and test activities shall include running tests to prove that the Instrumentation, Control and Information System is capable of continuously, safely and reliably regulating processes, as required by the Contract, under service conditions that simulate, to the greatest extent possible, normal plant operating ranges and environmental conditions.

- G. A witnessed functional acceptance test shall be performed to demonstrate satisfactory performance of individual monitoring and control loops and control strategies. At least one test shall be performed to verify that the control and instrumentation system is capable of simultaneously implementing all specified operations.
 - H. Each loop and control strategy test shall be witnessed and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.
- 1.07 FACILITY STARTUP COORDINATION:
- A. Facility start-up shall comply with requirements specified in the Contract documents and those requirements specified herein. Facility start-up shall commence after all previously described start-up and test activities have been successfully completed and shall demonstrate that the Instrumentation, Control and Information System can meet all Contract requirements with equipment operating over full operating ranges under actual operating conditions.
 - B. The control system start-up period shall be coordinated with process startup activities and shall be extended as required until all plant processes are fully operational and to satisfy the Engineer that all control system Contract requirements have been fulfilled in accordance with the Contract documents.

END OF SECTION

SECTION 13307
CONTROL AND INFORMATION SYSTEM FACTORY TESTING

PART 1 - GENERAL

1.01 REQUIREMENTS:

- A. The Contractor shall perform a Factory Acceptance Test on the Control and Information System as specified herein to demonstrate compliance with the Contract documents. Factory acceptance testing will be witnessed by two (2) persons from Owner's and/or Engineer's staff.

1.02 FACTORY ACCEPTANCE TEST

- A. The Control and Information System equipment shall not be shipped until the Contractor receives notice of acceptability of the factory tests.
- B. Each item of equipment shall be fully factory inspected, calibrated and tested for function, operation and continuity of circuits. Exceptions shall be approved in writing by the Engineer.
- C. Each subsystem shall be fully factory tested for function and operation. As a minimum, all tests shall conform to "Hardware Testing of Digital Process Computers", recommended practice RP55.1. International Society of Automation.
- D. System performance shall be tested using a fully integrated system, including all software and hardware. To achieve this, the entire control system, including all peripheral devices and all interconnecting cables (field instruments are not included in this requirement), shall be assembled on the factory test floor and the complete operational program loaded and simulated inputs applied.
- E. All hardware and software required to perform the specified testing shall be furnished by the Contractor at no additional cost to the Owner.
- F. The instrumentation subcontractor shall perform a 100-hour full system test, during which the entire system shall operate continuously without failure in accordance with the requirements of the Contract documents. If a system component fails during the test, the 100-hour test period shall be restarted after its operation is restored.
- G. The factory testing shall demonstrate all aspects of system sizing and timing including:
 - 1. Monitoring and control scan times at the PLC level.
 - 2. Response times at the OIT level.

- H. The overall system as well as individual component hardware shall be tested under conditions of power failure to ensure proper response as specified herein.
- I. Operator Interface Terminal Operation - This demonstration shall provide proof of system operation on an individual subsystem basis first, and then in the expected operating environment. Both normal and abnormal operating modes shall be demonstrated. Operator workstation testing shall include the following:
 - 1. Demonstrate proper operation, under both normal and abnormal conditions of the Operator Interface Terminal application software (SCADA, remote alarm dial-up, etc.). This shall include demonstration of system on-line diagnostics, fail-over features, reconfiguration operations, system initialization and restart, software fault tolerance, error detection and recovery, communications, and all additional features necessary to assure the successful operation of the system.
 - 2. Demonstrate the standard features of the system. This shall include proof of operation of the process control database generator, the display generator, data storage and retrieval functions, data acquisition and control, trending functions, and reporting functions.
 - 3. Demonstrate the configuration of the system to verify conformance with the Contract documents. This shall include graphic displays and vectoring, operator interface functions, trending, reports, alarm management, security system configuration, etc.
 - 4. The system shall be operated with data input/output with the PLC's and associated panels to prove operation of all workstation functions.
 - 5. The testing in Items 2 and 3 above may be performed concurrently (i.e., the standard and configured features of the system may be demonstrated simultaneously).
- J. PLC Operation - All functions comparable to those demonstrated for the operator workstations shall be demonstrated on the PLCs. This shall include the following:
 - 1. On-line and off-line diagnostics.
 - 2. For redundant units, fail-over operation and reconfiguration.
 - 3. System initialization and restart.
 - 4. Network communications, including fieldbus communications where required.
 - 5. Non-volatility of memory.
 - 6. Operation of all control logic shall be demonstrated as described herein.

- K. Process I/O Simulation - Process input/output simulation for PLCs shall be performed with a manual simulation control panel, a separate programmable logic controller, network-based simulation software, analog signal generators, and/or jumpering of discrete signals between outputs and associated inputs, or some combination of these. Alternate process I/O systems such as plug-in circuit cards or I/O test modules may be utilized subject to approval by the Construction Manager to provide the specified simulation functions. The simulation system shall provide analog and discrete I/O hardware devices in sufficient quantity to allow complete and thorough testing of the control strategies and functions of the system. The process I/O simulation system shall be used in several ways as follows:
1. To provide a means of communications checkout from the operator workstations through the various levels of software in the PLC's and to the process, i.e., the simulation panel. Likewise, a discrete or analog input shall be initiated from the simulation panel and the result monitored at the workstations.
 2. Alarm response to discrete status changes or analog value limits shall be verified. Database entries or attributes such as engineering units and conversion equations shall be verified by varying analog inputs.
 3. To provide data for use at all levels of the control system at the time of system integration.
- L. Control Strategy Testing - Provision shall be made to test all control strategies to prove the integrity of each strategy and the process control language in which it is implemented. For each control strategy, all functions shall be tested individually (where possible) and collectively to verify that the control strategy performs as described herein and as required for overall functionality within the control system.

END OF SECTION

SECTION 13308
CONTROL AND INFORMATION SYSTEM FINAL ACCEPTANCE TESTING

PART 1 - GENERAL

1.01 REQUIREMENTS:

- A. The CONTRACTOR shall perform the Final Acceptance Test on the Control and Information System as specified herein to demonstrate compliance with the Contract documents.

1.02 AVAILABILITY DEMONSTRATION AND FINAL SYSTEM ACCEPTANCE:

- A. Upon completion of all control system startup activities and prior to final system acceptance, the Contractor shall demonstrate that the availability of the entire control system, including operation under conditions of digital equipment fail-over, initiated either automatically or manually, shall be not less than 99.8 percent during a 30-day availability test period. The Owner/Engineer shall be given two (2) weeks notice of the starting date of the 30-day availability test.
- B. For purposes of determining availability figures, downtime of each system or portions of each system resulting from the causes specified hereunder will not be considered system failures.
1. Downtime of any Ethernet-connected device that is automatically backed-up upon failure shall not be considered a system failure provided that the downtime of the failed component does not exceed 24 hours.
 2. Downtime of a PLC that is not automatically backed-up shall be considered a system failure.
 3. Downtime of a portion of the system resulting from failure of any field sensor shall not be considered a system failure provided that the system operates as specified under this condition.
 4. The failure of the same component more than one time during the 30-day test shall be considered a system failure.
- C. If the system fails the 30-day availability test, the 30-day test period shall be restarted after the failed component or software is repaired/replaced and full operation is restored.
- D. The Contractor shall submit an availability demonstration report that shall state that all system availability requirements have been met.

END OF SECTION

SECTION 13310
PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.01 REQUIREMENTS:

- A. This section specifies requirements for small and medium programmable logic controllers (PLC) designed to execute discrete and continuous control logic with high reliability in industrial applications.
- B. All PLC provided for this project shall comply with the requirements of this section. PLCs provided with vendor package systems are provided by the equipment manufacturer. Other PLCs are provided by the systems integrator.
- C. The Owner has standardized on Allen-Bradley PLC systems as specified herein. Allen-Bradley PLCs shall be provided for process control systems without exception on this project.
- D. Manufacturer
 - 1. The Owner requires the specified manufacturer to provide the equipment and/or products to be furnished under this Section. The Owner believes the manufacturer is capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed to mean that the named Manufacturer's standard product will comply with the requirements of this Section.
 - 2. Manufacturers and models shall be as specified for the purpose of compatible and efficient utilization of existing equipment, supplies, and personnel training and experience, no substitutions are permitted.
- E. Equipment and/or products shall be new and unused at the time of system assembly.
- F. Provide all cables, taps, terminators, power supplies, and accessories for a complete operating PLC system.
- G. Controller conforming to NEMA IA 2.2, and with required memory and functional capacity to perform specified sequence of operation with scheduled input and output points.
 - 1. RFI/EMI Susceptibility: MIL STD 461B CS02.

2. Showering Arc Test: NEMA Pub No ICS2-230.42.
3. Surge Withstand: ANSI C37.90a.
4. RFI Immunity : IEC 801-3.
5. Ground Continuity: IEC 801-5.
6. Electrostatic Discharge: IEC 801 -2.
7. Electromagnetic Field: IEC 61000-4-3.
8. Fast transients : IEC 61000-4-4.

PART 2 – PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLER - MEDIUM

- A. General: SCADA Panel PLCs
- B. Manufacturer:
 1. Allen-Bradley CompactLogix 5069 series
- C. NEMA IA 2.3 and IEC 61131-3 compliant program editor with program written in Ladder Logic Language. Program to be written using the same type of software as is specified below.
- D. Networking Connections: Provide all communication interfaces, network cables, taps, terminators, power supplies, and accessories for a complete operating network.
 1. Dual Ethernet/IP ports.
 2. USB (for communication use)
- E. Processor:
 1. With a USB port for programming use, minimum 2 Mbytes of user memory for IEC 1131 control programs, with additional nonvolatile storage provided by Secure Digital media. Provide additional serial communications adapters required for other serial interfacing. Include real-time clock.
- F. Input and Output Modules:
 1. Discrete Inputs: 120Vac or 24 Vdc, 16 channel.

2. Discrete Outputs: Relay output, 120Vac or 24Vdc, 16 channel
3. Analog Inputs: 4-20 mAdc/1-5 Vdc, 8 channel differential.
4. Analog Out puts: 4-20 mAdc, 4 channel.
5. I/O module terminations :
 - a. By Manufacturer to match module.
6. I/O module interface modules:
 - a. Provide as necessary including cabling to interface all 1/0to processor.
7. Spare Input/Outputs:
 - a. The greater of a minimum one channel or 15 percent of each type provided per control panel.
- G. Power Supplies:
 - a. 24 Vdc. Refer to Section 40 67 00 for power supply.
- H. Miscellaneous:
 - a. Provide all cables, taps, terminators, power supplies, and accessories for a complete operating PLC system.

2.02 PROGRAMMABLE LOGIC CONTROLLER - SMALL

- A. General: Offsite cellular pump stations PLCs
- B. Manufacturer:
 1. Allen-Bradley MicroLogix 1400
- C. NEMA IA 2.3 and IEC 61131-3 compliant program editor with program written in Ladder Logic Language. Program to be written using the same type of software as is specified below.
- D. Networking Connections: Provide all communication interfaces, network cables, taps, terminators, power supplies, and accessories for a complete operating network.
 1. Ethernet port supporting Ethernet/IP, Modbus TCP/IP, and DNP3 over IP protocols.

2. Dual serial ports with DF1, DH485 , Modbus RTU/DNP3/ASCII protocol support
- E. Processor:
1. With Ethernet port and serial port dedicated solely for programming use, 20kB for IEC 1131program and data space, supported by non-volatile battery-backed RAM memory. Provide additional serial communications adapters required for other serial interfacing. Include real-time clock.
- F. Input and Output Modules:
1. Discrete Inputs: 120Vac or 24 Vdc, 16 channel.
 2. Discrete Outputs: Relay output, 120Vac or 24Vdc, 16 channel
 3. Analog Inputs: 4-20 mAdc/1-5 Vdc, isolated channel-to-channel, 4 channel.
 4. Analog Out puts: 4-20 mAdc, 4 channel.
 5. I/O module terminations :
 - a. By Manufacturer to match module.
 6. I/O module interface modules:
 - a. Provide as necessary including cabling to interface all I/O to processor.
 7. Spare Input/Outputs:
 - a. The greater of a minimum one channel or 15 percent of each type provided per control panel.
 8. Processor and I/O Chassis:
 - a. Individually fused 120 Vac input.
 9. I/O only Chassis:
 - a. Individually fused 120 Vac input.
- G. Power Supplies:
- a. 24 Vdc. Refer to Section 40 67 00 for power supply.
- H. Miscellaneous:

- b. Provide all cables, taps, terminators, power supplies, and accessories for a complete operating PLC system.

2.02 PROGRAMMING SOFTWARE

- A. The following software shall be provided by the Systems Integrator for this project.
- B. Provide the latest version of software compatible with the processor.
- C. Provide PC to PLC programming cable(s) for each license.
- D. Programmable Logic Controller - Medium
 - 1. Manufacturer:
 - 1. Allen-Bradley Studio 5000 Logix Designer Professional Edition
 - 2. Licenses: Provide 1 License. Request Owner/ City licensee information prior to ordering for registration. Provide one PC to PLC programming cable for each license.
- E. Programmable Logic Controller - Small
 - 1. Manufacturer:
 - 1. Allen-Bradley Studio 5000 Logix
 - 2. Licenses: Provide 1 License. Request Owner/ City licensee information prior to ordering for registration. Provide one PC to PLC programming cable for each license.

2.03 SPARE PARTS

- A. The following spare parts shall be provided for each PLC no matter type, size or use:
- B. Programmable Logic Controller
 - 1. One of each unique processor card.
 - 2. One of each unique remote I/O and communication card.
 - 3. One for each ten, minimum of one for each unique I/O card.
 - 4. One of each unique power supply.

2.04 ETHERNET SWITCH

- A. General: Scada panels (DIN-rail mounted) and Scada Rack (rack mount) ethernet switches.
- B. Manufacturer: Hirschmann BOBCAT Switch BRS20-4TX/2FX
- C. The Ethernet switch shall be an industrial, managed switch compliant to IEEE 802.3 and shall include the following features:
- D. Manufacturer shall offer a family of similar switches that vary based on the port type and quantity similar to Hirschmann Compact OpenRail. Switches will have a web based graphical user interface for configuration that is common to all products in the family. The family will include switches of 4, 8, 16 & 24 port varieties at 10/100 M baud. Two (2) additional Giga-Bit ports shall be optional for high speed backbone or ring configurations on the 8, 16 & 24 port versions.
- E. Switches will employ "line speed" switching fabric to ensure full bandwidth capacity.
- F. Switches shall be designed for DIN-rail mounting
- G. Redundant 24 VDC power supply inputs; power supply failure is indicated by LED and fault relay
- H. Fanless design
- I. Supports a device discovery protocol
- J. Capable of ring-based media redundancy
- K. Broadcast limiter to prevent broadcast storms and protect network devices
- L. Packet Prioritization using COS and QOS with 8 priorities and 4 queues
- M. IGMP snooping (multicast filtering) with IGMP querier V1, 2 & 3.
- N. Diagnostics include RMON and up to eight (8) trap management stations. Fault conditions can be independently reported to the management station, including: cold/warm start, link up/down, power supply failure, redundancy mechanisms, authentication violation, RMON thresholds, port security, indicator contact
- O. Supports port-based and overlapping VLANs
- P. MAC or IP address-based port security

- Q. RJ45 ports shall be 10/100 BASE-TX and support auto-negotiation and auto-crossover
- R. Input voltage range: 9.6 - 60 volt DC and 18 – 30 volt AC
- S. Minimum operating temperature range: 0°C to +60°C
- T. Optional operating temperature range must be available at: -40°C to +70°C
- U. Humidity: 10% to 95% (non-condensing)
- V. Protection Class: IP 20
- W. Approvals: cUL508, cUL1604 Class I Division 2

2.05 FIREWALL

- A. Firewall shall be rack mounted in Scada Rack
- B. Manufacturer: Hirshman Eagle One industrial firewall and security router
0200TITISSDDY90000HHEXX.X.XX

2.08 NETWORK ROUTER/CELLULAR MODEM

- A. Phoenix P/N 2702532, TC Router 3002T-4G VZW. Industrial LTE 4G router or equal.
- B. Version for Verizon wireless (US)
- C. 2 Ethernet interfaces
- D. Firewall, NAT, IPsec and OpenVPN support, 2x SMA-F antenna socket,
- E. SMS and e-mail transmission, 2 digital inputs, 1 digital output.

2.06 PRODUCT DATA

- A. The following Product Data shall be provided.
- B. Factory Acceptance Test Results:
 - 1. Submit per the requirements of this Section.
- C. Operating and Maintenance Information:
 - 1. Operating and maintenance information shall be provided.

- a. Manufacturer, representative ,and supplier contact information.
- b. Manufacturer instruction manuals shall include only the following as applicable to the PLC system:
 - 1) Safety Precautions.
 - 2) Environmental Conditions.
 - 3) Troubleshooting guides and diagnostic techniques.
 - 4) Component connection diagrams.
 - 5) Removal and replacement instructions.
- c. Warranty information.
- d. Final reviewed submittal.
- e. As-built drawings with record of switch and jumper settings for all components.
- f. List of spare parts provided.

D. PLC Program - Equipment Manufacturer:

- 1. Provide the as-built programmable controller program on a CD, prepared using the software type specified in Part 2. Provide 2 copies. Label the CD to include:
 - a. Owner's name, facility name, project name and project number as shown on the drawings.
 - b. "Application Programs For (equipment and/or PLC name)".
 - c. Programming software name and revision.
 - d. Supplier name and program revision date.

E. PLC Program - Systems Integrator

- 1. Provide the as-built programmable controller program prepared using the software type specified.
- 2. Provide the as-built programmable controller program on a USB drive,

prepared using the software type specified in Part 2. Provide 2 copies. Label the USB drive to include:

- a. Owner's name, facility name, project name and project number as shown on the drawings.
- b. "Application Programs For (equipment and/or PLC name)".
- c. Programming software name and revision.
- d. Supplier name and program revision date.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Refer to Process Control Panels and Hardware section. Connect input and output devices to the PLC via control panel terminal blocks, not directly to the PLC.

3.02 FIELD INSPECTION AND TESTING

- B. Refer to Process Control Panels and Hardware section.
- C. Equipment manufacturer and systems integrator : The supplier of each PLC system shall provide a qualified service representative to perform the following:
 1. Inspect the PLC installation including I/O and network systems, hardware configuration switch and jumper settings.
 2. Monitor all PLC system diagnostic indicators, both hardware and software, and certify that the PLC system performance meets or exceeds the manufacturer's published specifications.
 3. The systems integrator shall assist in all testing provide the required quantity of man-weeks on-site for each PLC I/O rack to sufficient install, test and commission each system as required by the specifications.
 4. Equipment manufacturers shall provide the required quantity of man-days on-site per equipment assembly to install, test and commission each system as required by the specifications.
 5. PLC programs shall be modified PLC as required.

6. Equipment manufacturer certification requirements are per the associated equipment Specification.

D. Supplier/Subcontractor

1. Fault or trouble conditions shall be investigated and resolved by the Supplier/Subcontractor to the satisfaction of the PLC supplier.

END OF SECTION

SECTION 13320
PROCESS CONTROL PANELS AND HARDWARE

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor 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. Control enclosures shall be assembled, wired, and tested in the instrumentation subcontractor's own facilities, unless specified otherwise. 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 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 Engineer.
- C. Due consideration shall be given to installation requirements for enclosures in new and existing structures. The Contractor 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 Engineer and all affected contractors. The Contractor shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (incidental, accidental or unavoidable).

PART 2 - PRODUCTS

2.01 CABINETS AND PANELS

- A. Cabinets and panels shall be formed or welded construction, reinforced with

Unistrut, Powerstrut, or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the cabinet's equipment. Doors shall be removable. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common-keyed locks.

- B. Cabinets and panels shall be minimum 14 USS gauge. Cabinets and panels with any dimension greater than 36 inches shall be 12 USS gauge.
- C. Cabinets and panels located inside buildings, but located in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum 316 stainless steel NEMA 4X construction, or as specified or shown on the Drawings for hazardous area classification (Class, Division, Group), or submersible (NEMA 6) applications. Epoxy coated cast copper-free aluminum construction shall also be acceptable for NEMA 4, 6 and 7 applications. Cabinets located in chlorine storage/feed areas shall be of non-metallic, FRP construction, rated NEMA 4X.
- D. Cabinets and panels within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.
- E. Cabinets and panels shall have doors on the front and shall be designed for front access. NEMA 12 cabinets shall be fitted with three-point door latches. Door latches for NEMA 4X cabinets shall be all stainless steel, fast operating clamp assemblies that do not require bolts or screws to secure. Door hardware on NEMA 4X cabinets located in chlorine storage/feed areas shall be non-corrosive in that environment.
- F. Panels and cabinets located outside fence-secured areas shall be fitted with padlockable latch kits.
- G. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.
- H. Panels with any dimension greater than 36 inches that contain a programmable controller (PLC) shall be provided with a folding laptop programmer shelf on the inside of the door.
- I. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman or Rittal. The Contractor may optionally provide cabinets that are custom-fabricated by the instrumentation subcontractor or by a reputable panel fabrication shop acceptable to the Construction Manager.

2.02 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, Wieland, Square D, or equal.
- B. Power terminal blocks shall be single tier with a minimum rating of 600 volts, 30 amps. C. Signal terminal blocks shall be single tier with a minimum rating of 600 volts, 20 amps.

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.

- 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 Construction Manager, a vendor's pre-engineered and prefabricated wiring termination system will be acceptable.
- F. Wiring shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 16 of the specifications. 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.
- 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. A copper 120 VAC ground bus shall be installed in each cabinet, and shall be connected to the building power ground. A separate, isolated copper ground bus shall be installed in each cabinet for the logic (24 VDC) ground. Both ground buses shall be clearly labeled as to voltage and function.
- J. Interior panel wiring and field wiring shall be tagged at all terminations with machine-printed plastic sleeves. The wire numbering system and identification tags shall be as specified in Section 26 05 19 – Low Voltage Electrical Power Conductors and Cables. Where applicable, the wire number shall be the ID number listed in the input/output schedules.
- K. 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

- L. 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.
- M. Enclosures with any dimension larger than 36 inches shall be provided with 120-volt duplex receptacles for service equipment and fluorescent service lights. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.
- N. 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.
- O. 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

- 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/Construction Manager from a minimum of six color samples provided. Refer to Division 09 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.

3.03 INSTALLATION

- A. Refer to Section 13300 for additional requirements.

END OF SECTION

SECTION 13321
UNINTERRUPTIBLE POWER SYSTEMS

PART 1 - GENERAL

1.01 REQUIREMENTS:

- A. The Contractor shall furnish, test, install and place in satisfactory operation all uninterruptible power systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.
- B. One UPS shall be provided for each new programmable logic controller (PLC) provided under this Contract. Courtesy receptacles in PLC cabinets shall not be powered by the UPS.
- C. UPS systems shall be mounted in or near enclosures containing digital hardware, unless otherwise specified or shown on the Drawings, as follows:
 - 1. UPS systems for control panels containing PLCs shall be mounted within the cabinet.
 - 2. Where the UPS is mounted within a dedicated enclosure, that enclosure shall be properly sized for heat dissipation and all other applicable requirements as specified in Section 13320 and referenced Sections.
 - 3. Where the UPS is mounted within the PLC cabinet, it shall not interfere with access to other equipment or wiring within the panel (i.e., it shall not be necessary to move or remove the UPS to remove or service other panel-mounted equipment). For floor-mounted PLC cabinets with bottom wiring access (including those cabinets with legs), the UPS shall be placed on a dedicated shelf within the cabinet.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

- A. Section 13300 – Instrumentation & Control For Process Systems - General Requirements.
- B. Section 13310 – Programmable Logic Controllers.

1.03 SUBMITTALS:

- A. The Contractor shall submit UPS sizing calculations for all UPS systems furnished under this Contract in accordance with Section 13302 - Control and Information System Submittals.

PART 2 - EQUIPMENT

2.01 UNINTERRUPTIBLE POWER SYSTEMS:

- A. Each UPS shall consist of a tower or rack-mounted UPS module and battery modules as required to meet backup run time requirements.
- B. UPS systems shall be true on-line, double-conversion type. Each UPS shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies and accessories. Under normal operation, the AC power shall be converted to DC. The DC power from the battery charger shall supply an inverter and maintain the battery module at full charge. The AC output from the inverter shall be fed to the associated digital equipment power supply unit and/or other equipment power supplies as appropriate. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.
- C. UPS units using line interactive or ferro-resonant transformer technology shall not be acceptable.
- D. An automatic bypass switch shall be provided on each UPS. The transfer switch shall be of the solid state, make-before-break type and shall automatically transfer load from the inverter to the AC line in the event of an inverter malfunction. The total transfer time shall be 5 milliseconds or less. The transfer switch shall be provided with a manual override.
- E. A manually operated maintenance bypass switch shall be provided for each UPS installation to allow hardware to be powered while the UPS is removed for maintenance. The bypass switch shall be the make-before-break type to ensure continuous power to the associated PLC.
- F. Loss of AC power shall be monitored on the line side of the UPS and reported via normally closed (fail safe) unpowered contacts to the associated PLC/RTU.
- G. Each UPS shall meet the following requirements:
 - 1. Input voltage shall be 117 VAC, single phase, 60 Hz.
 - 2. Voltage regulation shall be +/-5 percent for line and load changes.
 - 3. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz +/-0.5 percent when on battery operation.
 - 4. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte

type, or VRLA absorbed glass mat (AGM) type. The battery modules shall have a minimum full- load backup time of 30 minutes for PLC-based control panels, and 45 minutes for remote telemetry units.

5. A status monitoring and control panel shall be provided and shall include the following:
 - a. Status indicating lights for both normal and abnormal conditions.
 - b. Common alarm contacts that shall be wired to the closest discrete input subsystem.
 - c. Where computers are powered from the UPS, an RS-232 and USB port shall provided for communication of UPS status to a server, client, or other suitable hardware. All required interface software and hardware shall be provided.
 - d. Circuit breaker for the AC input.
6. Sound absorbing enclosure.
7. EMI/RF noise filtering.
8. Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.
- H. UPS systems shall be Eaton Powerware 9130, Emerson Network Power (Liebert) Model GXT3, APC or equal.

2.02 UNINTERRUPTIBLE POWER SYSTEMS - RACKMOUNT:

- A. Rack mount UPS systems shall be Schneider Electric SRT3000RMXLA Smart-UPS SRT 3000VA RM120V, 2U. 9 Outlets: (8) 5-20R, (1) L5-30R. with Schneider AP9641 UPS Management Adaptor, and Schneider SRT96RMBP Smart-UPS SRT 96V 3kVA RM Battery Pack, 2U. Input: (1) L5-20P (1)C20 inlet. (16) 5-20R

END OF SECTION

SECTION 13322
SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 THE REQUIREMENT

- A. The Contractor 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 13300 – Instrumentation and Control for Process Systems - General Requirements
- B. Section 13320 - Process Control Panels & Hardware

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. The following specific spare parts items shall be provided:
 - 1. Five of each type of surge protection device provided under this Contract.

PART 2 - PRODUCTS

2.01 ELECTRICAL TRANSIENT 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, Edco, Transtector, or equal.
- 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 discrete signal circuits that have any portion of the circuit extending outside of a protecting building.
 - 4. At both ends of all copper-based communications cables which extend outside of a building, including at field instruments and the field side of analog valve position signals.
 - 5. On all external telephone communications 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, second 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 a threaded mounting/grounding stud or 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

END OF SECTION

SECTION 13330 COMPUTER EQUIPMENT

PART 1 – GENERAL

1.01 REQUIRMENTS:

- A. Workstation computers shall be furnished as described herein by the systems integrator. All Labor for furnishing, testing, loading the software, installing and placing the workstations in satisfactory operation is required.
- B. The system integrator shall review the computer specifications for any deviation from the HMI software manufacture's computer requirements and inform the Engineer of alterations in the computer requirements to be suitable for use with the HMI software and network architecture.

PART 2 – EQUIPMENT

2.01 SCADA WORKSTATION COMPUTERS

- A. Dell Precision 3630 Tower:
 - Precision 3630 Tower with 300W up to 90% efficient PSU (80Plus Gold)
 - 338-BOSO Intel Xeon E-2136, 6 Core HT, 12MB Cache, 3.3Ghz, 4.5Ghz Turbo
 - Windows 10 Pro for Workstation (4 Cores Plus) Multi - English, French, Spanish
 - Microsoft Office Professional 2016 DFO
 - 32GB (4x8GB) 2666MHz DDR4 UDIMM Non-ECC
 - 400-AYGU 2.5" 1TB SATA Class 20 Solid State Drive
 - 401-ABRD 2.5 inch 1TB Class 20 SATA Solid State Drive
- B. . Black Dell KB216 Wired Multi-Media Keyboard English
- C. Black Dell MS116 Wired Mouse
- D. Dell 24inch Monitor PN: P2417H

2.02 SCADA SERVERS - RACKMOUNT

- A. Dell R-Series 360 EIA Rackmount Computer:
 - Processor: Intel Xeon E-2468 2.6GHz 8C/16T
 - Memory: 32GB
 - RAID 0 Storage: (2) 960GB SSD SATA
 - Power Supply: Dual (1+1) Redundant, Hot-Plug, 600W with (2) NEMA 5-15P plug Bezel
 - Windows Server 2022 Standard
 - Microsoft Office Professional 2016 DFO
 - Dell Sliding Ready Rails with Cable Management
 - Support: 3-year ProSupport & Next Business Day Onsite Service
- E. Black Dell KB216 Wired Multi-Media Keyboard English
- F. Black Dell MS116 Wired Mouse

2.03 RACK & ACCESSORIES

- A. Tripp-Lite Eaton SR42UB - 42UB Reduced Depth Server Rack enclosure/cabinet with doors and side panels (78" H, 25" W x 32" D)
- B. Tripp-Lite Eaton B02-U8-19-IP – Pull out station 8 port KVM switch and LCD console with accessories and cables as required.

END OF SECTION

SECTION 13500 SCADA SOFTWARE

PART 1 - GENERAL

1.01 General Requirements

1. SCADA software shall be commercially available off-the shelf and shall be non-proprietary, such that independent systems integrators are able to provide configuration and maintenance services as required.
2. Software shall be a Client/Server architecture. No Microsoft Client Access Licenses (CAL) or Terminal Services shall be required for full installation (thick) or browser-based (thin) clients.
3. Software shall offer options for unlimited, concurrent Thin Client connections for connectivity of common mobile device operating systems.
4. Software shall support running as a Microsoft Windows® service.
5. Software shall support development from a thin client.
6. Software shall support running in a virtualized server environment.
7. Software shall support installation on a Storage Area Network (SAN) or Network-Attached Storage (NAS).
8. Software shall support IPv6 addressing and be able to run on networks that support IPv4, IPv6 or both.
9. Software licenses shall be upgradable for an annual fee such that the client is able to download and install the current version of the product.
10. Software shall be tag-based and have an integrated development environment for creation of all aspects of the application.
11. Software shall be compatible with commercially available, off-the shelf PC hardware running Microsoft Windows client and server operating systems currently available at the time of installation.
12. Software shall not require dedicated server-level PC hardware for any individual system components.
13. Software shall support any computer running a thick copy of the software performing as both an application server and a user interface. Software shall support automatic server failover to an unlimited number of servers.
14. Software shall include the following integrated components available as standard components or for an optional add-on price. These components shall not require 3rd party software. However, the system shall allow 3rd party components to be used if required.

- I. Online application development environment with version control.
 - II. I/O drivers for a wide selection of communication protocols.
 - III. Alarms management and alarms/events history.
 - IV. Fully-integrated Historian.
 - V. Real-time and historical data trending and tabular views.
 - VI. Report generation.
 - VII. Security management.
 - VIII. Unlimited operator logbooks.
 - IX. Support for networked applications.
 - X. Support for server redundancy.
 - XI. Native High Performance / HMI widgets.
 - XII. Support for master applications, which are able to monitor multiple independent subordinate applications.
 - XIII. An object oriented scripting language with debugging tools.
 - XIV. Browser-based thin clients for PCs and Mobile devices.
 - XV. Alarm notification to off-site operators (email, text message and voice.)
 - XVI. Interfaces for 3rd party software programs to access data and alarms from the SCADA software via ODBC/SQL via a REST interface, OPC, SNMP.
 - XVII. Drivers to read MQTT, JSON, SQL and XML data sources.
 - XVIII. Support for translating the user interface into any language.
- 15. Software shall automatically compensate for deploying the same application simultaneously on a variety of monitor resolutions, while maintaining the aspect ratios of all displays.
 - 16. Software shall protect against file corruption in the event of an unexpected loss of power or hardware failure. Software shall support an automatic, orderly shutdown when power levels drop to a user defined setpoint.
 - 17. Software shall support automatic startup upon computer restart, to full operation without user intervention.
 - 18. Software shall provide a mechanism to backup and restore the entire application configuration.

19. Software shall include an integrated security system supporting an unlimited number of user accounts, roles and privileges. System users with appropriate account privileges shall be capable of changing the application configuration without requiring the software supplier's assistance. No lockout mechanisms or passwords shall be withheld from the final customer.
20. Integrated software help manuals shall be provided to assist operators and maintenance personnel with operational and configuration tasks.

PART 2 - PRODUCT

2.01 Server Redundancy and Load Balancing

1. Redundancy
 - I. A minimum of two levels of redundancy for all application services shall be supported. Software shall support automatic failover from primary server to backup server. No manual intervention shall be required. This functionality shall be supported in both standard and virtual server environments.
 - II. Software must not require each redundant server to use a second network card to monitor the availability status of the primary server.
 - III. All servers shall be aware of which server is in control of each software process. No two servers shall perform the same function at the same time (e.g. I/O communications to a specific device, incrementing a totalizer.)
2. Load Balancing
 - I. Software shall support the assignment of specific services (e.g. driver connections, alarms management, alarm notification) to specific computers.
 - II. Software shall support the use of named server lists, to which drivers can be assigned rather than requiring that a separate list be created for each driver.
 - III. Software shall support distribution of historical data storage to an unlimited number of computers.
 - IV. Software shall support management of alarm and event history separately from I/O process history.
 - V. Software shall allow each workstation to hold a complete and automatically synchronized copy of alarm and event history so that alarms can be managed locally on any workstation if the workstation's connection to the rest of the network is lost.
 - VI. Software shall automatically redirect incoming thin client connections to the server with the lowest number of active thin client connections.

- VII. Software shall support redundant networks and shall be able to use these for load distribution when both are available.

2.02 Thick (full-installation) Client User Interface

1. Software licensing shall not limit the number of application display pages allowed.
2. Software shall support the following navigation methods:
 - I. A menu for navigating from one display to another. Menu shall be configurable to allow logical grouping of displays.
 - II. Tiled view of any number of displays concurrently, all tiles showing real-time data or pictures of displays (user-selectable). Selecting one of the tiles will switch to the full-screen view of that display.
 - III. Mouse-over selectable hot box for navigating to a specific display.
 - IV. Button for navigating to a specific display.
 - V. Browser-like forward and reverse buttons to scroll through previously viewed displays.
 - VI. A list of previously viewed displays with the option to navigate to a selection from the list.
 - VII. A mapped view of assets with the option to navigate to an application display by selecting any asset from the map.
3. Application displays shall be event-driven, in that data will be delivered to client computers by the server immediately upon receipt. Client computers will not poll the server for new data.
4. Means shall be provided to allow the operator to print graphical displays.
5. Software shall support flagging tags as 'questionable data' (i.e. not commissioned or value is in question.) These values will continue to display the incoming values. These flags shall be removable by users with sufficient privileges.

2.03 Thin (browser-based) Clients

1. Software shall offer an optional zero-footprint thin client for use with HTML5-compatible browsers running on operating system variants, including:
 - I. Windows
 - II. Linux
 - III. Apple
 - IV. Android

2. Server for thin clients shall be an integral feature of the SCADA software. Use of the thin client shall not require a 3rd party Internet server software (e.g. Microsoft IIS, Apache).
3. System shall support two levels of server redundancy for thin client connectivity, with automatic failover and client load sharing.
4. System shall support cyber security measures including Firewalls, Virtual Private Networks (VPN) and Secure Socket Layer (SSL.)
5. OpenID Connect shall be supported for secure thin client logons.
6. Thin client connections shall be concurrent. Tools shall be provided to monitor client connectivity and to disconnect users or switch them to alternate servers on demand.
7. The thin client shall share the same security accounts as the rest of the SCADA Software. A separate privilege shall be required for browser client access. Revocation of this privilege will immediately terminate the user's client connection.
8. Thin Client displays shall be generated automatically, requiring no additional configuration.
9. On-line configuration changes shall be deployed immediately to all thin client interfaces without requiring the client interface to be restarted or refreshed.
10. An authorized user on a thin client connection shall be able to perform configuration changes.
11. The Thin Client user interface shall be offered in two variants, the choice of which to use being user-selectable.
 - I. Graphical (preferred for large user interfaces) – A user experience mirroring (graphically and operationally) that of the Thick Client.
 - II. Text-based (preferred for mobile phone interfaces) – Simplified lists of monitored values, with support for control actions, alarms management, trending and mapped asset view.

2.04 Historian

1. Historian shall support logging of all the SCADA system data, including real-time, historical, transactions, alarms and events, regardless of the number of tags in the system. For example, a 25,000 tag system shall support historical data storage for 25,000 tags, plus alarms and events.
2. Software shall include an integrated Historian and historical data storage at no additional cost, but may optionally use Oracle, MySQL, Microsoft SQL Server, SQLite PostgreSQL as the database.

3. The Historian and its historical data storage shall not require dedicated server computers, however, dedicated servers may be used if preferred by the customer.
4. Historian shall be capable of logging up to 4,000 values per second.
5. A synchronization scheme shall be included such that a copy of all historical data storage resides on all designated computers. Data shall be synchronized in real-time.
6. Any historical database that has been offline must be automatically resynchronized with the historian holding the most recent data. Software shall be capable of synchronizing 100,000+ values per second between databases. This process shall occur in parallel with runtime SCADA processes and shall be designed to minimize interference.
7. Distributed Historian architecture shall be supported. For example, two plants (A and B) may be responsible for historical storage for locally collected data, while a central facility (C) may be responsible for redundant historical storage for both A's and B's data. This architecture shall be scalable to support the addition of future plants.
8. Historian shall support SQL queries of logged historical data. Queries of historical data may be for raw data or summary (value at beginning, average, max, min, delta) over a period.
9. Historian shall be able to import collected data that was not available to be logged in real-time.

2.05 Transaction Data

1. System shall provide a means to reliably collect and log (to historical data storage) transaction data from a field device. Transaction data is defined as a data set of related values stored with the same timestamp.
2. The transaction data capture process must include error checking.

2.06 Historical Data Display (trend plots and tabular)

1. Software shall display historical and real-time data in both plot and tabular format.
2. Software shall allow users to generate ad-hoc plots of historical data by clicking on each of the values to be trended. Selected groups shall be recordable for future recall.
3. Software shall support ad-hoc and preconfigured trend plots of real-time and historical data as integrated elements of graphical process displays. Historical and real-time plotted values shall be shown in a continuous, uninterrupted, scrolling fashion. The display shall support:
 - I. An unlimited number of pens (i.e. tag values), including both analog and digital values. Name and description of each tag shall be provided.
 - II. Analog pens as either layered or as stacked individual plots.

- III. Time frame selectable from one second to five years.
 - IV. Scaling for each pen as high/low values or graduated divisions.
 - V. Value of each tag at the date/time of the mouse location.
 - VI. Statistical data, including average, minimum and maximum values, for each plot.
 - VII. Annotating trends
 - VIII. Stop/pause scrolling.
 - IX. Zoom in/out on the time (x) and value (y) axis'.
 - X. Pan/Scroll along the time axis or select a date to display.
 - XI. Move analog tag plots vertically (in the value (y) axis), either individually or as a group.
 - XII. Print displayed plot data.
 - XIII. Annotate a moment in time on the plot.
 - XIV. Display alarm setpoints that are associated with the tag(s) as continuous marker lines across the plot.
 - XV. Export plotted data to comma separated value (.csv) file or directly to a database, for use by 3rd party data analysis software.
 - XVI. Display plot data on a dedicated page, or as a component of a process display page.
 - XVII. Allow configuration of the plot display characteristics.
4. For tabular data, means shall be provided for the following;
- I. An unlimited number of pens (i.e. tag values), including both analog and digital values. Name and description of each tag shall be provided.
 - II. Time frame selectable from one second to five years.
 - III. Stop/pause scrolling.
 - IV. Show raw data.
 - V. Show summary data for a duration sampled at consistent periods (e.g. average, minimum or maximum value every 15 min for past 8 hrs).

Export plotted data to comma separated value (.csv) file or directly to a database, for use by 3rd party data analysis software.

2.07 Alarms and Events Management

1. Software shall include alarms and events management tools consist with implementation of the ANSI/ISA 18.2-2009 Management of Alarm Systems for the Process Industries standard.
2. Software shall include a predefined alarms and events management interface. The interface shall provide the following operational tools.
 - I. Lists of Current, Unacknowledged, Disabled, Active, Configured Historical and Shelved alarms and events.
 - II. Tools for searching and filtering lists.
 - III. Add a blog-style note to any alarm.
 - IV. Notes may not be edited after saving, but comments may be added.
 - V. Day and night view toggle.
 - VI. Acknowledgement of individual alarms or all visible alarms.
 - VII. Option to require confirmation before acknowledging all alarms in the list.
 - VIII. Option to require that a note be created when alarms are acknowledged.
 - IX. Font size adjustment for visually impaired users.
 - X. Representation of alarm priorities using shape, color and numeric priority level for enhanced operational awareness.
 - XI. Option to plot data associated with an alarm.
 - XII. Option to open a process display where the alarm is currently shown.
 - XIII. Option to have a relevant process display open automatically if there is no operator action for a defined period of time following the triggering of that alarm.
 - XIV. Alarm mute and silence.
 - XV. Alarm shelving options for a defined period or indefinitely. Shelved alarms shall still be recorded to the alarms history but shall not annunciate or require acknowledgement.
 - XVI. Option to include or exclude shelved alarms in the list of Current, Unacknowledged, and Active alarms. Shelved alarms to be visible at all times in lists of Historical alarms and events, Configured alarms and Shelved alarms.
3. Alarm acknowledgement shall immediately be propagated to all networked stations.

4. A full redundant copy of alarm and event history shall be stored on every workstation, allowing that workstation to continue to process local alarms if it becomes isolated from the network. History to be automatically synchronized when the workstation is reconnected to other servers.
5. Software shall allow alarms to be associated with functional areas, such that a user only has to deal with alarms in his/her functional area(s).
6. Alarm occurrence, acknowledgement, clear, disable and shelve actions shall be recorded.
7. Alarm disabling to be provided only as a configuration option, not as an operational action.
8. Software shall provide user-configurable settings for deadband on analog alarms and delay on analog and digital alarms.
9. Alarms and events records shall include;
 - I. Time/Date stamp.
 - II. The name and description of the alarm tag.
 - III. Priority.
 - IV. Status of Alarm (i.e. Active, Acknowledged, Cleared). Alarm Acknowledgement records shall include the name of the user who acknowledged the alarm.
 - V. The value of the associated tag at the time of alarm occurrence.
 - VI. The value of the alarm setpoint at the time of alarm occurrence.
10. Software shall support an unlimited number of alarm priorities and shall allow unique annunciation sounds, shapes, and colors for each.
11. Alarm annunciation shall be configurable to use alarm tones, text to speech descriptions, sound files or popup displays.
12. Users must be notified, both visibly and audibly, of the occurrence of an alarm, regardless which display is presently being viewed.

2.08 Alarm System Auditing and Reporting

1. Software shall support printing of alarms/events created over a range of dates/times.
2. Software shall provide a means to identify frequently occurring alarms (e.g. nuisance alarms).
3. Software shall provide a means to identify and analyze alarm flood conditions.
4. Software shall provide a summary of alarm percentages by priority, for comparison with generally accepted percentages as defined in the ANSI/ISA 18.2-2009 Management of Alarm Systems for the Process Industries standard.

2.09 Alarm Notification System (for remote users)

1. The Alarm Notification System shall support alarm notification via dial-out over voice modem (using text-to-speech), an Internet service such as Twilio®, SMS text message, email and alphanumeric pager. Alarm acknowledgement shall be supported during voice calls and via email and text message.
2. The Alarm Notification System shall allow status retrieval and alarm acknowledgement via dial-in over voice modem (using text-to-speech.)
3. The Alarm Notification System shall be an integrated feature of the SCADA systems and shall not require a separate tag database and security system.
4. Email messages shall support outgoing mail with transport layer security (e.g. Gmail, Yahoo Mail, or corporate email server.)
5. The Alarm Notification System shall be capable of annunciating alarms to rosters of users with up to 30 contacts per roster. An unlimited number of rosters shall be supported. The system shall support associating rosters with functional areas, such that alarms in these functional areas will activate notification to the appropriate contacts.

2.10 Site Lists and Mapping

1. Software shall allow for the creation of "sites" which are collections of I/O tags, with an optional location that can be represented using Latitude and longitude coordinates.
2. Sites shall be user-definable to store and provide a configuration interface for any user-specified data.
3. Sites shall be user-configurable to control whether and how they are to be displayed in Site Lists.
4. Sites shall be user-configurable to control whether they will open a pre-defined screen showing the associated collection of I/O tag data, or open a user-selected display screen.
5. Software shall include an integrated map display with zoom and pan features such that remote assets can be automatically mapped based on latitude and longitude coordinates.
6. Software shall support user-selection of the map style to use, including night-time and day-time modes.
7. Software shall allow for user creation and selection of the icons used to represent sites on the map.
8. Software shall allow users to navigate the map including zoom and pan features.

9. Icons used to represent sites on the map shall be capable of displaying information about the site including current connection status and presence or absence of active alarms within the site.
10. Icons used to represent sites on the map shall include a built-in navigational link to either an automatically-generated page displaying all I/O tags within the site, or to a user-selected page.
11. Software shall provide a means to define and display pipes or other connections between sites.
12. Pipes or other connections between sites shall be user-configurable to include any relevant information about the connection.

2.11 Security Management

1. Software shall include a security system with privilege and role based user accounts. Level-based access shall not be acceptable.
2. All output controls shall be locked automatically when no user is signed in.
3. Security system shall support an unlimited number of user accounts and roles. System shall allow creation of an unlimited number of additional security privileges where necessary.
4. User passwords must be configurable to require a minimum length, contain a combination of letters, numbers and special characters, and expire after a pre-set period. User passwords shall be stored in an encrypted format.
5. System shall allow changes to user accounts, roles and privileges while the application is running. Changes shall become effective immediately.
6. User sign-in and sign-out activity shall be recorded in the application event log. Disabling accounts after X failed attempts within Y seconds shall be supported where X and Y are configurable options.
7. System shall provide a mechanism to limit client access to specific IP addresses.
8. System shall support authentication of user accounts via a Windows domain and authorizing SCADA user roles from domain security groups.
9. System shall support the use of proximity cards/readers.
10. The integrated version control system shall allow the option of including or excluding security-related changes if returning the application to an earlier configuration state.

2.12 Report Generation

1. Authenticated operators shall, in the runtime environment, be able to produce reports including any analog, digital or calculated tag data from the historical database.

2. Data format options shall be as follows:
 - I. To screen.
 - II. To a comma separated value (.csv) file.
 - III. To a text file.
 - IV. To an ODBC-compliant database.
 - V. To any direct-connected or networked printer.
 - VI. To a 3rd party software (e.g. Microsoft Excel) template for advanced data analysis and formatting.
 - VII. To e-mail, if an external email server is provided.
3. Reports may be created for one-time use or saved for reuse.
4. The following reports should be included:
 - I. Analog Summary Report
 - II. Daily Snapshot Report
 - III. Daily Total Report
 - IV. Derived Flow Report
 - V. Detail Report
 - VI. Driver Communication Error Detail Report
 - VII. Driver Communication Summary Report
 - VIII. Hourly Snapshot Report
 - IX. Hourly Total Report
 - X. Rainfall Report
 - XI. Pump Activity Report
 - XII. Pump Discrepancy Report
 - XIII. Standard (raw data) Report
5. Report generation shall be invoked either on demand, by a monitored event, or on a scheduled basis.
6. For reports that are created on a scheduled basis, a mechanism shall be provided to allow operators to re-create the last scheduled report.
7. A data-query add-in tool be available for addition to Microsoft Excel®, thereby allowing reports to be generated in that program.

2.13 Electronic Operator Notebooks

1. System shall support operator logbooks for recording ad-hoc notes or predefined notes as threads, in that notes can have associated comments.
2. Notebooks shall be searchable by keyword, user account and time/date.
3. Notebooks shall be color-coded for easy identification.
4. System shall support creation of an unlimited number of notebooks for association with system elements, such as equipment and trended pen groups.
5. All notes shall be encrypted and include the name of the user's account and the time/date of creation. All notes entered into the notebook shall be immediately viewable from all clients and servers.
6. System shall not allow editing or deleting notes once created, to prevent tampering.
7. System shall support the addition of comments to existing notes.
8. System shall support the option of requiring operator authentication as part of the note creation process.
9. System shall support printing of notes by range of dates/times.
10. System shall support the export of notes for a selected range of dates, to a format that can be easily viewed / printed from any workstation without the need for a (HTML)

2.14 Integrated Development Environment

1. An intuitive graphical development environment with drag and drop tools shall be used for configuration of application displays. A ribbon bar along the top of the display, as common to Microsoft office tools, is preferred.
2. Displays shall support zoom and pan actions.
3. A large library of static and animated graphics including High Performance / HMI tools shall be provided with the software. Software shall support dragging and dropping additional graphics into the library.
4. Standard features shall be included for the following;
 - I. Analog and digital inputs and outputs.
 - II. Retentive counters. Values will persist if power is lost and subsequently restored or if failing over to a backup server.
 - III. Retentive totalizers. Values will persist if power is lost and subsequently restored or if failing over to a backup server.
 - IV. Historical calculations (e.g. average flow over last hour.)

5. Software shall include pre-built displays for standard user interfaces. The following pre-built displays shall be provided as a minimum;
 - I. Alarm display that can be filtered by name and includes current, unacknowledged, disabled, shelved and history.
 - II. Trending and tabular viewing of historical data.
 - III. Report creator.
 - IV. Operator notebook.
 - V. Site map.
 - VI. Site list.
6. Software shall allow calculations to be associated with each graphic object to facilitate movement, visibility, sizing and rotation.
7. Software shall allow multiple objects to be saved as a template graphic. The following template capabilities shall be supported;
 - I. A template may be associated with a tag structure.
 - II. Each new instance of the template will inherit the properties of the template, such that changes to the template will automatically update all instances created from it.
 - III. The template may have any number of parameters, including tags and text values, which can be used to animate objects within the template. Each new object created from the template may include different parameters.
 - IV. Templates may be imported from other projects.
 - V. Copy/paste/rename/delete for any template.
 - VI. Ungrouping of any instance of the template.
8. Software shall support the creation of template displays. The following capabilities shall be supported;
 - I. A template display may be associated with a tag structure.
 - II. Each new instance of the template will inherit the properties of the template, such that changes to the template will automatically update all instances created from it.
 - III. The template may have any number of parameters, including tags and text values, which can be used to animate objects within the template. Each new object created from the template may include different parameters.
 - IV. Templates may be imported from other projects.
 - V. Copy/paste/rename/delete for any template.

9. There shall be no limit to the number of animated graphics that can be used to represent the same tag value.
10. Software shall support background bitmaps on graphical pages.
11. Users shall be able to select all or a subset of the graphics on any display and see a list of the associated tags. The list of tags shall be modifiable individually or using search and replace tools.

2.15 I/O Drivers (Field Device Communications)

1. Software shall support an unlimited number of field devices and different I/O drivers in the same application.
2. Software shall include support for communications over [Serial port] [TCP/IP] [UDP/IP]
3. Software shall include, at no additional cost, I/O drivers for:
 - I. Protocols - Aquatrol BACNet Bristol BSAP Ethernet/IP (CIP) Allen Bradley DF1 Koyo/Automation Direct DirectNet CalAmp Diagnostic DNP3 Omron FINS Foxboro GE Series 90 Granville Phillips Grundfos Dedicated Controls Grundfos Control MPC Omron Hostlink IEC 60870-5-104 Internet Bristol Protocol IDEC IEC 60870-5-101 Mitsubishi Modbus ACSII, Embedded, TCP, RTU Enron Modbus Landis & Gyr ODBC Dexter Fortson Associates OpenLink Siemens OP/PG NMEA 0183 Opto22 Optomux Campbell Scientific Pakbus, Loggernet and RTU QNet Fisher ROC, ROC Plus Serial SNMP Client GE SNP, SNPX Square D SRTP Stevens Water Serial Surfline Toshiba SQL Data Query MQTT data JSON/XML data.
 - II. Manufacturers - Acromag Rockwell/Allen Bradley Aquatrol BACNet Bailey Campbell Scientific Control Microsystems CSE Semaphore DAQ Data Flow Systems Dexter Fortson Enron Emerson Fisher Foxboro General Electric Granville Phillips Grundfos Hewlett-Packard IDEC IEC Landis & Gyr Lantronix Mitsubishi Motorola NMEA OSI Soft Omron OPC Opto 22 PLC Direct (Koyo) Power Measurements Ltd. Quindar Schneider (Bristol Babcock, Control Microsystems) Schlumberger Siemens Sixnet Square D Stevens Water Surfline Texas Instruments Tesco Toshiba Woodward Zetron
 - III. Other - DDE Client, API, OPC Client to support OPC Servers from 3rd party software providers.
4. Software shall support the development of additional I/O drivers where necessary.
5. Software shall support multiple communications protocols over a single communications port.

6. I/O drivers shall support redundant failover to one of more server computers. Software shall support redundant physical links to any field device, such as primary connectivity via Ethernet and redundant connectivity via serial port. Redundant links shall support similar or different protocols.
7. Software shall provide tools for polling telemetry devices (e.g. RTUs) directly. Software shall allow real-time tuning of each device's polling frequency without interrupting the polling cycle or restarting the application. To optimize I/O communications for telemetry applications, the polling order shall be configurable, and polling shall be asynchronous (if permitted by the remote telemetry unit.)
8. Software shall be capable of pooling modems connected to one or more servers, for use in I/O communications.
9. Tools shall include methods for monitoring communication statistics and reporting errors for each I/O driver. Software shall support radio diagnostics monitoring for radio modems (e.g. Dataradio/Calamp, MDS.)
10. Software shall support writing to multiple output tags via a single write request. This shall allow writing a set of default values to a set group of field device registers.
11. Software shall support rewriting the last written value to an output.

2.16 Tag Database

1. A browser shall be provided for tag creation, modification and deletion. The tag browser shall include a summary of all tags' current addresses and values.
2. A tag export/import utility shall be provided to allow bulk tag changes using Microsoft Office tools.
3. Software shall support the creation of template tag structures to represent a typical piece of equipment (e.g. a pump, an engine.)
4. Tag configuration shall support the use of expressions that can set configuration parameters based on developer-defined rules.
5. Template tag structures shall be copied and pasted to create any number of equipment instances having similar structures but differing configuration.

2.17 Configuration Management

1. Software shall be capable of on-line configuration. That is, changes to most aspects of the application (e.g. tags, displays, calculations, reports, trends, server lists) can be deployed in real-time without recompiling or restarting the application or restarting computers.
2. Software shall be capable of offline configuration, such that changes to most aspects of the application can be imported and deployed without recompiling or restarting the application or restarting computers.

3. Software shall be capable of testing configuration changes to tags and displays in the runtime environment before changes are deployed.
4. Users shall be able to deploy a set of changes either automatically or manually, with the option to select and deploy specific changes.
5. Software shall allow multiple users to configure an application simultaneously.
6. Any shut down client shall automatically download newly deployed changes from the server when the client is restarted.
7. All application servers and clients shall automatically synchronize with the primary application server. No manual file duplication shall be required.

2.18 Application Version Control

1. The software shall have an integrated version control system that automatically logs application configuration changes to an encrypted repository. Versions shall be auto-numbered. No manual changes to the repository shall be permitted.
2. A chronologically ordered summary of versions shall display the time and date when the version was created, the user who created the version and any comments entered by the user when deploying the version.
3. It shall be possible to determine which version is currently deployed on each client and server station.
4. The version history shall allow review of all changes applied within each version.
5. The version control system shall allow the following version management methods.
 - I. Switch (aka rollback) to a previous version of the application.
 - II. Reverse changes applied during a specific version.
 - III. Merge changes made local to a specific workstation.
 - IV. Option to include or exclude security changes made between the current revision and the target revision when switching.

2.19 Multi-Plant Application Support

1. Software shall allow centralized configuration, security management and monitoring of multiple sub-applications by one master application. The sub-applications may be connected via either LAN or WAN.
2. Tags viewed in both the sub-application and the master application shall not be counted twice.
3. The master application shall be capable of monitoring all tags, pages, alarms, etc. in all sub-applications.

4. Data logging shall be managed by each sub-application, but the master application shall be able to generate reports using any sub-application's data.
5. Each of the sub-applications must be capable of running autonomously in the event of network unavailability.
6. Software shall allow users to be authorized for access to information from one or more sub-applications, or all sub-applications, of the large application.
7. Software shall support limiting the sub-applications that can be accessed from a specific SCADA node.

2.20 Information Technology (IT) Tools

1. Software shall include server-to-server and server-to-client IP link monitoring for the SCADA network. Link failure shall generate an alarm.
2. Software shall include tools for monitoring of historical data storage.
3. Software shall include tools for monitoring of any modems and SMS appliances used for sending alarm notifications to remote operators.
4. Software shall include an SNMP Agent option for integrating with Network Monitoring Software.
5. Software shall include tools to monitor computer resources (e.g. CPU, virtual memory, drive space) with the ability to generate an alarm on an out of range condition.

2.21 Product Upgrades, Support and Training

1. Software must have a history of allowing applications that have been deployed on current technology (operating systems and PC hardware) to be upgradable to new technology with minimal change to the application.
2. Software must have a history of allowing applications that have been deployed on one version of the product to be upgradable to a new version with minimal change to the application.
3. Software manufacturer shall offer product support via phone, email, user forum and remote access methods (e.g. Remote Desktop.)
4. Software training shall be available from the manufacturer via classroom courses and self-directed study (e.g. workbooks and tutorials online.)

2.22 SCADA Software License Requirements per Computer

A. Tag Limit: 5K

B. License Type

1. Runtime License (SCADA node for runtime and/or server use)

C. Additional Components

1. Alarm Notification (SMS, Email and phone notifications)
2. Concurrent Thin Client Connections, quantity: 2
3. Remote Data Access (ODBC, OPC Server, REST connections to Historian)
4. Custom Installation (including branding)
5. Remote (thin client) access to tools for display editing

END OF SECTION

SECTION 13600
FIBER OPTIC CABLING AND EQUIPMENT

PART 1 - GENERAL

1.01 REQUIREMENTS:

- A. The Work of this Section includes providing a fiber optic communications infrastructure including, but not limited to, fiber optic cable (FOC), patch panels, Rack enclosure terminations, testing, and implementation.
- B. The Work includes testing individual fiber cables installed under this Contract, and testing a completed fiber optic communications network.

1.02 REFERENCE STANDARDS

- A. The optical fiber cable shall conform to the latest issue of the following standards documents, which are incorporated by reference into this specification:
 - 1. EIA-455: Standard Fiber Optic Test Procedures (FOTPs) Devices.
 - 2. EIA-598-A: Standard Colors for Color Identification and Coding.
 - 3. MIL-202: Test Methods for Electronic and Electrical Component Parts
 - 4. MIL-454: Standard General Requirements for Electronic Equipment.
 - 5. MIL-810: Environmental Test Methods and Engineering Guidelines.
 - 6. EIA-568-B.3: Commercial Building Telecommunications Cabling Standard: Optical Fiber Cabling Components.
 - 7. ICEA 5-83-696: Fiber Optic Premises Distribution Cable (Indoor/Outdoor).
 - 8. National Electrical Code (NEC) Article 770.
 - 9. UL 1581 VW-1 – Vertical Tray Cable Flame Test.
 - 10. UL 1666 - UL Standard for Safety Test for Flame-Propagation Height of Electrical and Optical-Fiber Cables Installed in Vertical Shafts.
 - 11. NFPA 262 – Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use IN Air-Handling Spaces.

12. IEEE Standard 383 - Flame Retardancy.

13. DOD-STD-1678.

14. National Electrical Manufacturers Association (NEMA).

- B. All fiber optical cables shall be constructed in accordance with EIA-455, and 100 percent of all optical fibers and jacketing shall meet or exceed the requirements contained in this specification.

1.03 SPARE PARTS AND TEST EQUIPMENT

A. Spare Parts

1. Provide five percent (minimum 20) spares of fiber connectors and dust covers.
2. Provide five percent (minimum 2) spare 2-fiber patch cables with connectors (both ends) terminated.

PART 2 - EQUIPMENT

2.01 FIBER OPTIC CABLE

- A. Provide 50 MICRON fiber, 12 fiber
- B. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding. The fiber shall be matched clad design.
- C. Single mode: Provide single mode, optical glass fiber compatible with LED or laser based transmission systems, utilizing 1310nm wavelength.
- D. Furnish sufficient lengths of cable such that splices are not required.
- E. For cable runs that extend more than 50 feet indoors before termination, the cable type used must be rated for indoor use per NEC 770.

2.02 FIBER OPTIC CABLE TERMINATIONS, CONNECTORS, AND CABLE ASSEMBLIES

A. Pigtail Splicing

1. For termination of fiber cables at a termination or connector panel (patch panel), with one end of a piece of cable preconnectorized and the other end unterminated for splicing to the cable that needs to be terminated. Splicing

and connectors shall meet the requirements listed in this Section.

2. A splice/termination tray shall house the splices and serve to fully protect excess lengths of loose tube fibers from exposure. Splice tray shall be compatible with the selected patch panel and installed for easy access to the spliced cable sections.
3. Pigtail assemblies shall match fiber cable type and model.

B. Buffer Tube Fan-Out Kits

1. Individual fibers within a loose tube cable with 250 μm coated fibers shall use a fan-out kit to maintain flexibility and ease of handling fibers within a termination cabinet. Fan-out kits shall be installed in the patch panel enclosures to transition the loose tube fibers to ruggedized tight-buffered fiber pigtail cables. Optical fusion splices shall connect the loose tube fibers to the tight-buffered pigtail cables. The optical splice loss shall comply with the specifications for optical splices. Splice protection sleeves shall be employed on all splices to protect the splices.
2. The tight-buffered pigtails shall be factory-preconnectorized with STTM connectors as specified.

C. Connectors (Cable Assemblies)

1. The fiber optic communications system shall utilize stainless steel LC style connectors for all fiber optic connections. The connectors shall be designed for use with 50 micron cable.
2. After termination with connectors, the fiber ends must be visually inspected at a magnification of not less than 100 power for multimode and 200x for single mode to check for cracks or pits in the endface of the fiber.
3. Connectors shall have a maximum allowable connection loss of 0.3 dB per mated pair, as measured per EIA-455-34.

D. Fiber Optic Patch Cables

1. Fiber optic patch cable shall be two-fiber zipcord 50/62.5/125 core/clad micron single- mode riser rated cable.
2. Installation of patch cables shall include all spares and observe the minimum fiber bend radius and strain relief.

2.03 FIBER OPTIC TERMINATION PATCH PANELS

A. General

1. Patch panels shall be suitable for wall mounting, comprised of internal mounting plate, cable holders, slack cable take up/organizer blocks, patch block with connectors, and ground lugs as indicated. Panels shall be NEMA 4X, 316 stainless steel construction for outdoors; and NEMA 12, 316 stainless steel or fiberglass for indoor use. Patch panels shall be suitable for single mode system operation at 1310 and 1550 nm. Patch panels shall be suitable for ST or LC connectors. The patch panels shall be sized to handle the number of fibers as required. All fibers shall be terminated in the patch panel.
2. Where shown on the plans or in the related specification Sections, the fiber optic cable shall terminate inside a communications cabinet on a termination patch panel. All fiber sub-cables within the exposed buffer tube shall be terminated with fan-out kits with preconnectorized pigtails. The patch panel shall have a fiber capacity equal to the total number of fibers (connected and spare) for all cables to be connected.
3. Unused buffer tubes shall be uncut and looped within the patch panel for continuous routing of the fiber buffer tube within the cable assembly.
4. Patch panels shall be designed for either rack mounting on a standard equipment rack or housed in an enclosure for direct wall mounting. The patch panel shall contain LC couplings. All unused couplings shall have protective dust covers. All panels shall be furnished with locking doors.
5. Factory-terminated, tight-buffered, aramid-reinforced fiber optic jumper assemblies or interconnect cables, standard 3.0-mm O.D., shall connect the optical cable terminations to the patch panel couplings.
6. The termination patch panel shall be equipped with a suitable means for routing and securing of cables, and shall provide a suitable means of protection for the mounted fiber connectors to prevent damage to fibers and connectors during all regular operation and maintenance functions. All cables shall be provided with strain relief. Bend diameters on cable fibers and jumpers must be greater than four inches at all times to ensure optical and mechanical integrity of the optical fibers.
7. Termination panels shall be equipped with splice trays (where applicable) and holders for pigtail and through fiber splicing.

8. Termination panels shall be provided with all hardware, options, and accessories to provide for a complete installation of the fiber optic system.
9. Panels shall be Clearfield FieldSmart or equal.

2.04 19" RACK

- A. Where indicated on the Drawings, a 19" rack shall be furnished. for the mounting of fiber patch panels. Furnish and install any and all appurtenances required.
- B. 45U Rack Enclosure Server Cabinet
- C. Rack will have Roof-Mount Panel Fan
- D. Rack will have 2-pack Door Handles
- E. Magnetic Door Switch Kit, Tripp-Lite PN: SRSWITC
- F. Rack will have Cooling Horizontal Brush Strip
- G. Rack will have 6ft Horizontal Cable Ring
- H. Horizontal Cable Ring Flexible 1URM
- I. Rack shall be Tripp-Lite PN: SR45UB or equal.

END OF SECTION

E. ELECTRICAL SPECIFICATIONS

**SECTION 260000
GENERAL**

1.01 CONTRACT DOCUMENTS:

- A. All work of Section 26 shall comply with the requirements of:
1. General Conditions
 2. Supplementary General Conditions
 3. General Requirements
 4. Specifications
 5. Drawings
 6. Modifications incorporated in the documents before their execution.

1.02 WORK INCLUDED

- A. This Division of the specifications (26 00 00) covers the complete interior and exterior electrical system for all work shown on the drawings as specified herein providing all material, labor and equipment required for the installation of the electrical systems complete and in operating condition.
- B. Include in the electrical work all the necessary supervision and the issuing of all coordinating information to any other trades who are supplying work to accommodate the electrical installations.

1.03 DRAWINGS

- A. The drawings for electrical work utilize symbols and schematic diagrams which have no dimensional significance. The work shall therefore, be installed to fulfill the diagrammatic intent expressed on the electrical drawings.
- B. Review architectural drawings for door swings, cabinets, counters, moldings and built-in equipment, conditions indicated on architectural drawings shall govern. Prior to rough-in of receptacles and systems outlets, refer to architectural casework drawings for rough-in coordination.

- C. Coordinate electrical work with the architectural details, floor plans, elevations, structural and mechanical drawings. Provide fittings, junction boxes and accessories to meet conditions.
- D. Do not scale drawings. Dimensions for layout of equipment, or spaces shall be obtained from architectural, structural or mechanical drawings unless specifically indicated on the electrical drawings.
- E. Discrepancies shown on different drawings, between drawings and specifications or between drawings and field conditions shall be promptly brought to the attention of the Engineer.
- F. Provide as used on the drawings and in the specifications shall mean, furnish, install, connect, adjust and test.
- G. The drawings and specifications are complimentary and any work or material shown in one and omitted in the other, or described in the one and not shown in the other, or which may be implied by both or either, shall be furnished as though shown on both, in order to give a complete and first class installation.

1.04 SITE INVESTIGATION

- A. Potential Contractors shall visit the project site prior to bid date to satisfy themselves as to the existing conditions and distances which may effect the cost of the project. Where work under this project requires extension, relocation, re-connecting or modifications to existing equipment or systems, the existing equipment or systems, shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project.

1.05 SHOP DRAWINGS

- A. Submit for approval by the Engineer all materials and equipment to be incorporated in the electrical work.
- B. Submit only shop drawings which comply with the contract documents. Shop drawings shall be checked and corrected by the Contractor before they are submitted to the Engineer. Shop drawings that are not corrected by the Contractor shall be returned for correction without detailed notations by the Engineer as to the necessary corrections.

- C. Mark each individual submittal item to show specification section which pertains to the item.
- D. Submit information as required under SUBMITTALS, for each of the individual electrical sections of the specifications.
- E. Data submitted shall contain all information required to indicate compliance with equipment specified.
- F. Submit field information drawings to explain fully all procedures involved in erecting, mounting and connecting all items of equipment which differ from that specified.
- G. When Shop Drawings are reviewed, some errors may be detected but others may be overlooked. This does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings, the requirements of the Drawings and Specifications shall be followed and are not waived or superseded in any way by the Shop Drawing review.

1.06 RECORD DRAWINGS:

- A. One complete set of electrical drawings shall be reserved for as-built drawings. Any approved deviation from the contract drawings shall be recorded on these drawings. Drawings shall be checked monthly for completeness.
- B. Completed as-built drawings shall be presented to the Engineer prior to final inspection.

1.07 MAINTENANCE AND OPERATING INSTRUCTIONS:

- A. Provide at the time of final inspection three sets of maintenance and operating instruction for:
 - 1. Lighting and Power Panelboards
 - 2. Fuses
 - 3. Wiring Devices
 - 4. Lighting Fixtures
 - 5. Disconnect Switches
 - 6. Photo Control and Contactors

7. Fire Alarm System
8. Generator/ATS
9. Generator Docking Station
10. Surge Protection System
11. Switchboard
12. Motor Control Center
13. Dry-type Transformers

- B. Furnish a qualified and accredited factory trained technician to train personnel designated by the Owner in the proper operation and maintenance of specialized equipment.
- C. The issuing of operating instructions shall include the submission of the name, address, and telephone number of the manufacturer's representative and service company for each item of equipment so that service and spare parts can be readily obtained.

1.08 CODES AND PERMITS:

- A. All electrical work shall meet or exceed the latest requirements of the following codes and/or other authorities exercising jurisdiction over the electrical construction work and the project.
 1. The National Electrical Code (NFPA 70) - 2023 Edition
 2. The National Electrical Safety Code (ANSI C-2)
 3. The Life Safety Code (NFPA 101) - Current Edition
 4. The International Building Code - Current Edition, with Georgia Amendments.
 5. Regulations of the local utility company with respect to metering and service entrance.
 6. Municipal and State ordinances governing electrical work.
- B. All required permits and inspection certificates shall be obtained, and made available at the completion of the work. Permits, inspections, and certification fees shall be paid for as a part of the electrical work.

1.09 DEVIATIONS:

- A. No deviations from the plans and specifications shall be made without the full knowledge and consent of the Engineer or his authorized representative.

- B. Should the Contractor find at any time during progress of the work that, in his judgment, existing conditions make desirable a modification in requirements covering any particular item or items, he shall report such items promptly to the Engineer for his decision and instruction.

1.10

COOPERATION:

- A. This Contractor shall schedule his work and in every way possible cooperate with all other Contractors on the job to avoid delays, interferences, and unnecessary work. He shall notify them of all openings, hangers, excavations, etc., so that proper provisions shall be made for his work. This shall not relieve him of the cost of cutting, when such is required.
- B. This Contractor shall do all cutting and excavating necessary for the complete installation of his work, but he shall not cut the work of any other Contractor without first consulting the Engineer. He shall repair any work damaged by him or his workmen, employing the services of the Contractor whose work is damaged. Saw cut existing slab as required for routing conduits and floor boxes noted to be installed in existing floors. Restore to original finish.
- C. This Contractor shall by all means coordinate the location of ceiling lighting fixtures, both recessed and surface mounted, with the Ceiling Contractor so that proper hangers and supports shall be provided.
- D. Any conflict between electrical and other trades shall be reported before construction starts. No extra charges will be approved for work resulting from failure to coordinate with other trades.

1.11

INSTALLATION:

- A. Raceways, fixtures, devices, and other electrical equipment shall be installed in a neat and workmanlike manner and in accordance with recognized good practice for a first class installation.
- B. The Engineer or his representative shall have the authority to reject any workmanship not complying with the contract documents.
- C. The Electrical Contractor shall personally or through an authorized licensed and competent electrician, constantly supervise the work from beginning to complete and final inspection.

- D. Electrical equipment shall be installed in accordance with manufacturer's recommendations.
- E. Locations of proposed raceway, riser, location of structural elements, location and size of chases method and type of construction of floors, walls, partitions, etc., shall be verified before construction starts.
- F. Consult owner and utility companies for underground lines before any underground work is started. Contractors shall be responsible for any damage.
- G. All empty conduits shall have a pull string installed. All flush recessed boxes shall have black plates installed.

1.12

EXCAVATION, TRENCHING AND BACKFILLING:

- A. General. The Contractor shall perform all excavation to install conduit structures and equipment specified in this Division of the Specifications. During excavation, materials for backfilling shall be piled back from the banks of the trench to avoid over-loading and to prevent slides and cave-ins. All excavated materials not to be used for backfill shall be removed and disposed of by the Contractor. Grading shall be done to prevent surface water from flowing into trenches and other excavations and water accumulating therein shall be removed by pumping. All excavations shall be made by open cut. No tunneling shall be done. All requirements of OSHA shall be complied with.
- B. Trench Excavation. The bottom of the trenches shall be graded to provide uniform bearing and support for each section of the conduit on undisturbed soil at every point along its entire length. Over depths shall be backfilled with loose, granular, moist earth, tamped. Removed unstable soil that is not capable of supporting the conduit and replace with specified material.
- C. Backfilling. The trenches shall not be backfilled until it is reviewed by the Engineer or his representative. The trenches shall be backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, and gravel or soft shale, free from large clods of earth or stones, deposited in 6" layers and tamped until the conduit has a cover of

not less than the adjacent existing ground but not greater than 2" above existing ground. The backfilling shall be carried on simultaneously on both sides of the trench so that conduit is not displaced. The compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material, except that trenches occurring under paved areas or in areas to be filled shall be backfilled in 6" maximum layers and each layer compacted to 95% maximum density. Settling the backfill with water will not be permitted. Any trenches not meeting compaction requirements or where settlement occurs shall have backfill removed down to the top of the conduit then backfill with approved materials as specified hereinbefore.

- D. Positively no tree roots are to be damaged, hand dig where required. Damaged trees or shrubbery shall be replaced in kind and must be approved by Engineer.

1.13

MATERIALS:

- A. Materials specified by manufacturer's name shall be used unless approval of other manufacturers are listed in addenda to these specifications. Request for prior approval shall be submitted by mail only. Facsimile will not be acceptable.
- B. Drawings indicating proposed layout of space, all equipment to be installed therein and clearance between equipment shall be submitted, where substitution of materials alter space requirements on the drawings.
- C. Material Standards: All materials shall be new and shall conform to the standards where such have been established for the particular material in question. Publications and Standards of the organization listed below are applicable to materials specified herein.
 - 1. American Society for Testing and Materials (ASTM)
 - 2. Underwriter's Laboratories, Inc. (UL)
 - 3. National Electrical Manufacturer Association (NEMA)
 - 4. Insulated Cable Engineers Association (ICEA)
 - 5. Institute of Electrical and Electronic Engineers (IEEE)
 - 6. National Fire Protection Association (NFPA)
 - 7. American National Standards Institute (ANSI)
- D. Material of the same type shall be the product of one manufacturer.

- E. Materials not readily available from local sources shall be ordered immediately upon approval.
- F. The Engineer shall have authority to reject any materials, or equipment, not complying with these specifications and have the Contractor replace materials so rejected immediately upon notification of rejection.
- G. Any material or equipment so rejected shall be removed from the job within 24 hours of such rejection, otherwise the Engineer may have same removed at the Contractor's expense.

1.14

EQUIPMENT CONNECTIONS:

- A. All equipment requiring electrical power connections shall be connected under this Division of these specifications.
- B. Where electrical connections to equipment require specific locations, such locations shall be obtained from shop drawings.
- C. Drawings for location of conduit stub-up boxes mounted in wall or floor to serve specific equipment, shall not be scaled.
- D. Electrical circuits to equipment furnished under other sections of these specifications are based on design loads. If actual equipment furnished has loads other than design loads electrical circuits and protective devices shall be revised to be compatible with equipment furnished at no additional cost to the Owner. Any revisions must have prior approval by the Engineer. **Before submitting shop drawings, Electrical Sub-Contractor shall along with the Plant Equipment providers/contractors, Mechanical and Plumbing Sub-Contractor review voltage and load requirements for mechanical and plumbing equipment to determine the compatibility between what is being furnished and what is shown in the contract drawings. The Electrical Sub-Contractor shall along with his submittals submit a statement that he has reviewed all shop drawings including review with the Plant Equipment providers/contractors, Mechanical and Plumbing Sub-Contractor.**
- E. Where equipment is indicated to be served thru conduit stub-up, conduit shall be stubbed up not less than four inches above floor where transition shall be made to sealtite flexible conduit for connection to equipment.

- F. The Contractor's attention is invited to other Divisions of these specifications, where equipment requiring electrical service or electrically related work is specified to become fully aware of the scope of work required for electrical service or related work.
- G. Where electricity utilizing equipment is supplied separate from the electrical work, and is energized, controlled or otherwise made operative by electrical work, the testing to provide the proper functional performance of such wiring systems shall be conducted by the trade responsible for the equipment. The electrical work shall, however, include cooperation in such testing and the making available of any necessary testing or adjustments to the electrical equipment.
- H. Heating, air conditioning, and ventilating equipment is specified to be furnished and installed under other sections of these specifications. The controls, likewise are specified to be furnished thereunder. All necessary wiring, wiring troughs and circuit breakers for power for this equipment shall be furnished and installed under this section of the specifications, in accordance with the plans and/or diagrams furnished with the equipment, or shown on these plans. Starters furnished by the Mechanical Contractor shall be installed under this Division of the specifications. Power wiring to auxiliary equipment on a piece of equipment remote from its main terminal box and interlocking of apparatus shall be accomplished under Heating Ventilating Equipment section of the specifications. Conduit and outlets for control wiring shall be furnished and installed under Mechanical Division of these specifications. Control conductors for mechanical equipment shall not be installed in same conduit with power conductors.
- I. Contractor is to note that location of disconnect switches shown are schematic in nature. Exact location of disconnect switch and mounting height shall be coordinated with field conditions and equipment shop drawings. Locate disconnect as required to maintain clearances required by National Electrical Code.
- J. Contractor shall provide a rooftop mounted, GFCI receptacle with weatherproof cover within 20' of a rooftop mounted HVAC unit. Serve from closest receptacle circuit with ½"C., 3#12's. See mechanical plan for unit locations.

1.15

PRODUCT DELIVERY, STORAGE, HANDLING, & PROTECTION

- A. Inspect materials upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material. Handle materials in accordance with manufacturer's applicable standards and suppliers recommendations, and in a manner to prevent damage to materials. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact. Containers which are broken, opened, damaged, or watermarked are unacceptable and shall be removed from the premises.
- B. All material, except items specifically designed to be installed outdoors such as pad mounted transformers or stand-by generators, shall be stored in an enclosed, dry building or trailer. Areas for general storage shall be provided by the Contractor. Provide temperature and/or humidity control where applicable. No material for interior installation, including conductors, shall be stored other than in an enclosed weather tight structure. Equipment stored other than as specified above shall be removed from the premises.
- C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

1.16

CLEANING AND PAINTING

- A. Remove oil, dirt, grease and foreign materials from all raceways, fittings, boxes, panelboard trims and cabinets to provide a clean surface for painting. Touch-up scratched or marred surfaces of lighting fixtures, panelboard and cabinet trims, motor control center, switchboard or equipment enclosures with paint furnished by the equipment manufacturers specifically for that purpose.
- B. Do not paint trim covers for flush mounted panelboards, telephone cabinets, pull boxes, junction boxes and control cabinet unless required by the Engineer. Remove trim covers before painting. Under no conditions shall locks, latches or exposed trim clamps be painted.

- C. Unless indicated on the drawings or specified herein to the contrary, all painting shall be done under the PAINTING Section of these Specifications.
- D. Where plywood backboards are used to mount equipment provided under Division 26, paint backboards with two coats of light grey semi-gloss paint. Plywood shall be 3/4" fire rated plywood. Paint shall be fire retardant paint.

1.17 GUARANTEE:

- A. All systems and component parts shall be guaranteed for one year from the date of final acceptance of the complete project. Defects found during this guaranteed period shall be promptly corrected at no additional cost to the Owner.

1.18 SERVICE:

- A. The electrical service and telephone service for this project has been coordinated between the Engineer and the Utility Company. However, before installing service conduit (underground or mast), Contractor shall contact Utility Company and verify voltage, location and type of service. Prior to rough-in, coordinate an on-site meeting with each Utility Company to review exact requirements. Submit letter of coordination to Engineer for review.
- B. Where contract documents show a pad mount transformer provide by Utility Company, the following items shall be coordinated with Civil Plans, Architectural Plans, and Utility Company prior to rough-in.
 - 1. Transformer pad locations shall be a minimum of 10'-0" from any building overhangs, canopies, exterior walls, balcony, exterior stairs and or walkways connected to the building.
 - 2. Transformer pad edge shall be no less than 14'-0" from any door way.
 - 3. Transformer pad edge shall be no less than 10'-0" from any windows or other openings.
 - 4. If the building has an overhang, the 10'-0" clearance shall be measured from a point below the edge of the overhang only if the building is three (3) stories or less. If the building is four (4)

stories or more, 10'-0" shall be measured from the outside building wall.

5. Fire escapes, outside stairs, and covered walkways attached to or between buildings, shall be considered part of the building.

Note: This information above has been obtained from the NEC 450-27 and the Office of Insurance and Safety Fire Commissioner Chapter 120-3-3-.04.

6. If required by Utility Company, Contractor shall provide concrete pad for transformer per Utility Company requirements.
7. Contractor shall install meter (provided by Utility Company) on a 6" channel iron set in concrete. Paint channel iron to match transformer. Install 1 ¼" galvanized rigid steel conduit from meter to transformer C.T. compartment.
8. Install a 1" steel conduit from meter and stubbed up into Main Electrical Room for future energy management monitoring. Install pull string and cap conduit.

END OF SECTION

SECTION 260003
ELECTRICAL SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for the preparation of Electrical Division 26 Shop Drawings, Product Data, Samples, and other submittals.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
- B. All submittals shall be submitted in electronic format.
- C. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:
 - 1. Assemble complete submittal package into indexed files incorporating submittal requirements of each single Specification Section and transmittal form with links enabling navigation to each item.
 - 2. Name file with submittal number or other unique identifier, including revision identifier.
 - a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01.A).
 - 3. Transmittal Form for Electronic Submittals: Use software-generated form from electronic project management software acceptable to Owner, containing the following information for EACH SECTION:
 - a. Project name.
 - b. Date.

- c. Name and address of Engineer.
 - d. Name of Construction Manager/General Contractor.
 - e. Name of Electrical Contractor.
 - f. Name of firm or entity that prepared submittal.
 - g. Names of subcontractor, manufacturer, and supplier.
 - h. Specification Section number and title.
 - i. Indication of full or partial submittal.
- D. Options: Identify options requiring selection by Engineer.
- E. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- F. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
- 1. Note date and content of previous submittal.
 - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 - 3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.
- G. HVAC/Plumbing/Plant Equipment/Electrical Equipment connection coordination letter as noted below: Before submitting shop drawings, Electrical Sub-Contractor shall along with the Mechanical and Plumbing Sub-Contractor review unit locations, unit quantities, unit voltage, phase, MCA and MOCP requirements for mechanical and plumbing equipment to determine the compatibility between what the Mechanical and Plumbing Sub-Contractor is providing and installing versus what is shown in the contract drawings. The Electrical Sub-Contractor shall along with his gear submittals submit a statement that he has reviewed all equipment shop drawings with the Mechanical and Plumbing Sub-Contractors. Any discrepancy between such shall be listed for Engineer review and corrective action. Do not submit the electrical gear without this coordination letter. Contractor is to note that electrical gear submitted without this coordination letter shall not be reviewed, nor returned until Engineer receives such coordination letter.

2.2 SUBMITTAL DATA

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 - 1. Mark each copy of each submittal to show which products and options are applicable.
 - 2. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 - 3. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 - 4. Submit Product Data before or concurrent with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
- C. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of engineers and owners, and other information specified.
- D. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that

submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEER'S ACTION

- A. Submittals: Engineer will review each submittal, make marks to indicate corrections or revisions required, and return it.
- B. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- C. Submittals not required by the Contract Documents may be returned by the Engineer without action.

END OF SECTION

**SECTION 260010
LIGHTING AND POWER PANELBOARDS**

PART 1 – GENERAL

1.01 SUBMITTALS

- A. Complete panelboard shop drawings shall be submitted, listing as a minimum the following items:
 - 1. Voltage rating.
 - 2. Bus assembly rating.
 - 3. Main breaker rating by capacity, number of poles and interrupting rating in RMS symmetrical amperes.
 - 4. Surface or flush mounting.
 - 5. Listing of branch breakers by capacity number of poles and interrupting rating in RMS symmetrical amperes.
 - 6. Top or bottom feed.
 - 7. A schedule similar to that shown on the drawings, depicting branch breaker arrangement and breaker sizes and giving full explanation for any difference between the two.
 - 8. Coordinate lug sizes as required for feeders shown on drawings.
- B. Contractor shall submit ¼" layouts of all electrical rooms delineating placement of equipment of minimum required clearances specified in National Electrical Code.

1.02 MANUFACTURERS

- A. For the purpose of selecting quality and types of panels, equipment as manufactured by Square "D" Company has been specified. Following manufacturers meeting these specifications are acceptable.
 - 1. G. E.

2. Siemens
3. Eaton

1.03 EQUIPMENT

- A. Furnish and install circuit breaker lighting and power panelboards as indicated in the panelboard schedule and where shown on the plans. Panelboards shall be of the dead-front safety type, equipped with thermal magnetic molded case circuit breakers with frame and trip rating as shown in the schedule.
- B. Circuit breakers shall be HACR rated, quick-make, quick-break, thermal-magnetic, trip-indicating, and have common trip on all multi-pole breakers. Trip indication shall be clearly shown by the breaker handle taking position between ON and OFF, when the breaker is tripped. Branch circuit breakers feeding convenience outlets shall have sensitive instantaneous trip setting of not more than 10 times the trip rating of the breakers. Connection to bus in all panels shall be bolted. All breakers shall be 20 ampere trip, unless otherwise shown. All breakers shall be minimum for 120/240 volts (10,000) A.I.C. sym. unless otherwise noted.
- C. Bus bar connections to the branch circuit breakers shall be the distributed phase type. Three-phase, four-wire bussing shall be such that any three adjacent single-pole breakers are individually connected to each of the three different phases in such a manner that two or three-pole breakers can be installed at any location. **All current-carrying parts of the bus assembly shall be copper. Main ratings shall be as shown in the panelboard schedule on the drawings.**
- D. Panel front shall be provided with a continuous piano hinge on one side.
- E. A steel circuit directory frame permanently attached (spot welded) at factory (not glued), and card with a clear plastic covering shall be provided on the inside of the door. The directory card shall provide a space at least 1/4" high x 3" long for each circuit.
- F. All panels shall be equipped with a copper equipment grounding bar. The bar shall have lugs of sufficient size to handle all grounding conductors.
- G. Sub-feed circuit breakers are not permitted in panels unless specifically called for.

- H. Provide mounting hardware for all spaces shown on panelboard schedule.
- I. Panelboard circuit numbering shall be such that starting at the top, odd numbering shall be used in sequence down the left hand side and even numbers down the right hand side.
- J. Except where otherwise indicated on the drawings or required to avoid conflicts, mount the panelboards so the tops of the cabinets will be 6 feet above the finished floors. For panelboards which are too high, mount them so the bottoms of the cabinets will be not less than 6 inches above the finished floors.
- K. Locate the cabinets so that present and future conduits can be connected to them conveniently. Coordinate the dimensions of the cabinets with the dimensions of the spaces designated for installation prior to fabrication of the cabinets. Cabinet shall be minimum 20" wide.
- L. Wiring in panelboards shall be neatly grouped and secured with ty-wraps.
- M. Electrical panels shall not be used as wireways or junction boxes for control conductors.
- N. Where spaces are called for in a panel, all mounting hardware shall be provided for the frame size indicated.
- O. Splices in panelboards are not permitted.

END OF SECTION

SECTION 260015
FUSES

PART 1 – GENERAL

1.01 SUBMITTALS

- A. Shop drawings shall be submitted and shall consist of manufacturer's published literature and technical data sufficient for the engineer to determine whether system function will be adversely affected, whether proposed fuses meet this specification, and whether they are equal in quality.

1.02 MANUFACTURERS

- A. Acceptable manufacturers are:
 - 1. Littelfuse
 - 2. Cefco
 - 3. Gould - Shawmut

1.03 EQUIPMENT/MATERIAL

- A. All fuses rated 600 volts or less and used for main, feeder, or branch circuit protection with 200,000 ampere interrupting rating and shall be so labeled. Fuse classes and sizes indicated on the drawings have been selected to provide a fully coordinated selective protection system. To maintain this design, all fuses provided shall be furnished by the same manufacturer. Should equipment provided require a different U.L. Class or fuse size, the engineer shall be furnished with sufficient data to ascertain that system function will not be adversely affected.
- B. Current-Limiting Fuses 600 Amperes or Less
All fuses 600 amperes and below shall be true dual-element time delay fuses with separate spring-loaded thermal overload elements in all ampere ratings. All ampere ratings shall be designed to open at 400 degrees Fahrenheit or less when subjected to a non-load oven test. To eliminate induction heating, all fuse ferrules and end caps shall be non-ferrous and shall be bronze or another alloy not subject to stress cracking.

C. Spare Fuses

At the time of final acceptance, the contractor shall furnish the owner's representative, not less than three (3) spare fuses of each size and type installed.

END OF SECTION

**SECTION 260020
RACEWAYS**

1.01 SUBMITTALS

- A. Submit manufacturer's literature for each type of conduit or tubing and fittings used in the project.

1.02 MANUFACTURERS

- A. Acceptable manufacturers of rigid steel and electrical metallic tubing conduit are:
 - 1. Allied Tube and Conduit Co. (Kwik-Fit)
 - 2. Wheatland Tube Co.
 - 3. Triangle
 - 4. L.T.V.
 - 5. American Brass
 - 6. E.T.P.
 - 7. Robroy
 - 8. PYTCO
 - 9. RYMCO
 - 10. Galvite
 - 11. Western Tube
- B. Acceptable manufacturer's of polyvinyl chloride (PVC) conduit are:
 - 1. Certainteed
 - 2. Georgia Pipe
 - 3. Carlon
 - 4. Can-Tex
 - 5. Queen City
- C. Acceptable manufacturer's of conduit fittings, bushings, and locknuts are:
 - 1. O-Z/Gedney
 - 2. Thomas and Belts
 - 3. Raco

1.03 MATERIALS

- A. All metallic conduit and electric metallic tubing shall be steel, of standard pipe dimensions, smooth inside and out, and shall be galvanized, unless located in a highly corrosive area. Where the word "conduit" is used

hereinafter it shall mean either rigid steel conduit, electric metallic tubing, flexible steel conduit, liquid tight flexible steel conduit or schedule 40 plastic conduit. Intermediate grade conduit is not acceptable.

- B. Stainless steel conduits shall be used in highly corrosive areas where the conduit is subject to damage, specifically, but not limited to, in the headworks/bar screen, odor control, grit removal, influent pump station and the SBR tanks.
- C. Galvanized rigid steel conduit shall be used in all areas where it will be exposed to physical damage, unless located in a highly corrosive area. Schedule 40 plastic conduit shall be used underground and in slab-on-grade. In no case shall plastic conduit be exposed; switch to rigid steel conduit when turning up exposed. All other conduit, unless otherwise specified or called for on the plans, may be galvanized electric metallic tubing. Any exposed conduit on exterior of the building shall be galvanized rigid steel only, unless located in a highly corrosive area.
- D. Plastic conduit shall be made from virgin polyvinyl chloride C-300 compound. Conduit and fittings shall carry a UL label. Fitting and cement shall be produced by the same manufacturer as the conduit to assure system integrity.
- E. All conduit shall be concealed in building construction except as noted or shown otherwise. In areas with no finished ceiling and where conduit is run exposed all runs down to switches, receptacles, etc. shall when possible be concealed in wall. It is the intent of these specifications that all conduit will be concealed whenever possible.
- F. EMT fittings shall be compression and made of steel for sizes two inches or smaller, steel set screw type fittings may be used on sizes 2 1/2" or larger. Connectors and couplings shall be rain tight and shall have a nylon insulated throat. All fittings shall be "UL" approved. EMT conduit (in sizes 2 1/2" through 4") provided with integral steel compression or set screw coupling on one (1) end of the conduit is acceptable. Die cast, and indenter type fittings are not acceptable. Fittings for flexible steel conduits and liquid tight flexible conduit shall be steel and have nylon insulated throat.
- G. Rigid steel conduit, stainless steel conduit, and EMT shall be not less than 1/2 inch trade size, schedule 40 plastic conduit shall not be less than 3/4"

trade size and not less than required by the NEC or indicated. Conduit runs with more than 5 #12 conductors shall not be less than 3/4".

- H. Conduit and EMT systems indicated on the drawings for communication and signaling systems are for typical systems. Install conduit and EMT systems for the system being installed.
- I. Connect individual recessed lighting fixtures to the conduit or EMT system with "maximum 6'-0" flexible, galvanized steel conduit. Use flexible galvanized, steel metal conduit for final connection to all rotating equipment and transformers. The flexible conduits shall be long enough to permit the full range of required movements without strain and to prevent the transmission of vibration. Do not utilize flexible conduit to loop between fixtures and devices.
- J. Galvanized rigid steel conduit couplings and connections:
 - 1. Install standard, conduit-threaded fittings.
 - 2. Ream the ends of conduits after cutting and threading them.
 - 3. For connection to sheet metal boxes, cabinets and other sheet metal enclosures, install locknuts on the inside and outside of the enclosure for each connection. See Section 16110 of these specifications.
- K. EMT couplings and connectors:
 - 1. Ream the ends of EMT after cutting them.
 - 2. Install the following threadless type fittings:
 - a. Connectors: steel compression type with insulated throat or steel tap-on type with insulated throat.
 - b. Couplings: steel compression or tap-on type.
- L. Installation of plastic conduit:
 - 1. Shall be installed in complete accordance with manufacturer's recommendations.
 - 2. Shall be a minimum of 2'-0" below finished grade when not covered by concrete.

3. Shall have properly sized bond wire installed with all circuits.
4. Bends and turns shall be kept to a bare minimum.
5. Extreme care shall be taken to avoid crushing or cracking conduit. "DO NOT" run vehicles over exposed conduit under any conditions.
6. All conduit and fittings shall be solvent welded.
7. Plastic conduit maybe turned up in masonry walls only. PVC conduit shall be allowed to be routed concealed in masonry walls to a maximum height of 48" A.F.F.
8. Do not install conduit in slab. All conduit shall be installed a minimum of 6" below slab. Conduits shall not be bunched together. Maintain 1" clearance between conduits.
9. Plastic conduit shall not be bent with a propane torch or open flame. Contractor shall utilize a heat gun, heat blanket, or hot box. Plastic conduit bent with such shall not be scorched or marred.

M. Insulated bushings:

1. Install nylon insulated bushings on the end of all rigid conduit.
2. The insulating material shall be designed for rugged, long service.
3. Bushings which consist of only insulating material will not be accepted.
4. Fittings which incorporate insulated bushings will be considered for approval in lieu of fittings with separate bushings.

N. All couplings and connections in location where water or other liquid or vapor might contact the conduit and EMT shall also be watertight.

O. Close empty conduit and EMT as complete runs before pulling in the cables and wires.

P. Install exposed conduit and EMT parallel to or at right angles with the lines of the building. Locate them so they will not obstruct headroom or walkways or cause tripping.

Q. Avoid bends or offsets where practicable:

1. Do not install more bends, offsets or equivalent in any conduit or EMT run than permitted by the NEC.
2. Make bends with standard conduit bending machines.
3. Conduit hickies may be used for making slight offsets and for straightening conduits stubbed out of concrete.
4. Conduit or EMT bent with a pipe tee or vise will not be accepted.
5. Do not install crushed or deformed conduits or EMT.

R. Install conduit or EMT clamps:

1. At intervals as required by the NEC.
2. Above suspended ceilings, metal supports may be installed as permitted by the NEC, except that conduit cannot be supported or secured to the T-bar grid or from the wire supporting the T-bar grid.
3. Trapeze, split ring, band or clevis hanger may be installed as permitted by the NEC. Trapeze hangers shall be structural metal channels, angle irons or preformed metal channel shapes with the conduit and EMT runs held on specific center by U bolts, clips or clamps. Do not support conduit from ceiling suspension wire or from other conduit.
4. Chain, wire or perforated strap supports will not be acceptable. Nor are they acceptable as a means of securing the conduit.
5. Fasten the clamps and other supports as follows:
 - a. For new masonry or concrete structures, install threaded metal inserts prior to pouring the concrete.
 - b. For existing solid masonry or reinforced concrete structures:
 1. Install expansion anchors and bolts or approved power-set fasteners.

2. Expansion anchors and bolts shall be not less than 1/4 inch diameter and shall extend not less than 3 inches into the concrete or masonry.
 3. Power-set fasteners shall be not less than 1/4-inch diameter and shall extend not less than 1-1/4-inch into the concrete.
 - c. For hollow masonry install toggle bolts. Bolts supported only by plaster will not be accepted.
 - d. For metal structures install machine screws.
 - e. Attachments to wood plug, rawl plug, soft metal insert or wood blocking will not be permitted.
- S. For vertical runs of conduit of EMT:
1. Install supports for conduit, EMT, cables and wires at intervals as required by the NEC and as indicated on the drawings.
 2. Conduit and EMT supports shall be supported by framing for the floors.
- T. Conduits and EMT shall be kept 6" away from parallel runs of steam or hot water pipes.
- U. Clogged raceways shall be entirely free of obstructions or shall be replaced.
- V. Rigid steel conduit installed underground and in concrete shall be wrapped with Scotchwrap #50 corrosion protection tape.
- W. All empty conduits shall have nylon pull cord installed to provide for installation of cables, conductors or wiring. All empty conduits stubbed out below grade shall have be capped and provided with a concrete marker. All spare conduits stubbed up through slab shall have a cap installed to prevent debris from entering conduit.
- X. Do not combine conduit homeruns. Each homerun shall be separately routed directly to panel unless specifically noted otherwise.

Y. Install service conduit (TV, electrical, and telephone) as follows:

1. All underground entrances shall have metallic sleeves through building foundation walls and extend to undisturbed ground to avoid shear, and shall be full weight, threaded hot-dipped galvanized rigid steel conduit.
2. All 90 degree bends to be rigid metallic conduit, with a radius of not less than 10 times the diameter of the conduit.
3. Maintain a minimum cover of 24 inches below final grade for conduits.

Z. Telephone conduits:

1. Where telephone conduit runs are longer than 100'-0" or have more than two 90° bends (or equivalent) or have a reverse bend, pull boxes shall be provided.

AA. Do not install conduit in cavity between concrete block and brick. Conduit shall not be stubbed up into this cavity or routed horizontally in cavity.

BB. All underground conduit installed outside of the building shall have yellow, 4" wide, warning tape, reading "CAUTION-ELECTRICAL LINES BELOW" installed in trench above conduit. Install warning tape 12" below grade.

CC. For exterior locations provide 304 stainless steel channel, conduit clamps, threaded rod and hardware of equivalent dimensions identified for exterior locations. For interior locations all parts and hardware shall be zinc-coated or have equivalent corrosion protection.

END OF SECTION

SECTION 260030
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Connectors, splices, and terminations rated 600 V and less.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire Company.
2. Cerro Wire LLC.
3. Encore Wire Corporation.
4. General Cable; General Cable Corporation.
5. Senator Wire & Cable Company.
6. Southwire Company.

2.2 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. RoHS compliant.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- D. Conductor Insulation:
 - 1. Type THHN and Type THWN-2: Comply with UL 83.
 - 2. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
 - 3. Type XHHW-2: Comply with UL 44.

2.3 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Copper.
 - 2. Type: Two hole with long barrels.
 - 3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Type THHN/THWN-2, single conductors in raceway.
- B. Branch Circuits: Type THHN/THWN-2, single conductors in raceway.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.4 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements.
 - 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression applied connectors for correct cable match and indentation.

- d. Inspect for correct identification.
- e. Inspect cable jacket and condition.
- f. Insulation-resistance test on each conductor with respect to ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
- g. Continuity test on each conductor and cable.
- h. Uniform resistance of parallel conductors.

B. Test and Inspection Reports: Prepare a written report to record the following:

- 1. Procedures used.
- 2. Results that comply with requirements.
- 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION

SECTION 260040 OUTLETS

PART 1 GENERAL

1.01 SUBMITTALS

- A. Shop drawings shall be submitted and shall consist of manufacturer's published literature.

1.02 MANUFACTURERS

- A. Acceptable manufacturers are:
 - 1. Raco
 - 2. Steel City
 - 3. Appleton
 - 4. Hubbell

1.03 MATERIALS

- A. Boxes shall be galvanized pressed sheet steel for all concealed work, unless otherwise specified or indicated on the drawings.
- B. Where conduit runs are exposed, outlet shall be of the cast metal type, unless located in a highly corrosive area.
- C. For concealed work each box shall be provided with a square cornered plaster ring.
- D. Each surface lighting fixture, receptacle and switch shall be provided with flush mounted outlet box. All outlets installed in panels and other architectural features shall be centered. The location of any outlet may be moved as much as 10'-0" by the Engineer before the outlet is placed without incurring any extra cost. All dimensions refer to the finished floor line. Outlet boxes shall be pressed sheet steel and shall be galvanized for all concealed work. Where conduit runs are exposed outlets shall be of the cast metal type, unless located in a highly corrosive area.
- E. Boxes shall be for the service and the type of outlet and shall not be less than 4" square and 1-1/2" deep except where otherwise specified. Boxes

installed in walls shall be provided with a square cornered 1-1/2" plaster ring installed flush with surface of wall. Coordinate depth of plaster ring required for particular wall construction. Each outlet box above ceiling shall be supported from a structural member of the building either directly or by using a substantial and approved metal support. Conduit is not an approved means of support. Boxes installed in wall shall be supported either directly to a stud or between studs utilizing an approved bar hanger. In no case shall switch box support and clips used for mounting boxes in old work be used unless specifically called for. Top of outlet box shall be level.

- F. All ceiling or wall recessed outlet boxes or their associated plaster rings shall be flush with the finished surface. Using coverplate to secure wiring devices or shimming the device is not acceptable. Contractor shall exercise due care when cutting opening in walls or ceilings for outlet boxes so that opening size will permit the proper installation of boxes and devices. Fixture studs in ceilings and bracket outlets shall be bolted with stove bolts or shall be locking type of stud mounting.
- G. In addition to boxes indicated, install enough boxes to prevent damage to cables and wires during pulling-in operations.
- H. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- I. "There shall be no outlets installed back to back. A minimum of 4" shall separate each outlet."
- J. Where the volume allowed per conductor exceeds that allowed in Table 370-6(b) of the NEC for the minimum size outlet specified, a larger size outlet box shall be used and shall be sized in accordance with the table noted above.
- K. Outlet boxes shall be clean and free from dust, paint, dirt, plaster ready mix joint compound and /or any other debris.

1.04

LABELING AND IDENTIFICATION

- A. All junction box cover plates shall be labeled identifying the system it contains. The label shall be neatly hand written with a wide tip permanent non-removable marker and be easily identified. Junction

boxes containing line voltage wiring shall include panel and circuit designation (ex. HA - 1,3,5 or LA – 2,4,6). Junction boxes utilized for low voltage system shall be labeled in accordance with the system (ex. FA for Fire Alarm System).

END OF SECTION

SECTION 260050
WIRING DEVICES AND DEVICE PLATE

1.01 SUBMITTALS

- A. Submit product data under provisions of Section 260000, GENERAL.
- B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

1.02 REFERENCES

- A. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet.
- B. FS W-S-896 - Switch, Toggle.
- C. NEMA WD 1 - General-Purpose Wiring Devices.
- D. NEMA WD 5 - Specific-Purpose Wiring Devices.

1.03 MANUFACTURERS

- A. For the purpose of selecting quality and type of device, equipment manufactured by Hubbell has been specified. The following manufacturers meeting this specification are acceptable:
 - 1. Pass and Seymour
 - 2. Cooper
 - 3. Leviton

1.04 PRODUCTS

- A. Switches: All wall switches shall be rated 20 ampere, 120/277 volts, have self grounding provisions, side wiring only and shall be of the silent type.
 - 1. Single pole: HBL 1221.
 - 2. Double pole single throw: HBL 1222.
 - 3. Three way: HBL 1223.
 - 4. Four way: HBL 1224.

5. Key switch single pole HBL 1221I, three-way: HBL 1223L, four-way: HBL 1234L. Three way and four way key switches shall be keyed alike.
 6. Single pole, pilot light, red handle (lit in "on" position): HBL 1297.
 7. Despard single pole switches installed in mullions. Pass & Seymour ACD 201.
- B. Receptacle: All receptacles shall be of the grounding type, tamper resistant (TR) rated, of the configuration shown on the drawings and shall be flush wall mounting type.
1. Standard duplex receptacle: 20 ampere, 125 volt, NEMA type 5-20 R, 2 pole, 3 wire, straight blade, U-grounding slot. HBL 5362. (TR)
 2. Power, receptacle with matching plug: 20 ampere, 125/250 volt, NEMA type 14-20, 3 pole 4 wire grounded, straight blade type. HBL 8410.
 3. Power receptacle with matching plug: 20 ampere, 250 volt, NEMA type 6-20R 2-pole, 3 wire grounded, straight blade type. HBL 5462.
 4. Power receptacle with matching plug: 30 ampere, 250 volt, NEMA type 6-30R 2-pole, 3 wire, u-grounded slot, straight blade type. HBL 9330.
 5. Power receptacle with matching plug: 50 ampere, 125/250 volt, NEMA type 14-50R, 3-pole, 4 wire grounded, straight blade type. HBL 9450A.
 6. Ground fault interrupter receptacle: Specification Grade, tamper resistant (TR) rated, 20 ampere, 125 volts, NEMA type 5-20R, 2-pole, 3-wire with grounded U slot. GF 5262. (TR)
- C. Device plates: Plates shall be furnished for all devices and outlets indicated on the drawings (telephone, computer, TV, etc.). All plates on masonry walls shall be oversized jumbo type.
1. Flush mounted plates: Beveled type with smooth rolled outer edge, stainless steel type 302 with brushed finish.

2. Surface box plates, beveled, galvanized steel, pressure formed for smooth edge to fit box, unless located in a highly corrosive area.
3. Die cast weatherproof cover. Lockable hasp vertical mounting. Intermatic #WP1010MC.

1.05 INSTALLATION

A. Switches:

1. Switches shall be connected to the live side of the circuit and shall control only the outlets indicated.
2. Conductors shall be looped around the terminal screw.
3. Where more than one switch is indicated in the same location switches shall be gang mounted under a common plate.
4. Where multi-wire switching (360 volt potential) occurs, a barrier shall be provided between switches.
5. Center line of switches in general, shall be set 3'-6" above the floor (off position down) and shall clear the door trim or corner by 4" or center the space occupied.
6. Architectural plans shall be consulted before placing switches so they will in every case be located on the strike side of the door and clear door, chair, window, and baseboard moldings.
7. Switches shall be screwed tight to the boxes and shall not depend on the cover plate to pull them tight.

B. Receptacles:

1. Conductors shall be looped around the terminal screws, "DO NOT BACK WIRE DEVICES."
2. Receptacles shall be grounded by the green wire bond and shall be pigtailed as shown on the drawings.
3. Receptacles shall be screwed tight to the plaster ring or outlet box and shall not depend on the device plate to pull them tight.

4. Center line of general use receptacles shall be in general, set 18" above the floor with receptacle mounted in the vertical position and with grounding pole at the bottom.
5. Coordinate receptacle height with Architectural drawings and locate so that bottom of receptacle plate shall be 1" above counter or back splash and clear all moldings.
6. Center line of receptacles located adjacent to lavatories in toilets shall be set 3'-6" above floor.
7. Receptacles serving water coolers shall be located within cooler housing or as close to bottom of housing as possible. Cord serving unit shall be as short as possible. In no case shall cord or receptacle be seen from normal viewing angle.
8. All receptacles installed in bathrooms, toilets, within 6 feet of lavatories or sinks or on building exterior shall be ground fault circuit interrupter type.
9. All receptacles installed outdoors shall be GFCI type.

C. Plates:

1. Plates shall be level and all edges shall be in full contact with wall.
2. Plates shall be furnished for all devices and other outlets indicated on the drawings.
3. Install plates on outlet boxes and junction boxes in unfinished areas above ceilings and on surface mounted outlets.
4. Plates shall not be used to keep devices secure.
5. Plates shall be clean and free from dust, plaster or paint and spots.
6. Plate shall cover openings around outlets.

END OF SECTION

**SECTION 260060
LED INTERIOR LIGHTING**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior solid-state luminaires that use LED technology.
 - 2. Lighting fixture supports.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.

5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests[, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples: For each luminaire and for each color and texture with standard factory-applied finish.

D. Product Schedule: For luminaires and lamps.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all fixture/lamp types used on Project; use ANSI and manufacturers' codes.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.8 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. Recessed Fixtures: Comply with NEMA LE 4.
- D. Bulb shape complying with ANSI C79.1.
- E. Lamp base complying with ANSI C81.61 or IEC 60061-1.
- F. CRI of 80. CCT of 4000 K.
- G. Rated lamp life of 50,000 hours.
- H. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- I. Internal driver.
- J. Nominal Operating Voltage: 120 V ac or 277 V ac.

1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

K. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear powder-coat finish.

2.2 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear powder-coat painted finish.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.3 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- B. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 14 gage.
- C. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- D. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.

- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaire Support:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- F. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- G. Ceiling-Mounted Luminaire Support:
 - 1. Ceiling mount with two 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
 - 2. Ceiling mount with pendant mount with 5/32-inch diameter aircraft cable supports adjustable to 120 inches in length.
 - 3. Ceiling mount with hook mount.
- H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing, rod or wire support for suspension for each unit length of luminaire chassis, including one at each end.
 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- I. Ceiling-Grid-Mounted Luminaires:
1. Secure to any required outlet box.
 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of two (2) locations, at opposite corners of luminaire.
 3. Use approved devices and support components to connect luminaire to ceiling grid and to building structure in a minimum of two (2) locations, spaced at opposite diagonal corners of luminaire.
- J. Flexible conduit and wiring from outlet box to fixture shall be minimum 3/8"C., and minimum #18 THHN conductors. Factory supplied whips of smaller ratings are not acceptable. Where 0-10 volt dimming is utilized, use #18 (TJP), grey/purple jacketed conductor integral to flex.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260120 " Equipment Identification."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
 - C. Prepare test and inspection reports.

END OF SECTION

**SECTION 260070
DISCONNECT SWITCHES**

PART 1 GENERAL

1.01 SUBMITTALS

- A. Shop drawings shall be submitted and shall consist of manufacturer's published literature.

1.02 MANUFACTURERS

- A. Acceptable manufacturers are:
 - 1. Square "D" Company
 - 2. G. E.
 - 3. Siemens
 - 4. Eaton

1.03 EQUIPMENT

- A. Disconnect switches shall be provided for all motors and strip heaters located out of sight of motor controller, and where specifically indicated on the drawings. Disconnect switches shall disconnect all ungrounded conductors. When exposed to weather, enclosure shall be NEMA – 4X. Switches shall be installed to be fully accessible in accordance with Article 110-26 of the National Electrical Code.
- B. All disconnects shall be heavy duty type and shall be equipped with factory installed equipment ground kit bonded to the can for grounding purposes.
- C. For single phase motors, a single - or double-pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Enclosed safety switches shall be horsepower rated in conformance with Table III of Fed. Spec. W-D-865. Switches shall disconnect all ungrounded conductors.
- D. Each disconnect serving ground mounted exterior A/C units shall be equipped with a padlock (Master 3206) all keyed alike.

- E. All disconnects shall be equipped with provisions to lock the handle in the OFF position.
- F. All disconnects shall be fusible type, fused in accordance with the name plate data on the unit. Disconnects serving water heaters or resistance heat strips shall be fused at 125% of the full load amps of the unit.
- G. Install fuses so that ampere rating can be read without having to remove fuses.
- H. All fuses shall be as noted in Section 26 00 15.
- I. Disconnects shall be identified as required under Section 26 01 20.
- J. Maintain 3'-0" clearance in front of disconnect having voltage rating of 250 volts and 4'-0" clearance in front of disconnect having voltage rating of 480 volts. Do not locate disconnect over other electrical equipment (i.e.: transformers). See 26 00 00-1.14-I.

END OF SECTION

SECTION 260090
PHOTO CONTROL AND CONTACTOR

1.01 SUBMITTALS

- A. Submittal shall be manufacturers published literature.

1.02 MANUFACTURERS

- A. Photo Controls:

1. Tork
2. Paragon
3. General Electric Company
4. Siemens
5. Intermatic

- B. Contactors:

1. Square "D" Company
2. Cutler-Hammer
3. ASCO
4. G. E.
5. Intermatic

1.03 EQUIPMENT

- A. Photo control shall be rated at 1800 V.A., 90% power factor on 277 volt system. Switching mechanism shall be hermetically sealed and shall be calibrated to close circuit when illumination falls below five foot candles. Switching mechanism shall contain delay feature to prevent circuit opening in transient illumination such as headlights from passing vehicles. (Photo Control shall contain manually adjustable light level slide.) Orient photo control light sensing element north.
- B. Contactor shall be electrically held, 120 or 277 volt operating coil and in NEMA 1 enclosure. The number and rating of poles shall be as noted on the drawings.

- C. Time clock shall be 24 hour type with astro dial and general purpose indoor case. Time clock shall be digital type with battery backup.

END OF SECTION

SECTION 260100
PULL BOXES AND JUNCTION BOXES AND FITTINGS

1.01 PULL BOXES AND JUNCTION BOXES AND FITTINGS

- A. Boxes shall be provided in the raceway systems wherever required for the pulling of wires and the making of connections.
- B. Pull boxes of not less than the minimum size required by the National Electrical Code Article 370 shall be constructed of code-gauge galvanized sheet steel. Boxes shall be furnished with screw-fastened covers. Covers on flush wall mounted boxes in well appointed areas (offices, reception, classrooms, media center, etc) shall be minimum 1/16 302 stainless steel. Boxes located on the exterior of the building shall be watertight. Covers shall be secured with tamper proof screws.
- C. Boxes shall be securely and rigidly fastened to the surface of which they are mounted or shall be supported from structural member of the building either directly or by using a substantial and approved metal rod or brace.
- D. All boxes shall be so installed that the wiring contained in them can be rendered accessible without removing part of the building.
- E. Where several circuits pass through a common pull box, the circuits shall be tagged to indicate clearly their electrical characteristics, circuit number and designation.
- F. All junction boxes larger than 4" x 4" flush mounted in wall shall have overlapping cover plate to cover rough-in openings.

END OF SECTION

SECTION 260110 GROUNDING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. The work required under this section of the specifications consists of furnishing, installation and connections of the building secondary grounding systems. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. The building electrical system shall be a 3 phase, 4 wire grounded wye delta system supplemented with equipment grounding system. Equipment grounding system shall be established with equipment grounding conductors; the use of metallic raceways for equipment grounding is not acceptable.

1.03 QUALITY ASSURANCE

- A. Industry Referenced Standards: The following specifications and standards are incorporated into and become a part of this Specification by Reference.
 - 1. Underwriters' Laboratories, Inc. (UL) Publications:
 - No.44 Rubber-Insulated Wire & Cables
 - No.83 Thermoplastic-Insulated Wires
 - No.467Electrical Grounding & Bonding Equipment
 - No.493Thermoplastic-Insulated Underground Feeder & Branch Circuit Cables
 - No.486Wire Connectors and Soldering Lugs
 - 2. National Electrical Manufacturers' Standards (NEMA):
 - WC-5 Thermoplastic Insulated Wire & Cable
 - WC-7 Cross-Linked-Thermosetting Polyethylene Insulated Wire

3. National Fire Protection Association Publication (NFPA):

No.70 National Electrical Code (NEC)

B. Acceptable Manufacturers: Products produced by the following manufacturer which conform to this specification are acceptable.

1. Hydraulically applied conductor terminations:

- a. Square D
- b. Burndy
- c. IlSCO
- d. Scotch (3M)
- e. Thomas and Betts (T&B)
- f. Anderson

2. Mechanically applied (crimp) conductor terminations:

- a. Scotch (3M)
- b. Ideal
- c. Thomas and Betts (T&B)
- d. Burndy

PART 2 PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

- A. Provide all materials under this section of the specifications. All materials shall be new.
- B. All materials shall be UL listed and bear a UL label.
- C. Refer to the specific specification section for the description and requirements of materials mentioned herein for installation.

2.02 GROUNDING CONDUCTORS

- A. Grounding electrode conductor shall be bare or green insulated copper conductor sized as indicated on the drawings.
- B. Equipment grounding conductors shall be green insulated type THHN conductors sized as indicated on the drawings. Where size is not

indicated on the drawings, conductor size shall be determined from the National Electrical Code table of sizes of equipment grounding conductors.

- C. Bonding jumpers shall be flexible copper bonding jumpers sized in accordance with the National Electrical Code table on sizes of equipment grounding electrode conductors.

2.03 MOTOR CONTROLLERS

- A. Provide a conductor termination grounding lug bonded to the enclosure of each motor controller.
- B. Provide an equipment ground bar with bonding screw in each disconnect for grounding purposes.

2.04 DEVICES

- A. Each receptacle and switch device shall be furnished with a grounding screw connected to the metallic device frame. Bond equipment grounding conductor to each outlet box. For isolated ground receptacles, bond equipment grounding conductor to box, and isolated ground conductor to device grounding screw.

2.05 GROUND RODS

- A. Ground rods shall be 3/4" x 10'-0" copper clad steel. Connection to all ground rods shall be by exothermic weld.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Ground all non-current carrying parts of the electrical system, i.e., wireways, equipment enclosures and frames, junction and outlet boxes, machine frames and other conductive items in close proximity with electrical circuits, to provide a low impedance path for potential grounded faults.
- B. Service entrance and separately derived electrical systems, grounding electrode system.

1. The neutral conductor of the electrical service serving the premises wiring system shall be grounded to the ground bus bar in the service equipment which shall be grounded to the cold water system, the ground rod system, and other grounding electrodes specified herein or indicated on the drawings. Grounding electrode conductors shall be installed in rigid, non-metallic conduit to point of ground connection, unless subject to physical damage in which case they shall be installed in galvanized rigid steel. Where metallic conduit is permitted, bond conduit at both ends to grounding electrode conductor with a UL bonding bushing.
2. Make connection to main water line, fire sprinkler piping, and gas piping entering the building. Make connections ahead of any valve or fittings whose removal may interrupt ground continuity. Install a bonding jumper of the same size as the grounding conductor around the water meter.
3. Bond together the following systems to form the grounding electrode system. All system connections shall be made as close as possible to the service entrance equipment and each connected at the service entrance equipment ground bus. Do not connect electrode systems together except at ground bus.
 - a. Cold water piping system
 - b. Ground rod system
 - c. Structural steel metal building frame, see detail on drawings
 - d. Main re-bar in a foundation footing
 - e. Fire sprinkler piping
4. Ground the neutral of all dry type transformers as indicated on the drawings.
5. Grounding electrode connections to structural steel, reinforcing bars, ground rods, or where indicated on the drawings shall be with chemical exothermic weld connection devices recommended for the particular connection type. Connections to piping shall be with UL listed mechanical ground clamps.
6. Bonding shall be in accordance with the National Electrical Code.

7. Install ground rods where indicated on the drawings with the top of the ground rods 12" below finished grade.

C. Equipment Grounding Conductor

1. Grounding conductors shall be provided in all branch circuit raceways and cables. Grounding conductors shall be the same AWG size as branch circuit conductors.
2. Grounding conductors for feeders are typically indicated on the drawings and the raceway is sized to accommodate grounding conductor shown. Where grounding conductor size is not indicated on the drawings, conductor shall be in accordance with the equipment grounding conductor table of the National Electrical Code.
3. A grounding conductor shall be installed in all flexible conduit installations. For branch circuits, grounding conductor shall be sized to match branch circuit conductors.
4. A feeder serving several panelboards shall have a continuous grounding conductor which shall be connected to each related cabinet grounding bar.
5. The equipment grounding conductor shall be attached to equipment with bolt or sheet metal screw used for no other purpose. Where grounding conductor is stranded, attachment shall be made with lug attached to grounding conductor with crimping tools.
6. Ground all motors by drilling and tapping the bottom of the motor junction box with a round head bolt used for no other purpose. Conductor attachment shall be through the use of a lug attached to conductor with a crimping tool.
7. Equipment grounding conductors shall terminate on panelboard, switchboard, or motor control center grounding bus only. Do not terminate on neutral bus. Provide a single terminal lug for each conductor. Conductor shall terminate the same section as the phase conductors originate. Do not terminate neutral conductors on the ground bus.

C. Other Grounding Requirements

1. Each telephone backboard and data network rack shall be provided with a No.6 grounding conductor. Ground conductor shall be routed to ground bar in nearest panel. Terminate conductor by stapling to backboard. Provide 6' slack conductor. If conductor is routed in a metal conduit, provide a grounding bushing at conduit end and bond to lug on ground bushing.
2. Lighting fixtures shall be grounded with a green insulated ground wire secured to the fixture with a UL listed bond lug, screw, or clip specifically made for such use.

3.02 TESTING

- A. Upon completion of the ground rod installation, grounding resistance reading shall be taken before connection is made to the building cold water piping system. Ground resistance readings shall not be taken within forty-eight hours of rainfall. Results of ground resistance readings shall be forwarded, in writing, immediately to the Architect and Owner.

END OF SECTION

SECTION 260120
EQUIPMENT IDENTIFICATION

1.01 SUBMITTALS

- A. Submit sample of laminated plastic identification plate with lettering.

1.02 MATERIALS

- A. Laminated plastic plates with 3/16" high white letter etched on black background.
- B. Plates shall be permanently mounted utilizing pop rivets or a permanent mastic/epoxy.
- C. Painted, stenciled or indented tape identification is not acceptable.

1.03 ITEM IDENTIFICATION

- A. All electrical apparatus such as wiring troughs, panelboards, individual circuit breakers, transformers and disconnect switches shall have laminated plastic identification plates. Identification shall match labeling shown on plans.
- B. A "steel" circuit directory frame permanently attached at factory (not glued), and a directory card with a plastic covering shall be provided on the inside of each panel door. The directory shall be typed to identify the load fed by each circuit and the areas served. Spaces or room numbers shown on the drawings are not necessarily the final numbers to be assigned to these areas. The Contractors shall before completion of the project obtain from the Architect final space or room numbers so that it can be typed onto directory.
- C. Circuit breakers and disconnects shall identify the equipment served and circuit and panel from which it is served.
- D. On all panelboards the exterior identification plate shall match that on the drawings and the panel and circuit number serving the panel shall be designated within the panel.

1.04 LABELING AND IDENTIFICATION

- A. All junction box cover plates shall be labeled identifying the system it contains. The label shall be neatly hand written with a wide tip

permanent non-removable marker and be easily identified. Junction boxes containing line voltage wiring shall include panel and circuit designation (ex. HA - 1,3,5 or LA – 2,4,6). Junction boxes utilized for low voltage system shall be labeled in accordance with the system (ex. FA for Fire Alarm System).

END OF SECTION

SECTION 260130
DATA OR VOICE CONDUIT AND OUTLET SYSTEM

1.01 CONDUIT SYSTEM

- A. Provide a complete system of conduits and outlet boxes for data and voice wiring. Each data or voice outlet shall have a 1" conduit routed from the flushed recessed outlet box up to the accessible ceiling space above. Turn conduit out above ceiling with a 90° horizontal elbow and terminate with an insulated bushing. Where ceiling finish is exposed structure (i.e. no acoustical tile ceiling), extend conduit to an area with an accessible gypboard/acoustical ceiling. Provide nylon pull string in conduit.
- B. All conduit and outlet boxes shall be for data and voice cable only. Joint use with sound systems, fire, telephone, etc. it is not acceptable.
- C. Location of outlets shall be as shown on the drawings.
- D. Height of wall outlets shall be as noted on the drawings. All wall outlet boxes in new construction shall be two gang type, 4" x 4" x 2 1/8" deep, with single gang plaster rings. Plaster rings shall be flush with finish of wall. Coordinate depth of plaster ring required with type of wall construction.
- E. Install a quaduplex receptacle at the telephone backboard and serve with a dedicated 20 ampere 120 volt circuit. The telephone shall consist of one - 3/4" x 4' x 8' plywood. Paint all sides and edges to match room finish. Install a #6 ground conductor from the nearest ground bar in panel, provide 8'-0" of coiled slack at board. Plywood shall be fire rated. Paint shall be fire retardant.
- F. See site plan for routing of telephone service conduit. Prior to routing of conduit, coordinate an on-site meeting with local utility company to determine exact location. Provide a 200 pound minimum pull strength nylon cord in the service conduit. Cap off any conduit not utilized.
- G. Each data network rack shall be grounded with a #6 copper routed in 1/2" conduit to the ground bar in the nearest panel. If conduit is metal, provide grounding bushings at each end of conduit. Provide a quadruplex

receptacle at each data network rack and serve from a dedicated 20 amp, 120 volt circuit.

- H. Conduit and its installation shall be as covered under Section 26 00 20 of these specifications.
- I. Outlets and their installation shall be covered under Section 26 00 40 of these specifications.
- J. All conduit shall be concealed unless otherwise noted.
- K. Provide 302 jumbo stainless steel blank wall plates for all outlets not cabled.

END OF SECTION

**SECTION 260140
FIRE ALARM SYSTEM**

PART 1 – GENERAL

1.01 SUBMITTALS

- A. Shop drawings shall be submitted as follows:
1. Manufacturer's published literature.
 2. One line schematic diagram covering the complete building system.

1.02 MANUFACTURERS

- A. Acceptable manufacturers are:
1. Notifier
 2. Edwards (EST)
 3. Fire Control Instruments, Inc.
- B. The acceptable manufacturers systems listed in 1.02 A, shall be installed by the authorized local factory dealer/representative for that product. The factory dealer representative shall hold a current low voltage contractor's license.

1.03 SCOPE

- A. This specification covers the installation of a complete electronically operated fire alarm system. The system within the building shall be electrically supervised and shall include, but not be limited to, the following components:
1. Manual non-code type alarm boxes, combination vibrating horns and flashing light, control equipment, duct smoke detectors, remote alphanumeric annunciator, conduit, and wiring.

1.04 GENERAL REQUIREMENTS

- A. The alarm equipment and all wiring shall be installed and interconnected by a factory certified installer and placed in working order. The name of the manufacturer and serial or identification numbers shall appear on all major components. Electrical supervision of the system shall conform to provisions of Article 240. NFPA Standard 72. Corresponding parts of all similar type equipment units shall be interchangeable, and locks for all cabinets shall be keyed alike. All devices, equipment and combination thereof shall be of the manufacturer's current production. All component parts of the system and the control unit shall be approved for the purpose intended. The stamp, label, seal or certificate of the Underwriter's Laboratories or the Factory Mutual Laboratories shall be considered as acceptable evidence of such approval.
- B. Fire Alarm Subcontractor shall submit a certification stating that he is an authorized representative for the manufacturer of the equipment he is submitting for approval and that he maintains a fully equipped and stocked service shop and shall respond to service within 12 normal working hours.

1.05 DRAWINGS AND MANUALS

- A. Three copies of complete instructions for the operation, inspection, testing and maintenance of the system, including wiring diagrams and replacement parts list shall be furnished upon final acceptance of the system. Also provide all special tools that are necessary for the maintenance of the equipment and include one set of fuses for each type and size.

1.06 INSTALLATION

- A. A qualified fire alarm technician shall install, adjust and test the equipment. The technician shall be qualified by training and experience in the installation and operation of the fire alarm system specified. The technician shall instruct operating personnel in the operation, adjustment and maintenance of the system. A statement signed by the person or persons instructed shall be supplied to the Architect prior to final operation.
- B. Provide a written certification that the system is in complete and proper working order and in compliance with all codes.

1.07 SYSTEM OPERATION

- A. Operation of any manual or automatic initiating device shall cause a general alarm to sound.
- B. Also circuits and audible sounding devices shall be electrically supervised. In the event of an open circuit or ground in the system, loss of operation of supervisory power, or other supervised component failure, a trouble signal shall be actuated until the system is restored to normal. A silencing switch shall be provided for silencing the trouble alarm.
- C. The system shall operate from one 120 volt circuit.
- D. Fire Alarm System shall be interlocked with range hood extinguishing system, such that when system is activated, general alarm is sounded and signal is sent to the annunciator. Provide control module to activate shunt trip breaker serving cooking equipment beneath hood.

1.08

SYSTEM COMPONENTS

- A. Fire alarm control panel: Furnish and install where shown an addressable control panel mounted in a recessed mounted code gauge steel cabinet, equipped with lock and keys. The control shall provide in one cabinet all necessary relays, resistors, compensators and power supplies for the signal circuits and duct type smoke detectors shown on the drawings and which are designated for 24 volt D.C. operation. Each signal circuit shall be capable of handling up to 10-24 volt D.C. horns. Provide battery backup with trickle charger. Panel shall be capable of handling up to a minimum of 198 initiating devices.

The panel shall include an auxiliary relay with contacts for interrupting power to the door holders release devices upon sounding of a general alarm. The time limit cutout shall be adjustable and shall instantly reset after system has been restored. On the cabinet door shall be mounted millimeter, trouble lights, silencing switch and reset switch.

The Fire Alarm Panel shall be 100% field programmable and field editable without the use of any exterior programming devices (i.e., laptop computer or chip-burning device). The Fire Alarm System shall have alarm verification, as well as a maintenance type alert function to warn of contaminated detectors before a false alarm occurs.

Each device in the field must be individually addressed with a point I.D. and Alphanumeric read-out.

The panel shall be equipped with a UL listed digital dialer for off premises central station monitoring. Low voltage contractor shall connect dialer to Telco line and include one (1) year of monitoring in contract.

Provide a 3/4" conduit from Fire Alarm panel to nearest telephone backboard for remote station monitoring.

- B. Fire alarm subcontractor shall determine the load based on the fire alarm device layout and provide additional power supply modules as required. Provide 120 volt circuit for power supply and serve from nearest 120/240 volt panel. Label panelboard schedules accordingly.
- C. Manual stations: Provide manual alarm stations, semi-flush mounted, of the pull-lever type, key resettable. Housing shall be of cast metal or impact resistance plastic with raised letters designating function and operating instructions. Housing will be red enamel with white lettering.
- D. Signal device: Provide combination low power D.C. strobe/horn with high intensity flashing strobe light for both audible and visual signaling or strobe light for visual signaling only. Minimum sound level indoors at 10 feet shall be 90 db. Maximum current draw for horn and strobe light of 0.063 amps, nominal voltage of 24 D.C. Units shall be flush wall mounted 6'-8" above the finished floor at points noted on the drawings. Minimum candela level shall be 75 candela. Candela level for areas under 300 square feet may be 15. All strobes in a common area shall be synchronized.
- E. Smoke detectors shall be furnished, installed and connected under Division 26. Power supply for detectors shall be 24 volt D.C. and supplied from Fire Alarm control panel. Detectors shall be photo electric type. Each detector shall have flashing LED for operational walk check.
- F. Smoke detectors in duct work shall be photo electric type furnished and connected under Division 26, installation in duct work shall be accomplished under Mechanical Division. Power supply for detectors shall be 24 volts D.C. and supplied from fire alarm control panel. Provide contacts to automatically shut down fan motors. Sampling tubes shall extend across the entire width of the duct. Provide remote station at readily accessible location in mechanical room, or if air handling unit is

above ceiling, mount remote station in wall below ceiling, having LED to indicate alarm condition and key switch to test and reset alarm relay. Mount remote station 6'-0" above finished floor. Detectors for air handling equipment rated over 2000 CFM, but under 15,000 CFM shall be located in the supply duct. Detectors for air handling equipment rated over 15,000 CFM shall be located in the supply and return ducts. Detectors shall be provided whether called for on the plans or not. Look up code section and reference. Location of detectors in duct work shall be as recommended by detector manufacturer, but in no case shall detector be located ahead of filters. Location of duct detectors shown are schematic in nature only. Verify exact location with unit and duct work placement. Where duct detector is required to be on building exterior, provide weatherproof detector and 120 volt power as required.

- G. Tamper switches and flow switches shall be provided and installed under Mechanical Division of these specifications, and connected under Division 26. Power supply shall be 24 volts D.C., supplied from the fire alarm control panel.
- H. Heat detectors, where called for, shall be provided, installed and connected under Division 26. Detectors shall be combination rate of rise and fixed temperature rated for a minimum of 135° F, and shall be rated at 200° F where required (i.e., Kitchen).
- I. Each fire alarm circuit shall be protected from lightning by installing surge protection devices either internally or externally. Circuits run between buildings shall be individually protected in addition to protection at control panel.
- J. All conductors shall be installed in conduit. Fire alarm conduit in its entirety shall be red. All fire alarm junction boxes and covers shall be red. Conduit installation shall be as covered under Section 260020 of these specifications. All fire alarm conduit, junction boxes, and covers shall be red.
- K. Number and size of conductors shall be as required by manufacturer of system being installed. Any cable run in conduit below grade shall be moisture proof, cable shall be equal to West Penn Aqua seal.
- L. At time of final inspection, Contractor shall turn over a red-lined set of plans showing device location, device address, and device descriptor. Panel shall be fully programmed to denote location of addressable

device. Provide a written report denoting that all fire alarm devices have been tested and are operable.

- M. 20A/1P breaker serving fire alarm control panel is required to be locked in the "on" position and label with red lettering. Contractor shall provide "lock out" device on 20A/1P breaker serving fire alarm control panel.
- N. Where a post indicator valve for fire sprinkler system is provided, Contractor shall provide a fire alarm system connection to tamper switch. Connection to such shall be waterproof. Provide lightning/surge protection devices at conductors serving such. Refer to civil plan for exact location of post indicator valve.

END OF SECTION

SECTION 260160
SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

1.2 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SPD: Surge protective device.
- H. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For SPDs to include in maintenance manuals.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.
- D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE SUPPRESSOR

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Corporation.
 - 2. Emerson Electric Co.
 - 3. GE Zenith Controls.
 - 4. PowerLogics, Inc.
 - 5. Schneider Electric Industries SAS.

B. SPDs: Comply with UL 1449, Type 2.

1. SPDs with the following features and accessories:

- a. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
- b. Indicator light display for protection status.
- c. Form-C contacts rated at 2 A and 24-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- d. Surge counter.

C. Comply with UL 1283.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 480 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Line to Line: 2000 V for 480Y/277 V.

F. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Line to Line: 1000 V.

G. SCCR: Equal or exceed 200 kA.

H. Inominal Rating: 20 kA.

2.3 PANEL SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Corporation.
 2. Emerson Electric Co.
 3. GE Zenith Controls.
 4. LEA International; Protection Technology Group.
 5. Schneider Electric Industries SAS.
- B. SPDs: Comply with UL 1449, Type 2.
1. Include LED indicator lights for power and protection status.
 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- D. Comply with UL 1283.
- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V - 700 V for 208Y/120 V.
 2. Line to Ground: 1200 V for 480Y/277 V - 700 V for 208Y/120 V.
 3. Neutral to Ground: 1200 V for 480Y/277 V - 700 V for 208Y/120 V.
 4. Line to Line: 2000 V for 480Y/277 V - 1200 V for 208Y/120 V
- F. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
1. Line to Neutral: 700 V.
 2. Line to Ground: 700 V.
 3. Neutral to Ground: 700 V.
 4. Line to Line: 1200 V.
- G. SCCR: Equal or exceed 200 kA.
- H. Inominal Rating: 20 kA.

2.4 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.
- B. Outdoor Enclosures: NEMA 250, Type 4X.

2.5 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Wiring:
 - 1. Power Wiring: Comply with wiring methods in Section 26 00 30 "Low-Voltage Electrical Power Conductors and Cables."
 - 2. Controls: Comply with wiring methods in Section 26 00 30 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

SECTION 260175 FIRESTOPPING

1.01 RELATED DOCUMENTS

- A. The requirements of the general conditions, supplementary conditions, and division 1, general requirements, apply to Work in this Section.

1.02 DESCRIPTION

- A. This Section describes the requirements for furnishing and installing firestopping for fire-rated construction. This includes:
 - 1. All openings in fire-rated floors and wall assemblies, both blank (empty) and those accommodating penetrating items such as cables, conduits, etc.

1.03 REFERENCES

- A. ASTM E 814: "Standard Method of Fire Tests of Through-Penetration Firestops"
- B. UL 1479, UBC 7-5: (both are same as A above)
- C. ASTM E 119: "Standard Method of Fire Tests of Building Construction and Materials"
- D. UL263, UBC 7-1: (both are same as C above)
- E. UL 2079: "Standard for Tests for the Fire Resistance of Building Joint Systems"
- F. Published Through-Penetration Systems by recognized independent testing agencies.
 - 1. UL Fire Resistance Directory.
 - 2. Warnock Hersey Certification Listings, current year.

1.04 QUALITY ASSURANCE

- A. Firestopping materials shall conform to Flame (F) and Temperature (T) ratings as required by local building code and as tested by nationally accepted test agencies per ASTM 814, UL 1479 or UL 2079. The F rating must be a minimum of one (1) hour but not less than the fire resistance rating of the assembly being penetrated. T rating, when required by code authority, shall be based on the measurement of the temperature rise on the penetrating item(s). The fire test pressure differential of a minimum 0.01 inches of water column is required.

- B. Fire stopping products shall be asbestos free, free of any PCBs and free of any lead.
- C. Do not use any product containing solvents, or that require hazardous waste disposal.

1.05 SUBMITTALS

- A. Submit manufacturer's product literature for each type of Firestop material to be installed. Literature shall indicate product characteristics, typical uses, performance, limitation criteria and test data.
- B. Submit manufacturer's Warranty.
- C. Material Safety Data Sheets: Submit MSDS for each firestop product.
- D. Shop Drawings: Show typical installation details for methods of installation. Indicate which firestop materials will be used where and thickness for different hourly ratings.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in the manufacturers' original, unopened containers or packages with manufacturers' name, product identification, lot number, UL or Warnock Hersey labels, and mixing and installation instructions, as applicable.
- B. Store materials in the original, unopened containers or packages, and under conditions recommended by manufacturer.
- C. All firestop materials shall be installed prior to expiration of shelf life.

1.07 PROJECT CONDITIONS

- A. Verify existing conditions and substrates before starting work.
- B. Do not use materials that are based on organic solvents.
- C. During installation, provide masking and drop cloths to prevent firestopping products from contaminating any adjacent surfaces.
- D. Conform to ventilation requirements by manufacturer's installation instructions or Material Safety Data Sheet.
- E. Weather Conditions: Do not proceed with installation of firestop products when temperatures are in excess of or below the manufacturer's recommendations.
- F. Schedule installation of firestop products after completion of penetration item installation but prior to covering or concealing of openings.
- G. Coordinate this work with work of other trades.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide products of one of the following manufacturers as shown below and further defined by the materials listed in Part 2.02 of this section.
1. The RectorSeal Corporation. Products as listed are a standard of generic types.
 2. International Protective Coatings
 3. 3M Company
 4. Hilti

2.02 MATERIALS

- A. Firestop Mortars:
1. Metacaulk Fire Rated Mortar by The RectorSeal Corporation
 2. HILTI CP637 Firestop Mortar
 3. 3M Firestop Mortar
- B. Firestop Sealants and Caulks:
1. Metacaulk 950 by The RectorSeal Corporation
 2. Metacaulk 835 by The RectorSeal Corporation
 3. Metacaulk 805 by The RectorSeal Corporation
 4. Metacaulk 1000 by The RectorSeal Corporation
 5. CP 25WB+Caulk by 3M
 6. Flame-Safe FS900 Series by International Protective Coatings.
 7. HILTI FS-One Intumescent Firestop Sealant
- C. Firestop Putty:
1. Metacaulk Fire Rated Putty by The RectorSeal Corporation
 2. Metacaulk Fire Rated Putty pads by The RectorSeal Corporation
 3. MPS-2 Moldable Putty Stix by 3M
 4. MPP-4S Moldable Putty Pads by 3M
 5. HILTI CP618 Firestop Putty
- D. Firestop Sleeves:

1. Metacaulk Pipe Collars by The RectorSeal Corporation
 2. Plastic Pipe Devices by 3M
 3. HILTI CP6421643 Firestop Collar
- E. Intumescent Wrap Strips:
1. Metacaulk Wrap Strip by The RectorSeal Corporation
 2. FS-195 Wrap Strip by 3M
 3. HILTI
- F. Firestop Mastic:
1. Metacaulk 1100 by The RectorSeal Corporation
 2. HILTI
 3. 3M
- G. Accessories:
1. Forming/Damming Materials: Mineral Fiberboard or other type recommended by manufacturer.
 2. Primer, sealant and solvent cleaner: As recommended by firestop manufacturer.
- H. Where subject to movement, firestop products used shall remain flexible to allow for such normal movement of building structure and penetrating item(s) without affecting the integrity of the firestop system.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine the areas and conditions where firestops are to be installed and notify the Architect of conditions detrimental to proper and timely completion of the work.
- B. Verify the penetrating item(s) are permanently installed and construction of fire rated assemblies are completed prior to firestop installation.
- C. Prior to installation of firestop systems, clean surfaces of penetrating item(s) that will be in contact with firestop materials. Do not use any cleaning material that will either attack penetrating item(s) or firestop product to be installed.

3.02 CONDITIONS REQUIRING FIRESTOPPING

A. General:

1. Provide fire stopping for conditions specified whether or not firestopping is indicated, and, if indicated, whether such material is designated as insulation, safing or otherwise.
2. Insulation types specified in other Sections shall not be installed in lieu of firestopping material specified herein.

B. Penetrations:

1. Penetrations include conduit, cable, wire, or other elements which pass through one or both outer surfaces of a fire rated floor, wall, or partition.
2. Except for floors on grade, where a penetration occurs through a structural floor or roof and a space would otherwise remain open between the surfaces of the penetration and the edge of the adjoining structural floor or roof, provide firestopping to fill such spaces in accordance with ASTM E 814 (UL 1479).
3. These requirements for penetrations shall apply whether or not sleeves have been provided. Firestop the annular space between sleeve and surrounding surfaces.

C. Provide firestopping to fill miscellaneous voids and openings in fire rated construction in a manner essentially the same as specified herein before.

D. All junction boxes larger than 4' x 4" located in a rated wall shall be protected on sides and back of box with firestop putty pads as required to maintain integrity of rated wall.

3.03 INSTALLATION

A. Regulatory requirements: Install firestop products in accordance with fire rated test assemblies as published by either UL or Warnock Hersey or accordance with manufacturer engineer drawings.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration firestop systems.

1. Firestop all holes or voids made in fire resistive assemblies, made by penetrations, to ensure against the passage of flames, smoke, and toxic gases.

2. Protect materials from damage on surface subjected to traffic and install cover plate as required on any installed firestop system that will or may be subject to traffic.
3. Tool surfaces of firestop products to provide a smooth and clean appearance.

3.04 FIELD QUALITY CONTROL

- A. Follow safety procedures recommended in Material Safety Data Sheets.
- B. Examine penetration firestopped areas to ensure proper installation before concealing or enclosing areas.
- C. Keep areas of work accessible until inspection by Architect.

3.05 ADJUSTING AND CLEANING

- A. Remove equipment, materials and debris, leaving areas in undamaged and clean conditions.
- B. Neatly cut and trim materials.

END OF SECTION

**SECTION 260190
ENGINE GENERATOR SET**

1.01 GENERAL

- A. Requirements contained in this Specification shall apply to and govern the work under this Section.

1.02 WORK INCLUDED

- A. Provide labor and material necessary to install a standby diesel engine-generator set of the latest commercial type and design as specified herein.

1.03 SUBMITTALS

- A. The Contractor shall furnish information showing manufacturers' model number, dimensions, and weights for the engine, generator, and major auxiliary equipment.

1.04 MANUFACTURERS

- A. The following manufacturers meeting these specifications are acceptable:
 - 1. Onan
 - 2. Caterpillar/Olympian
 - 3. Detroit Diesel/Williams
 - 4. Kohler
 - 5. Generac

1.05 SUBSTITUTIONS

- A. Proposed deviations from the specifications shall be treated as follows:
 - 1. Request for substitutions shall be made a minimum of ten (10) days prior to bid date. Manufacturers catalog data shall accompany each request and authorized acceptance shall be by addenda only.
 - 2. Under no circumstances will assemblers of units be acceptable. To qualify as a manufacturer, the engine or alternator must be the

item manufactured and the completed engine generator set supplied by that manufacturer's authorized dealer only.

3. The Contractor shall submit copies of pertinent drawings and schematic diagrams for approval and shall include the following:
 - a. Engine generator set including plans and elevations or riser views clearly indicating entrance points for each of the interconnections required.
 - b. Engine generator/exciter control cubicle.
 - c. Fuel consumption rate curves at various loads, ventilation and combustion CFM requirements.
 - d. Exhaust mufflers and vibration isolators.
 - e. Battery Charger, battery, and battery racks.
 - f. Automatic load transfer switch.
 - g. Actual electrical diagrams including schematic diagrams and interconnection wiring diagrams for all equipment to be provided.
 - h. Legends for all devices on all diagrams.
 - i. Sequence of operation explanations for all portions of all schematic wiring diagrams.
4. The specified standby KW shall be for continuous electrical service during interruption of the normal utility source and shall be certified to this effect by the manufacturer for the actual unit supplied.
5. These ratings must be substantiated by manufacturer's standard published curves. Special ratings or maximum ratings are not acceptable.

- A. Engine: The engine shall be 1800 RPM, water-cooled in line or Vee type four-stroke cycle compression ignition diesel. It shall meet specifications when operating on Number 2 domestic burner oil. Engines requiring premium fuels will not be considered. The engine shall be equipped with fuel, lube oil, and intake air filters, lube oil cooler, fuel transfer pump, fuel priming pump, engine driven water pump, and unit mounted instruments, water temperature gauge, lubrication oil pressure gauge, and battery charging ammeter.
1. Governor - A gear driven hydraulic governor shall maintain frequency regulation not to exceed 3% (1.8 hertz) from no load to full rated load.
 2. Mounting - The units shall be mounted on a structural steel sub-base and shall be provided with suitable spring-type isolators.
 3. Safety Devices - Safety shut-off for high water temperature, low oil pressure, over-speed, and engine over-crank shall be provided.
 4. Guards - Guards shall be provided over all exposed moving parts as required by OSHA.
- B. Generator:
1. The generator shall be rated for continuous stand-by service at 1000 KW, 1250 KVA at 0.8 power factor, 480/277 volts, three phase, four wire, 60 hertz, 1800 RPM.
 2. The generator shall be a three phase, 60 hertz, single bearing, rotating field, synchronous type built to NEMA standards. A voltage regulator shall be provided to match the characteristics of the generator and engine. Voltage regulation shall be + - 2% from no load to full rated load. Readily accessible voltage drop, voltage level and voltage gain controls shall be provided. Voltage level adjustments shall be a minimum of + - 5%. Generator and exciter shall be inherently capable of parallel operation with other power sources of equivalent electrical characteristics, and stator shall include a twelve lead, re-connectable buss bar system for easy load connection.

C. Cooling System:

1. Radiator - A radiator with blower type fan shall be sized to maintain safe operation 110 degrees F ambient temperature. Air flow restriction from the radiator shall not exceed 0.5" HO.
2. The engine cooling system shall be pre-treated by the system supplier for the inhibition of internal corrosion, and freezing.

D. Fuel System:

1. An in-base fuel tank shall be supplied and installed by the manufacturer of the power system. The tank capacity shall be sized to operate generator at full rated load for 48 hours. Tank shall be constructed of "I" beams with a 3/16" floor plates and 10 gauge tank bottom. Tank shall incorporate 1/2" drain plugs on each end, 2" fill cap with locking provisions, level indicator, supply pipe and return pipe. Tank shall have access plate for mounting of fuel level alarm and tank inspections. Tank shall be dual wall construction provided with leak detection. Leak detection alarm status shall be shown on remote annunciator. At job completion, fuel tank shall be topped off and left full.
2. Tank shall be mounted to the skids of engine generator. Isolator pads shall be installed between pad and skid tank.

E. Weather Proof Housing and Exhaust Muffler;

1. Housing shall consist of a weather proof enclosure to completely enclose the engine generator and accessories. Housing shall protect the engine generator from the environment, yet be conducive to easy maintenance. Housing shall have removable swing out doors on each side and lockable rear door for access to meters and controls. Side doors shall have a means to pad lock. Construction of housing shall be aluminum and painted manufacturers standard color.
2. Exhaust muffler shall be mounted on top of housing. The exhaust muffler shall be a critical grade muffler. Muffler shall be factory installed so that its weight is not supported by the engine. A flexible exhaust fitting shall be supplied and installed between the muffler and exhaust manifold. All accessories shall be factory

installed. This includes flanges, muffler, tail pipe and rain cap.

F. Automatic Starting System:

1. Starting Motor - A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer.
2. Automatic Control - fully automatic generator set start-stop controls in the generator control panel shall be provided. Controls shall provide shutdown for low oil pressure, high water temperature, over speed, over crank. Controls shall include a 30 second single cranking cycle limit with lockout.
3. Jacket Water Heater - A unit mounted thermal circulation type water heater incorporating a thermostatic switch shall be furnished to maintain engine jacket water to 70 degrees F. the heater shall be 120 volt, single phase, 60 hertz. Provide pressure switch actuated by oil pressure to shut down heater when oil pressure reaches running pressure.
4. Battery Charging Alternator - A belt driven battery charging alternator rated 24 volts, 35 amp DC shall be provided with transistorized voltage regulator.
5. Batteries - A lead - acid storage battery set of the heavy duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system. The battery set shall be rated no less than 220 amp-hours. Necessary cables and clamps shall be provided.
6. Battery Racks - Battery racks shall be provided for each battery and shall conform to NEC 480 - 7 (a) (1). They shall be constructed of metal and so treated as to be resistant to deteriorating action by battery electrolyte. Further, construction shall be such that non-conducting insulation material directly supports the cells.
7. Battery Charger - A current limiting battery charger shall be furnished to automatically recharge batteries. Chargers shall float at 2.17 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter,

DC volt- meter, and fused AC input. AC input voltage shall be 120 volts, single phase. Amperage output shall be no less than 6 amperes.

G. Generator Control Panel:

1. Type - A generator mounted NEMA 3R type vibration isolated aluminum control panel shall be provided. Panel shall contain, but not be limited to, the following equipment:
 - a. Frequency meter, 3 ½ inch, dial type.
 - b. Voltmeter, 3 ½ inch, 2% accuracy.
 - c. Ammeter, 3 ½ inch, 2 % accuracy.
 - d. Ammeter - Voltmeter phase selector switch.
 - e. Automatic starting controls as specified.
 - f. Voltage level adjustment rheostat.
 - g. Dry contacts for remote alarm wired to terminal strips.
 - h. Individual fault indicator lights for low oil pressure, high water temperature, over speed, and over crank.
 - i. Three position function switch marked, RUN-STOP and REMOTE.
 - j. Running time meter, oil pressure, battery charging ammeter, and water temperature gauges.

H. Main Line Circuit Breaker:

1. Type A main line, molded case circuit breaker mounted upon and sized to the output of the generator shall be installed as a load circuit interrupting and protection device. It shall operate both manually for normal switching functions and automatically during overload and short circuit conditions.
2. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breaker shall meet standards established by Underwriters Laboratories National Electric Manufacturer's Association, and National Electrical Code.

I. Automatic Load Transfer Switch:

1. The amperage rating of the automatic load transfer switch shall be 1600 amps. Transfer switches shall be Nema 1 floor mounted.
2. Automatic transfer switch shall be mechanically held on both the emergency and the normal side, and rated for continuous duty in an unventilated enclosure. The switches shall be double throw with the main contacts rigidly and mechanically interlocked to insure only two possible positions: Normal or Emergency. A manual operator must be provided to enable manual operation.
3. Rating and Performance: The automatic load transfer control shall be rated for continuous duty when enclosed in a non-ventilated NEMA 1 enclosure. It shall be rated for all classes of load including inductive and non-inductive at 600 volts and tungsten lamp load at 250 volts. The transfer switch portion of the control shall be designed, built, and tested to close on an inrush current up to and including twenty (20) times the continuous rating of the switch without welding or excessive burning of the contacts. The transfer switch shall be capable of switching load up to and including fifteen (15) times the continuous rating of the switch and capable of enduring six thousand (6000) cycles of operation, at rated current, at a rate of six (6) cycles per minute, without failure. One cycle shall consist of one complete opening and closure of both sets of contacts on an inrush current of ten (10) times the continuous rating of the switch.
4. Transfer switch shall be listed under U.L. 1008, and approved by Canadian Standards Association. Switches utilizing reversing contactor mechanisms as a means to transfer load are disallowed and will not be considered.
5. Accessories to transfer switches; All automatic load transfer switches shall include the following accessories:
 - a. Engine starting contacts to provide for generator starting from each unit independent of the other.
 - b. Full phase protection. Three phase relays shall be field adjustable, close differential type with 92-95% pickup and

82-85% drop out. Relays are to be connected across live lines.

- c. Test switch, to simulate a power outage.
 - d. Adjustable time delay on engine starting to over-ride momentary outages and nuisance voltage dips.
 - e. Adjustable time delay on transfer of load to emergency source. Adjustable time delay to open transfer switch contact to allow motor loads to decay.
 - f. Adjustable time delay on retransfer to load to normal with 5 minute cool-down timer wherein the generator set runs unloaded after transfer to line.
 - g. Plant exerciser to start and run the generator set with or without load each 168 hours for a 30 minute interval. Selector switch will be provided for with load or without load testing.
 - h. One auxiliary contact closed on emergency and one auxiliary contact open on emergency.
 - i. Pilot lights to indicate the normal and emergency position of the transfer switch.
 - j. Isolated (ungrounded neutral bar).
 - k. Disconnect plug.
 - l. Time delay neutral, programmed transition, or in phase monitor.
- J. Annunciator Panel: A flush recessed panel shall be provided for remote mounting as shown on the drawings to give audible and visual warning of fault or alarm conditions in the generator set. Wiring and conduit shall be as required by the system manufacturer. The panel shall conform with the requirements of the National Electrical Code, Section 700-12, and the National Fire Protection Associates publication, NFPA No. 110-3-5.5.1, Level One. Fuel tank leak detection status shall be indicated on the annunciator.

- K. Transient voltage surge protection shall be provided protecting all low voltage circuits serving the transfer switch and the annunciator. EDCO or equal.
- L. Provide one (1) remote emergency power off button. Provide Nema 3R enclosure for outdoor locations. Contractor to connect such to generator.
- M. Provide a 4' wide aluminum service platform with grating and aluminum handrails on three sides of the generator. The elevation of the platform shall be at the same height as the top of the fuel tank. Provide aluminum steps and handrails. Provide a concrete foundation for the service platform and steps.

1.07 MANUFACTURING

- A. The engine, including engine block, oil pan, and cylinder heads, generator and all major items of auxiliary equipment shall be manufactured in the U. S. by manufacturers currently engaged in the production of such equipment.
- B. The unit shall be shipped to the job site by the manufacturer's authorized dealer having a parts and service facility within a 75 mile radius of the job site. In addition, and in order not to penalize the owner for unnecessary or prolonged periods of time for service or repairs to the emergency system, the bidding generator set supplier must have no less than eighty percent (80%) of all engine replacement parts in his stock at all times. Certified proof of this requirement shall be available from the dealer.

1.08 TESTING

- A. Prior to acceptance of the installation, equipment shall be tested to show it is free of any defects and will start automatically and be subjected to full load test through the use of existing loads and, dry type load banks supplied for this purpose at the job site by the generator set supplier.
- B. Load bank testing shall be done in the presence of the Owner's engineer or his appointed representative only after the unit is permanently installed in accordance with the plans and specifications. If testing is completed without benefit of Engineers presence, testing shall be done

again in his presence. Testing shall be for a period of four (4) hours under full load.

- C. Contractor shall supply all fuel necessary for load bank testing and shall before final acceptance of generator unit top off tank leaving it full.

1.09

CERTIFICATE TEST REPORTS, MANUALS AND INSTRUCTIONS

- A. Prior to the final inspection, deliver 4 copies of the following items to the Engineer:
 - 1. A certificate by the manufacturer of the engine-generator set that the auxiliary electrical power system has been properly installed, adjusted and tested.
 - 2. Certified copies of all of the factory and construction site test data sheets and reports for the engine-generator set and major auxiliaries.
 - 3. Complete operating and maintenance manuals for the engine-generator set and auxiliaries including wiring diagrams, technical data sheets and information for ordering replaceable parts:
 - a. Include complete interconnection diagrams which indicate all components of the system.
 - b. Include complete diagrams of the internal wiring for each of the items of equipment.
 - c. The diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- B. Laminate or mount under plexiglas a set of operating instructions for the system and install it under a neat frame, adjacent to transfer switch.
- C. Provide signage, in accordance with section 26120, at main electrical service entrance equipment to indicate type and location of on-site emergency generator per N.E.C. 700.8(a).
- D. Furnish the services of a competent, factory-trained engineer or technician for instructing operating and maintenance personnel on the proper operation and maintenance of the system at the time of testing.

1.10 SYSTEM SERVICE CONTRACT

- A. The supplier of the standby power system shall provide a copy of and make available to the owner his standard service contract which, at the owner's option, may be accepted or refused. This contract will accompany any documents, drawings, catalog cuts, specification sheets, wiring, or outline drawings, etc. Submitted for approval to the designing engineer. The contract shall be for the complete power system.

1.11 WARRANTY

- A. The complete standby electrical system furnished under this Section shall be guaranteed against defective parts and workmanship under terms of the manufacturer's and dealer's standard warranty. But, in no event shall it be for a period of less than five (5) years or 3000 hours from date of final testing and acceptance of the system and shall include labor, parts and travel time for necessary repairs at the job site. Warranty information shall be submitted along with construction site test data sheets. This information shall list starting and ending dates and who is to be contacted for warranty service.

END OF SECTION

SECTION 260210
DATA/ VOICE NETWORK AND CABLING SYSTEM

1.01 SUBMITTALS

- A. Shop drawings shall be submitted as follows:
 - 1. Manufacturer's published literature for each separate type of equipment being provided. Indicate model number on cutsheet.
 - 2. One line schematic of complete system showing a floor plan to scale. Show locations and the type of outlets, as well as all rack locations, and cabling type.
 - 3. Documentation of testing on all wiring and terminations as per ANSI/TIA standards.

1.02 MANUFACTURERS

- A. Acceptable manufacturers for each type of equipment specified shall be as noted throughout this specification section.
- B. The acceptable manufacturers noted shall be installed by the authorized local factory dealer/representative for that product.
- C. The contractor shall hold a current low voltage contractor's license and RCDD certificate. Any other interested parties shall submit a company resume showing years in business, certification stating that he is an authorized representative for the manufacturer of the equipment he is submitting for approval and that he maintains a fully equipped and stocked service shop and shall respond to service calls within 12 normal working hours, list of key personnel, copies of appropriate licenses and list of recently completed jobs. Submittal must be received no later than ten business days prior to bid date in order to be considered.

1.03 GENERAL

- A. Workmanship
All work shall be performed in a workmanlike manner. Architect, Engineer, and/or Owner may observe the work procedures and workmanship of the Contractor but such observation will not relieve the contractor from responsibility for performance.
- B. Warranty
The Contractor shall furnish a written warranty that describes the equipment supplied under these specifications will be free from defects

of materials and workmanship for a period of fifteen years from the date of final acceptance unless otherwise specified and that all defects occurring within that period shall be corrected in a timely manner at no cost to the Owner.

C. Contractor's Qualifications

Contractor shall be required, before awarding of contract, to demonstrate to the complete satisfaction of the Engineer that he has the necessary facilities, ability and financial resources to execute the work in a satisfactory manner and within the time specified; that he has had experience in construction work as same or similar nature; that he has past history and references which will assure the Owner of his qualifications for executing the work.

Contractor shall submit a copy of a valid low-voltage license (Low-Voltage General, Low-Voltage Telecommunications or Low-Voltage Unrestricted as issued by the State Construction Industry Licensing Board of Low-Voltage Contractors).

Contractor shall submit a copy of a BICSI (Building Industry Consulting Service International) certified RCDD (Registered Communications Distributions Designer) certificate.

D. Comprehensive list of references

Attach a detailed list of references along with contact person, dates of work, mailing address, telephone numbers.

E. Contractor must provide proof of installation in a minimum of five sites using a Enhanced Category 6e structured cabling with 100 or more active (working) nodes installed.

1.04 SCOPE OF WORK

A. Scope of Project Standards and Description

The cabling and wiring placed for voice and data communications on this undertaking shall be "Unshielded Twisted Pair" type and conform to the requirements contained in the latest editions of the National Electric Code (NEC) and the latest editions of the following American National Standards Institute (ANSI) specifications:

1. ANSI/TIA 568-Commercial Building Telecommunications Cabling Standard
 2. TIA 569-Commercial Building Standard for Telecommunications Pathways and Spaces
 3. ANSI/TIA/EIA 606-Administration Standard for Commercial Telecommunications Infrastructure
 4. ANSI/J-STD 607-Commercial Building Grounding (earthing) and Bonding Requirements for Telecommunications
 5. Addendums to TIA/EIA 568
- B. Specifications for the Fiber Optic Backbone, Jacks Outlets, Horizontal Wiring, Patch Panel, and Racks are provided in this specification section.

1.05 GUARANTEES

- A. All communication outlets wired and serviceable must be tested and certified in compliance with ANSI/TIA 568-C.2-1 Enhanced Category 6e specifications. Testing must be "end-to-end". Test results shall be forwarded to Engineer a minimum of one week prior to final inspection.

1.06 TESTING AND CERTIFICATION

- A. Testing fiber optic and copper distribution systems are crucial in assuring the overall integrity and satisfactory performance of the network. Test results quantify system quality, identify system faults, and establish the baseline accountability performance of the system. Proper testing also maximizes the longevity of the system, minimizes downtime and maintenance, and facilitates system upgrades or reconfiguration.
- B. The Contractor shall provide proof of communications wiring systems certification and testing certification.
- C. All data and voice wiring and terminations shall be tested and must pass ANSI/TIA standards for Enhanced Category 6 Cabling. All faults shall be corrected.
- D. All test results must be printed and show the following primary results:
1. Wire map
 2. Length
 3. Insertion Loss

4. Near-end crosstalk (NEXT)
5. Power sum near end crosstalk (PSNEXT)
6. Equal-level far-end crosstalk (ELFEXT)
7. Power sum equal-level far-end crosstalk (PSELFEXT)
8. Return Loss
9. Propagation delay

1.07 FIBER OPTIC BACKBONE

- A. Fiber optic cable shall be provided for backbone inter-building and intra-building wiring. This includes all MDF to IDF and vertical riser applications. All fiber optic cabling used shall be, multimode 50 micron core diameter / 125 micron cladding diameter. The multimode fiber used in the cable shall meet TIA/EIA 492 AAAB standard. The cable shall meet the requirements of TIA/EIA 568-C.3 standard. As a minimum, backbone and vertical riser cables shall contain 12 fibers. All fibers in each cable must be multimode, with attenuation <3.5 dB loss / km and OFL bandwidth of 500 MHz-km at 850 nm and attenuation <1.25 dB loss/km and OFL bandwidth of 500 MHz-km at 1300 nm. Cables that provide additional fibers to replace defective fibers in the cable are not permitted.
- B. Intra-building fiber optic cabling used to interconnect IC's and MC's shall be a tight buffered, non gel-filled design composed of all dielectric materials and if not installed in conduit shall be plenum rated and listed as OFNP (UL). Fiber optic cable installed underground shall be water blocked with either gel or dry block and rated for outdoor underground duct installation. Any fiber not installed in conduit, shall be installed in plenum rated innderduct.

1.08 LOCAL AREA NETWORK (LAN) JACK AND OUTLET SPECIFICATIONS

- A. Locations shown on drawings will be equipped with a consistent arrangement of LAN communications outlets.
- B. Outlet faceplate for this arrangement shall be configured in the following fashion:
 1. The jacks used shall fit properly in the outlet openings of the outlet faceplate. The jacks used shall conform to Enhanced Category 6 parameters of ANSI/TIA 568-C.2-1

- a. In a properly installed Category 6 UTP cabling system, the jacks used shall be capable of supporting LAN data rates of 1000 Mbps.
 - b. The wiring arrangement of the jack shall conform to the ANSI/TIA 568.
 - c. The jack shall possess the following characteristics:
 - 1. The eight (8) position / eight (8) conductor jack shall be capable of supporting the previously defined data rates as well as voice (including ISDN).
 - 2. Utilization of 110 type or equivalent insulation displacement hardware for horizontal wire attachment and acceptance of 22 or 23 AWG conductors.
 - 3. The jack wires shall consist of 50 micro-inch lubricated gold plating over 100 micro-inch nickel underplating.
 - d. Any vacant faceplate position shall be reserved for future growth and should have a dust cover/blank inserted.
- C. Acceptable Manufacturer's: Molex, Ortronics, Commscope, AMP, and Belden, Leviton, Panduit, Siemon, and OCC.
 - D. Each jack shall have faceplate labeled. Also neatly label backside of faceplate with a permanent marker to note jack number.
 - E. Labeling of multiple drops in a common space shall be sequentially numbered. Numbers shall not be assigned randomly. Coordinate prior to terminating at racks, no exceptions.

1.09

LOCAL AREA NETWORK (LAN) HORIZONTAL WIRING SPECIFICATIONS

- A. This section covers the cable from the communications outlet to the patch panel in the IC or wiring closet. These cables shall be Enhanced Category 6e Unshielded Twisted Pair cable. Each cable shall be placed in a "point-to-point" fashion from the work area outlet to the wiring closet for each communications outlet needed. There shall be no intermediate splices or cross connects in these cables.
- B. The characteristics of the horizontal cable are as follows:

1. Enhanced Category 6e cable consisting of four pair of 23 AWG bare solid copper conductors insulated with a plenum rated material. The insulated conductors are tightly twisted into pairs and jacketed with plenum rated material. No type of shield is required in the sheath.
 2. Each sheath shall contain four unshielded copper pairs. Each pair shall have a different twist per foot ratio ranging from 12 to 24 twists per foot. No more than 1/2" inch may be untwisted and the sheath may not be stripped back more than 1/2" inch at the jack during installation.
- C. The cable component shall meet or exceed the following requirements:
1. ASNI/TIA 568-C.2 "Commercial Building Telecommunications Standard, Part 2: Balanced Twisted-Pair Telecommunications Cabling and Components Standard"
 2. ASNI/TIA 1152 Requirements for Field Test Instruments and Measurements for Balanced Twisted Pair Cabling "
 3. Certified Enhanced Category 6e Cable under Third Party Cable Certification Program.
 4. ICEA S-102-700
 5. ANSI/ICEA S-102-732
 6. UL Standard 444
 7. National Electric Code - Article 800
- D. Subject to compliance with specification requirements, the only acceptable Enhanced Cat. 6e cables approved for use as follows:
1. Mohawk Advancenet
 2. Commscope Ultramedia 7504
 3. Belden Datatwist 4800
 4. Central Cable Genspeed 6000
 5. Berk-Tek Lanmark 1000
- E. Plenum rated cable shall be used. The plenum cable shall be composed of four pair of 23 gauge bare solid copper conductors insulated with a plenum rated insulation that is the same material configuration on all four pairs, 3+1 or 2+2 designs are not allowed. The insulated conductors are tightly twisted into pairs and jacketed with low smoke plenum rated PVC. It shall conform to a NEC Type CMP for plenum and NEC Type CMR for riser applications.

1.10

LOCAL AREA NETWORK (LAN) PATCH PANEL SPECIFICATIONS

- A. This section covers the termination hardware located in the MC and IC (wiring closet). The termination hardware shall provide the capability to be able to patch connections between ports on the LAN hardware (electronics) and the horizontal cables to the work area outlets.
- B. The Patch panels shall be Category 6 Modular Jack Panels. Provide 24 port or 48 port patch panels as required for number of drops.
- C. The termination hardware will be co-located on 19" inch racks with the LAN electronics. The configuration of the patch panels shall be in an agreement that minimizes patch cord lengths. Provisions for cable management (organization of horizontal and vertical cable and patch cords) on the rack should be included.
- D. Horizontal cables to the work area outlets will be directly connected to 110 insulation displacement hardware or equivalent associated with each jack on the patch panel. The jacks on the patch panel shall be wired in accordance with ANSI/TIA 568- C.2 standard.
- E. Fiber Termination requirements:

Fiber optics connections should be terminated using a rack mountable Interconnect enclosure or equivalent to insure that the connections are protected. The enclosure should be locked and no fiber cable should be visible in the rack.
- F. Acceptable Manufacturer's: Molex, Pass & Seymour, AT&T, AMP, Hubbell, Leviton, Panduit, Siemon, and OCC.

1.11

LOCAL AREA NETWORK (LAN) RACK SPECIFICATIONS

- A. The rack shall be EIA 19" open equipment rack, 84" high, aluminum construction, drilled and tapped on both sides to EIA Standard. Rack shall have top and bottom angles for support, 15 inch wide foot with holes for bolting to floor, and factory installed grounding lugs. Black powder coated. Rack shall have two (2) position ring runs and rear cable management tray as required per number of patch panels. Provide cable management rings on sides of rack.

1.12

SYSTEM DOCUMENTATION

- A. As part of the wiring system installation, the Contractor shall provide detailed documentation of the distribution system to facilitate system administration, system maintenance and future system changes. This requirement includes as-built drawings with all cables and terminations identified, a bill of materials of all installed equipment and wiring, rack and backboard equipment layouts showing placement of support equipment, and model and serial numbers of all installed equipment. A clear and consistent nomenclature scheme is to be defined and used on the documentation and cable labeling which facilitates locating and identifying each cable.
- B. System verification and acceptance documentation signed and dated by the installer (Contractor) and the design professional shall also be provided. This documentation shall include test measurements and system calibrations performed for the entire system. Sample system operations shall also be performed with actual hardware or using contractor provided test equipment and documented to verify that the system is operational and ready for acceptance. This shall also establish the baseline performance of the system.

1.13 TRAINING

- A. Training of owner's personnel (a minimum of two) shall be provided. Training will cover the location nomenclature, documentation structure and contents, documentation maintenance procedures, a "walk-through" for location and labeling orientation, system reconfiguration using the MDF, and IDF facilities (Termination hardware, punch blocks, etc.), operation of network equipment installed as part of the contract, test documentation, and trouble shooting of the signal and power cable portion of the installation.
- B. Provide a record set plan noting drop locations and jack designations. As-built shall be a full size plan and shall be computer generated in AutoCAD 2007 format. Provide a CD to Owner with (as-built) on disc at project closeout. At each rack provide a copy of (as-built) mounted on wall. Mount plan under plexiglass.

END OF SECTION

SECTION 260220
CONSTRUCTION REVIEWS INSPECTION AND TESTING

1.01 GENERAL

- A. Comply with Division 1 - General Requirements.

1.02 CONSTRUCTION REVIEWS

- A. The Architect or his representative shall observe and review the installation of all electrical systems shown on the drawings and as specified herein.
- B. Before covering or concealing any conduit below grade or slab, in wall or above ceiling, the contractor shall notify the Architect so that he can review the installation.

1.03 CONTRACTOR'S FINAL INSPECTION

- A. At the time of the Contractor's final inspection, all systems shall be checked and tested for proper installation and operation by the Contractor in the presence of the Architect or his representative.
- B. The Contractor shall furnish the personnel, tools and equipment required to inspect and test all systems.
- C. Following is a list of items that the contractor must demonstrate to the Architect or his representative as complying with the plans and specifications. Please note that this list does not necessarily represent all items to be covered in the final inspection, but should give the Contractor an idea of what is to be reviewed.
 - 1. Service ground, show connection to ground rod and cold water main.
 - 2. Demonstrate that main service equipment is properly bonded.
 - 3. Demonstrate that all panels have breakers as specified, ground bar, copper bus, typed directory for circuit identification and that they are free of trash.

4. Demonstrate that all conduits are supported as required by the National Electrical Code.
5. Demonstrate that all outlet boxes above or on the ceiling are supported as required by the National Electrical Code.
6. Demonstrate that outlet boxes in wall or ceilings of combustible materials are flush with surface of wall or ceiling, and that outlet boxes in walls or ceilings of non-combustible materials are so installed that the front edge of the box or plaster ring is not set back more than 1/4".
7. Demonstrate that outlet boxes in wall are secure.
8. Demonstrate that all devices are properly secured to boxes, that device plates are properly aligned and are not being used to secure device.
9. Utilizing a Woodhead No. 1750 testing device, demonstrate that all 125 volt receptacles are properly connected.
10. Demonstrate that all fixtures have specified lamps, ballast and lens, and that they are supported as required by the National Electrical Code or as called for on the drawings or in the specifications.
11. Demonstrate that all disconnects requiring fuses are fused with the proper size and type, and that all disconnects are properly identified.
12. Demonstrate that Fire Alarm System is in proper working order, initiating an alarm signal from each manual and automatic device (including smoke detectors).
13. Demonstrate that Engine Generator Set is in proper working order and meeting all requirements outlined in specification.
14. Demonstrate that the Data/Voice Network Cabling System is in proper working order and meeting all requirements outlined in the specifications.

END OF SECTION

SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 SUBMITTALS

A. Product Data: For each type of product including but not limited to:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.
4. Clamps.
5. Hangers.
6. Fasteners.
7. Anchors.
8. Brackets.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Painted Coatings: Manufacturer standard painted coating applied according to MFMA-4.
 - 3. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 5. Toggle Bolts: All-steel springhead type.
 6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. All hanger and support materials shall be suitable for the environment in which installed.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 .
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet anchorage requirements.

- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 6 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi 28-day compressive-strength concrete.
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

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

END OF SECTION

SECTION 260544
SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Grout.

B. Related Requirements:

1. Division 7 Section "Through-Penetration Firestop Systems" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.

- b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

END OF SECTION

SECTION 260573
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1. Study results shall be used to determine coordination of series-rated devices.

1.2 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.

- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and equipment evaluation reports.
3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Coordination Study Software Developer and Coordination Study Specialist.

- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section "Operation and Maintenance Data," include the following:
 - a. The following parts from the Protective Device Coordination Study Report:
 - 1) One-line diagram.
 - 2) Protective device coordination study.
 - 3) Time-current coordination curves.
 - b. Power system data.

1.5 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- C. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- D. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Software Developers: Subject to compliance with requirements, available software developers offering software that may be used for the Work include, but are not limited to, the following:
 - 1. ETAP
 - 2. SKM Systems Analysis, Inc.
- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.

5. Switchgear, switchboard, motor-control center, and panelboard designations.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study:
1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
 2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
 3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- F. Protective Device Coordination Study:
1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

- a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.
- G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
- 1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
 - 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 - 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 - 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium-voltage equipment overcurrent relays.
 - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.
 - g. Ground-fault protective devices.
 - h. Motor-starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.

- j. The largest feeder circuit breaker in each motor-control center and panelboard.
- 5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.
- 6. Provide adequate time margins between device characteristics such that selective operation is achieved.
- 7. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 PROTECTIVE DEVICE COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. The study shall be based on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.

- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- H. Motor Protection:
 - 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
 - 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- J. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.
- K. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

- L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
 - 1. Electric utility's supply termination point.
 - 2. Switchgear.
 - 3. Unit substation primary and secondary terminals.
 - 4. Low-voltage switchgear.
 - 5. Motor-control centers.
 - 6. Standby generators and automatic transfer switches.
 - 7. Branch circuit panelboards.
- M. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
 - 3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

3.3 LOAD-FLOW AND VOLTAGE-DROP STUDY

- A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:
 - 1. Determine load-flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
 - 2. Determine load-flow and voltage drop based on 80 percent of the design capacity of the load buses.
 - 3. Prepare the load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.4 MOTOR-STARTING STUDY

- A. Perform a motor-starting study to analyze the transient effect of the system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of the motor starting on the power system stability.
- B. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and voltage sags so as not to affect the operation of other utilization equipment on the system supplying the motor.

3.5 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the overcurrent protective device study.
 - 1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
 - 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
- B. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 241 and IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 - 1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Electrical power utility impedance at the service.
 - 3. Power sources and ties.
 - 4. Short-circuit current at each system bus, three phase and line-to-ground.
 - 5. Full-load current of all loads.
 - 6. Voltage level at each bus.
 - 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 - 8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 - 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 - 10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 - 11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 - 12. Maximum demands from service meters.

13. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
14. Motor horsepower and NEMA MG 1 code letter designation.
15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
16. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.
17. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.
 - k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.6 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
- C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.7 DEMONSTRATION

- A. Engage the Coordination Study Specialist to train Owner's maintenance personnel in the following:
 - 1. Acquaint personnel in the fundamentals of operating the power system in normal and emergency modes.
 - 2. Hand-out and explain the objectives of the coordination study, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting the time-current coordination curves.
 - 3. Adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION

**SECTION 260913
ELECTRICAL POWER MONITORING**

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Multifunction energy meters.
2. Power meters.
3. Circuit meters and monitors.
4. Circuit meter and explorer.
5. PC operating system software.
6. Networked PC operating system software.
7. Power monitoring and control software.
8. Network configuration software.
9. Monitoring and control of power distribution equipment.
10. System operator interfaces.
11. Desktop workstations.
12. Portable workstations.
13. Raceways and boxes.
14. Wires and cables.
15. Surge protection devices.

1.2 DEFINITIONS

- A. Active Power: The average power consumed by a unit. Also known as "real power."
- B. Apparent (Phasor) Power: " $S = VI$ " where "S" is the apparent power, "V" is the RMS value of the voltage, and "I" is the RMS value of the current.
- C. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
- D. KY Pulse: A method of measuring consumption of electricity that is based on a relay operating like a SPST switch.
- E. KYZ Pulse: A method of measuring consumption of electricity based on a relay operating like a SPDT switch.

- F. L-G: Line to ground.
- G. L-L: Line to line.
- H. L-N: Line to neutral.
- I. MODBUS TCP/IP: An open protocol for exchange of process data.
- J. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- K. N-G: Neutral to ground.
- L. Power Factor: The ratio of active power to apparent power, sometimes expressed in percentage.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Multifunction energy meters.
 - 2. Power meters.
 - 3. Circuit meters and monitors.
 - 4. Circuit meter and explorer.
 - 5. PC operating system software.
 - 6. Networked PC operating system software.
 - 7. Power monitoring and control software.
 - 8. Network configuration software.
 - 9. Monitoring and control of power distribution equipment.
 - 10. System operator interfaces.
 - 11. Desktop workstations.
 - 12. Portable workstations.
 - 13. Raceways and boxes.
 - 14. Wires and cables.
 - 15. Surge protection devices.
- B. Shop Drawings: For power monitoring and control equipment.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.

- a. Attach copies of approved Product Data submittals for products (such as switchboards, switchgear, and motor-control centers) that describe the following:
 - 1) Location of the meters and gateways, and routing of the connecting wiring.
 - 2) Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
- 3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
- 4. Network naming and numbering scheme.
- 5. Include diagrams for power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
- 6. Specifications for workstations.
- 7. UPS sizing calculations for workstation.
- 8. Surge Suppressors: Data for each device used and where applied.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Design Data:
 - 1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.
 - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
 - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
 - c. As-built versions of submittal Product Data.
 - d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
 - e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.

- f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
- g. Engineering, installation, and maintenance manuals that explain how to do the following:
 - 1) Design and install new points, panels, and other hardware.
 - 2) Perform preventive maintenance and calibration.
 - 3) Debug hardware problems.
 - 4) Repair or replace hardware.
- h. Documentation of programs created using custom programming language including set points, tuning parameters, and object database.
- i. Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.
- j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- k. Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
- l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- m. Owner training materials.

1.5 COORDINATION

- A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of specified functions.
- B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control of electrical power distribution system(s) that includes the following:
 - 1. Electrical meters that monitor, control, and connect to the data transmission network.
 - 2. LAN: High-speed, multi-access, open, nonproprietary, industry-standard communication protocols.
 - 3. Include multiple PC-based workstations with web access, with its operating system and application software, connected to data transmission network.
- B. The electrical power monitoring and control system must be Internet based.
 - 1. System software must be based on server thin-client architecture, designed around open standards of internet technology.
 - 2. Intent of thin-client architecture is to provide operators complete access to power monitoring and control system via an Internet browser. No special software other than an Internet browser must be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
 - 3. Internet access must be password protected.
- C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with UL 61010-1 and marked for intended location and application.

2.2 MULTIFUNCTION ENERGY METERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Schneider Electric USA, Inc.
 - 2. Eaton
- B. Multifunction Energy Meter: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power and energy metering and monitoring; complying with UL 61010-1.

1. Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.
 2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.
- C. Comply with IEC 60529 degree of protection code of IP65 for the front of the meter, and code of IP30 for the body.
- D. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.
- E. Accuracy:
1. Comply with ANSI C12.20, Class 0.5.
 2. Neutral Current Measurement: Not more than 0.65 percent.
 3. Power Factor: 1.0 percent.
 4. Frequency: 0.1 percent.
 5. THD: 1.0 percent.
 6. Waveform Sampling: 64 per cycle.
- F. Data Link:
1. MODBUS TIA-485, RTU protocol, -wire connection to host devices with a compatible port.
- G. Meter Physical Characteristics:
1. Display: Backlit LCD with antiglare and scratch-resistant lens.
 2. Display of Metered Values:
 - a. One screen to show at least user-selected values displayed at the same time. Selections available to display must include the following:
 - 1) Meters.
 - 2) Measurements.
 - 3) THD.
 - 4) Energy.
 - 5) Demand.
 - 6) Minimum and maximum values.
 - 7) Power demand.
- H. Sampling Rate: Continuously sample and record voltage and current at a rate not less than samples per cycle, simultaneously on voltage and current channels of the meter.
- I. Meters:

1. Instantaneous, RMS:
 - a. Current: Each phase, and three-phase average.
 - b. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
 - c. Active Power (kW): three-phase total.
 - d. Reactive Power (kVAR): three-phase total.
 - e. Apparent Power (kVA): three-phase total.
 - f. Power Factor: three-phase total.
2. Energy:
 - a. Active Energy (kWh): Three-phase total.
3. Demand, Derived from Instantaneous RMS Meters:
 - a. Current: Present and maximum.
 - b. Active: Present and maximum.
 - c. Reactive: Present and maximum.
 - d. Apparent: Present and maximum.
4. Power Quality Measurements:
 - a. THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.
- J. I/O: Two optically isolated digital outputs for KY pulsing or control. Output signal characteristics must be 150 mA at 200 V.
 1. KY Pulse: Generate standard KY pulses for a user-defined increment of metered active energy as follows:
 - a. User-defined pulse output, associated with kWh.
 - b. User-defined pulse output, associated with kVARh.
- K. Capacities and Characteristics:
 1. Power Supply: .
 2. Circuit Connections:
 - a. Voltage: Measurement autoranging, 60 to 400 V(ac) L-N. Meter impedance must be 2 megohm L-L or greater. Overload Tolerance: 1500 V(ac), RMS, continuously.

- b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
- c. Frequency: 45 to 65 Hz.
- d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.3 NETWORKED PC OPERATING SYSTEM SOFTWARE

- A. Description: System software must monitor, analyze, display, control, and save parameters and features available at each of the connected meters.
- B. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Software must include interactive graphics client and must be web enabled.
- C. System Software Minimum Requirements:
 - 1. Real-time multitasking and multiuser bit operating system that allows concurrent multiple workstations operating and concurrent execution of multiple real-time programs and custom program development.
 - 2. Operating system must be capable of operating Microsoft Windows applications.
 - 3. Database management software must manage data on an integrated and non-redundant basis. Additions and deletions to database must be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
 - 4. Scheduling software must schedule centrally based time and event, temporary, and exception day programs.
- D. Operator Interface Software:
 - 1. Minimize operator training through use of English language prorating and English language point identification.
 - 2. Minimize use of a typewriter-style keyboard through use of a pointing device, touchscreen, or mouse.
 - 3. Operator sign-off must be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
 - 4. Automatic sign-off period must be programmable from 1 to 60 minutes in 1-minute increments on a per operator basis.

5. Record operator sign-on and sign-off activity.
6. Security Access:
 - a. Operator access to electrical monitoring and control system must be under password control.
 - b. An alphanumeric password must be user assignable to each operator.
 - c. Software must have at least five access levels.
 - 1) View - View information. No change privileges allowed.
 - 2) User - Same as View, but is able to initiate control functions.
 - 3) Controller - Same as User, but is able to initiate communications.
 - 4) Operator - Same as Controller, but is able to modify configurations.
 - 5) Supervisor - Same as Operator, but is able to administer security privileges.
 - d. Each menu item must be assigned an access level so that a one-for-one correspondence between operator-assigned access level(s) and menu-item access level(s) is required to gain access to menu item.
 - e. Display menu items to operator with those menu items capable of access highlighted. Menu and operator access level assignments must be online programmable and under password control.

E. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator.
2. Descriptors for graphics, points, alarms, and such must be modified through workstation under password control.
3. Display operator accessed data on the monitor.
4. Help Features: On-line context-sensitive help utility to facilitate operator training and understanding.

2.4 MONITORING AND CONTROL OF POWER DISTRIBUTION EQUIPMENT

- A. Power Distribution Equipment: Web-enabled, direct connected to the LAN or intranet.
- B. Instrument Transformers: Comply with IEEE C57.13.
 1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.
 2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

C. Ethernet Connectivity:

1. A multipoint, MODBUS TIA-485 serial communications network must be included within the equipment to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications.
2. Serial communications network must be wired to an Ethernet server in the incoming section of the equipment. Hardware and cabling required for the connection to the network must be included within the power distribution equipment.
3. Serial communications devices within the equipment must be factory addressed and tested to verify reliable communications to the equipment's Ethernet Server.

D. Ethernet Gateways:

1. User configurable; complying with UL 60950-1, and IEEE 802.3, Class 3 PoE.
2. Include provisions to set initial Ethernet parameters via a local operator interface, or standard (8PSJ) Ethernet port, that is accessible from the front of the equipment. Initial setup must be limited to basic Ethernet addressing parameters, as assigned by Owner.
3. Common Gateway Features:
 - a. User configurable, with secure password-protected login process.
 - b. Include communications diagnostic information for serial and Ethernet ports as well as internal health status and memory management information through embedded HTML web pages for viewing using a standard web browser.
 - c. Include embedded HTML pages providing real-time information from devices connected to the Ethernet gateway's TIA-485 port(s) through a standard web browser.
 - d. Allow firmware upgrades through the communications port.
4. Include a "Quick-Start" guide with the equipment to describe the commissioning process for setting the equipment's Ethernet network address and for ensuring trouble-free data access from any PC on the network, using a standard web browser.
5. Implement a common user interface ("look and feel") across different styles of power equipment.

E. Distribution Equipment Monitoring:

1. Main menu and summary pages, factory configured, to display data for each communicating device within the power equipment lineup.
2. Display Data:

- a. Circuit summary page to display circuit name, three-phase average RMS current, real power (kW), power factor, and breaker status (if applicable).
- b. Load current summary page to display circuit name, and phase a, b, and c RMS current values.
- c. Demand current summary page to display circuit name, and phase a, b, and c average demand current values.
- d. Power summary page to display circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
- e. Energy summary page to display circuit name, real energy (kWh), reactive energy (kVARh), and time/date of last reset.
- f. For unit substations equipped with dry-type transformer(s) and microbased temperature controller(s), the circuit summary web page listed above must be augmented with transformer coil temperatures, phase a, b and c current values, and cooling fan status (on/off).
- g. For motor-control centers, the circuit summary web page must be tailored specifically for this application, to display circuit name, three-phase average RMS current, thermal capacity (percentage), drive output frequency (in Hertz, where applicable), and contactor status.

2.5 SYSTEM OPERATOR INTERFACES

- A. Operator means of system access must be through the following:
 - 1. Desktop workstation with hardwired connection through LAN port.
 - 2. Portable terminal with hardwired connection through LAN port at each meter.
 - 3. Remote connection using outside of system PC, tablet, or phone using an internet portal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF POWER MONITORING AND CONTROL SYSTEMS

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- C. Wiring and Cabling Installation:
 - 1. Comply with Section 26 00 30 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
- D. Raceways Installation:
 - 1. Comply with Section 26 00 20 "Conduits for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.
 - 2. Comply with Section 26 01 30 "Pathways for Communications Systems" for control wiring, TIA-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.
- E. Identification Installation:
 - 1. Comply with Section 26 00 30 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.

3.3 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

3.4 GROUNDING

- A. For data communication wiring, comply with BICSI N1.
- B. For control-voltage wiring and cabling, comply with requirements in Section 26 01 10 "Grounding and Bonding for Electrical Systems."
- C. Prepare test and inspection reports.

3.5 FINAL REVIEW

- A. Submit written request to Architect when the power monitoring and control system is ready for final review. Written request must state the following:
 - 1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
 - 2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
 - 3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
 - 4. The system is complete and ready for final review.
- B. Review by Architect will be made after receipt of written request. A field report must be issued to document observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Final review must include a demonstration to parties participating in final review.

3.6 MAINTENANCE SERVICE

- A. Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by manufacturer's authorized service representative. Include annual preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.

3.7 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement must include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.8 TRAINING

A. Attendee Training Manuals:

1. Provide each attendee with a color hard copy of training materials and visual presentations.
2. Hard-copy materials must be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of hard-copy materials.

B. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Instructor must provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training must include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. The workstation provided with the system must be used in training. If workstation is not indicated, provide a temporary workstation to convey training content.

C. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.
2. Provide capability to remotely access to Project monitoring and control system for use in training.
3. Provide a workstation for use by each attendee.

D. At Completion of Training: Staff familiar with the system installed are capable of demonstrating operation of the system during final review.

E. Demonstration must include, but not be limited to, the following:

1. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
2. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and workstations.
3. Trends, summaries, logs, and reports set-up for Project.
4. Software's ability to communicate with controllers, workstations, and uploading and downloading of control programs.
5. Software's ability to edit control programs off-line.
6. Data entry to show Project-specific customizing capability including parameter changes.
7. Step through penetration tree, display graphics, demonstrate dynamic update, and direct access to graphics.
8. Execution of digital and analog commands in graphic mode.
9. Spreadsheet and curve plot software and its integration with database.
10. Online user guide and help functions.
11. For Each Meter:
 - a. Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
 - b. Operator Interface: Ability to connect directly to each meter with a portable workstation.
 - c. Wiring Labels: Match control drawings.
 - d. Network Communication: Ability to locate a meter on the network. Communication architecture matches Shop Drawings.
 - e. Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.
12. For Each Workstation:
 - a. I/O point lists agree with naming conventions.
 - b. Graphics are complete.
 - c. UPS unit, if applicable, operates.

END OF SECTION

SECTION 262213
LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.
 - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat in accordance with manufacturer's published instructions within enclosure of ventilated-type units, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Square D; Schneider Electric USA.
- B. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.
- B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- C. Transformers Rated 15 kVA and Larger:
 - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.

2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
 1. One leg per phase.
 2. Core volume must allow efficient transformer operation at 10 percent above nominal tap voltage.
 3. Grounded to enclosure.
- C. Coils: Continuous windings without splices except for taps.
 1. Coil Material: Aluminum.
 2. Internal Coil Connections: Brazed or pressure type.
 3. Terminal Connections: Bolted.
- D. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.
- E. Enclosure: Ventilated.
 1. Core and coil must be encapsulated within resin compound using vacuum-pressure impregnation process to seal out moisture and air.
 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
 3. Wiring Compartment: Sized for conduit entry and wiring installation.
 4. Environmental Protection:
 - a. Indoor: UL 50E, Type 2.
 - b. Outdoor: UL 50E, Type 3R.
 5. Finish Color: Gray weather-resistant enamel.
- F. Taps for Transformers 3 kVA and Smaller: None.
- G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

- I. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.
- J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 150 deg C rise above 40 deg C ambient temperature.
- K. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.
- L. K-Factor Rating: Transformers indicated to be K-factor rated must comply with UL 1561 requirements for nonsinusoidal load current-handling capability to degree defined by designated K-factor.
 - 1. Unit may not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding indicated insulation class in 40 deg C maximum ambient and 24-hour average ambient of 30 deg C.
 - 2. Indicate value of K-factor on transformer nameplate.
 - 3. Unit must comply with requirements of DOE 2016 efficiency levels when tested in accordance with NEMA TP 2 with K-factor equal to one.
- M. Electrostatic Shielding: Windings must have independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - 2. Include special terminal for grounding shield.
- N. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.
- O. Wall Brackets: Manufacturer's standard brackets.
- P. Low-Sound-Level Requirements: Maximum sound levels when factory tested in accordance with IEEE C57.12.91, as follows:
 - 1. 9.00 kVA and Less: 40 dB(A-weighted).
 - 2. 9.01 to 30.00 kVA: 45 dB(A-weighted).
 - 3. 30.01 to 50.00 kVA: 45 dB(A-weighted) for K-factors of 1, 4, and 9.
 - 4. 50.01 to 150.00 kVA: 50 dB(A-weighted) for K-factors of 1, 4, and 9.

2.4 IDENTIFICATION

- A. Nameplates:

1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Testing Administrant: Engage qualified electrical testing agency to evaluate transformer.
- B. Factory Tests and Inspections: Test and inspect assembled system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.12.01 and IEEE C57.12.91 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance on control units.
 1. Resistance measurements of windings at rated voltage connections and at tap connections.
 2. Ratio tests at rated voltage connections and at tap connections.
 3. Phase relation and polarity tests at rated voltage connections.
 4. No load losses, and excitation current and rated voltage at rated voltage connections.
 5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
 6. Applied and induced tensile tests.
 7. Regulation and efficiency at rated load and voltage.
 8. Insulation-Resistance Tests:
 - a. Line-side to ground.
 - b. Load-side to ground.
 - c. Line-side to load-side.
 9. Temperature tests.
 10. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.
- C. Nonconforming Work:
 1. System equipment that does not pass tests and inspections will be considered defective.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer.
- E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- C. Secure transformer to concrete base in accordance with manufacturer's published instructions.
- D. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

- E. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Architect .
- B. Tests and Inspections:
 - 1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:
 - a. Visual and Mechanical Inspection.
 - 1) Inspect physical and mechanical condition.
 - 2) Inspect anchorage, alignment, and grounding.
 - 3) Verify that resilient mounts are free and that shipping brackets have been removed.
 - 4) Verify that unit is clean.
 - 5) Perform specific inspections and mechanical tests recommended by manufacturer.
 - 6) Verify that as-left tap connections are as specified.
 - 7) Verify presence of surge arresters and that their ratings are as specified.
 - b. Electrical Tests:
 - 1) Measure resistance at windings, taps, and bolted connections.

- 2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
 - 3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
 - 4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- C. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.
- D. Nonconforming Work:
1. Transformer will be considered defective if it does not pass tests and inspections.
 2. Remove and replace units that do not pass tests or inspections and retest as specified above.
- E. Assemble and submit test and inspection reports.
- F. Manufacturer Services:
1. Engage factory-authorized service representative to support field tests and inspections.

3.5 ADJUSTING

- A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.7 MAINTENANCE

- A. Infrared Scanning: Two months after Substantial Completion, perform infrared scan of transformer connections.
 - 1. Use infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform two follow-up infrared scans of transformers, one at four months and another at 11 months after Substantial Completion.
 - 3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION

SECTION 262413 SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Switchboards.
 - 2. Disconnecting and overcurrent protective devices.
 - 3. Control power.
 - 4. Accessory components and features.

1.2 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Switchboards.
 - 2. Overcurrent protective devices.
 - 3. Ground-fault protection devices.
 - 4. Accessories.
 - 5. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than UL 50E, Type 1.

3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.
8. Include diagram and details of proposed mimic bus.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field Quality-Control Reports:

- a. Test procedures used.
- b. Test results that comply with requirements.
- c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Handling, storing, and providing temporary heat.
2. Mounting accessories and anchoring devices.
3. Testing and adjusting overcurrent protective devices.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts: Furnish to Owner spare parts, for repairing switchboards, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
 - 1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
 - 2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
- B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to switchboards, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
 - 1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
 - 2. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards.
- C. Handle and prepare switchboards for installation in accordance with NEMA PB 2.1.

1.8 WARRANTY

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed switchboard perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.
 - 1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Square D; Schneider Electric USA.
 - 2. Eaton
 - 3. Siemens
 - 4. GE
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- E. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.
- H. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Fixed, individually mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- I. Indoor Enclosures: Steel, UL 50E, Type 1.
- J. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over rust-inhibiting primer on treated metal surface.
- K. Outdoor Enclosures: Type 4X.

1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
 2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.
- L. Barriers: Between adjacent switchboard sections.
- M. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- N. Customer Metering Compartment: Separate customer metering compartment and section with front hinged door, and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring must be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- O. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- P. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws, for access to rear interior of switchboard.
- Q. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- R. Buses and Connections: Three phase, four wire unless otherwise indicated.
1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from front of switchboard.
 2. Phase- and Neutral-Bus Material:
 - a. Hard-drawn copper of 98 percent conductivity, silver-plated.
 3. Copper feeder circuit-breaker line connections.
 4. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
 5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 6. Disconnect Links:
 - a. Isolate neutral bus from incoming neutral conductors.

- b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
- 7. Neutral Buses: 100 percent of ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- 8. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- S. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- T. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long and short time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
 - 6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30 mA trip).
 - 7. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.

- b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Communication Capability: Universal-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 26 09 13 "Electrical Power Monitoring and Control."
 - g. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - i. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
- B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
- 1. Fixed circuit-breaker mounting.
 - 2. Two-step, stored-energy closing.
 - 3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Time adjustments for long- and short-time pickup.
 - c. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - 5. Remote trip indication and control.
 - 6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring

and control system specified in Section 26 09 13 "Electrical Power Monitoring and Control."

7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.

2.3 INSTRUMENTATION

- A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
 - d. Megawatts: Plus or minus 1 percent.
 - e. Megavars: Plus or minus 1 percent.
 - f. Power Factor: Plus or minus 1 percent.
 - g. Frequency: Plus or minus 0.1 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

- B. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording 15-minute integrated demand of totalized system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards in accordance with NEMA PB 2.1.
 - 1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's published instructions.
 - 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
 - 3. Protect from moisture, dust, dirt, and debris during storage and installation.
 - 4. Install temporary heating during storage in accordance with manufacturer's published instructions.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect performance of equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

3.3 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 2.1.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:

1. Equipment Mounting: Install switchboards on concrete base, 4 inch nominal thickness. Comply with requirements for concrete base specified in Section 26 05 29 "Hangers and Supports for Electrical Systems."
 - a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend 2 inch above concrete base after switchboard is anchored in place.
 - b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around full perimeter of concrete base.
 - c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.
 - e. Install anchor bolts to elevations required for proper attachment to switchboards.
 - f. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.
2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
3. Operating Instructions: Frame and mount printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
4. Install filler plates in unused spaces of panel-mounted sections.
5. Install overcurrent protective devices, surge protection devices, and instrumentation.
 - a. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

- A. Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.
- B. Support and secure conductors within switchboard in accordance with NFPA 70.

- C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.5 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 26 01 20 "Equipment Identification."
- B. Switchboard Nameplates: Label each switchboard compartment with nameplate complying with requirements for identification specified in Section 26 01 20 "Equipment Identification."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with nameplate complying with requirements for identification specified in Section 26 01 20 "Equipment Identification."
- D. Service Equipment Label: Labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

3.6 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Architect.
- B. Tests and Inspections:
 - 1. Acceptance Testing:
 - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
 - b. Test continuity of each circuit.
 - 2. Test ground-fault protection of equipment for service equipment in accordance with NFPA 70.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Perform the following infrared scan tests and inspections, and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Nonconforming Work:

1. Switchboard will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Collect, assemble, and submit test and inspection reports, including certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

E. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.7 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "Coordination Studies."

3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature in accordance with manufacturer's published instructions, until switchboard is ready to be energized and placed into service.

END OF SECTION

SECTION 262419
MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SCOPE

- A. The Contractor shall furnish and install the motor control centers as specified herein and as shown on the contract drawings.

1.02 REFERENCES

- A. The Motor Control Centers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA, ANSI and UL 845.

1.03 SUBMITTALS – FOR REVIEW/APPROVAL

- A. The following information shall be submitted to the Engineer:
 - 1. Master drawing index
 - 2. Front view elevation
 - 3. Floor plan
 - 4. Top view
 - 5. Unit wiring diagrams
 - 6. Nameplate schedule
 - 7. Starter and component schedule
 - 8. Conduit entry/exit locations
 - 9. Assembly ratings including:
 - a. Short-circuit rating
 - b. Voltage
 - c. Continuous current
 - 10. Major component ratings including:
 - a. Voltage
 - b. Continuous current
 - c. Interrupting ratings
 - 11. Cable terminal sizes
 - 12. Product data sheets
- B. Where applicable the following information shall be submitted to the Engineer:
 - 1. Busway connection
 - 2. Connection details between close-coupled assemblies
 - 3. Key interlock scheme drawing and sequence of operations

1.04 SUBMITTALS – FOR CONSTRUCTION

- A. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process
2. Unit wiring diagrams
3. Certified production test reports
4. Installation information
5. Seismic certification and equipment anchorage details as specified

1.05 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. Provide Seismic tested equipment as follows:
 1. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest International Building Code (IBC).
 2. The Project Structural Engineer will provide site specific ground motion criteria for use by the manufacturer to establish SDS values required.
 3. The IP rating of the equipment shall be 1.5
 4. The Structural Engineer for the Site will evaluate the SDS values published on the Manufacturer's website to ascertain that they are "equal to" or "greater than" those required for the Project Site.
 5. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
 6. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.
 - a. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.
 - b. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

1.06 REGULATORY REQUIREMENTS

- A. The motor control centers shall bear a UL label. Certified copies of production test reports shall be supplied demonstrating compliance with these standards when requested by the Engineer.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.08 OPERATION AND MAINTENANCE MANUALS

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton
- B. Square D
- C. Siemens
- D. GE

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the engineer ten (10) days prior to bid date.

2.02 RATINGS

- A. The Motor Control Center(s) shall be 600-volt class suitable for operation on a three-phase, 60 Hz system. The system operating voltage and number of wires shall be as indicated on the drawings.

2.03 CONSTRUCTION

- A. Structures shall be totally enclosed, dead-front, free-standing assemblies. They shall be 90 inches high and 16 inches deep for front-mounted units.
- B. A vertical wireway with minimum of 35 square inches of cross-sectional area shall be adjacent to each vertical unit and shall be covered by a hinged door. Wireways shall contain steel rod cable supports.
- C. All draw-out units shall be secured by a spring-loaded, quarter turn, indicating type fastening device located at the top front of the unit. With the exception of the dual-mounted units, each unit compartment shall be provided with an individual front door.
- D. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access, unless the disconnect is in the "OFF" position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. A second interlock shall be provided to prevent removal or reinsertion of the unit while in the "ON" position. Padlocking facilities shall be provided to positively lock the disconnect in the "OFF" position with up to three (3) padlocks with the door open or closed. In addition, means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.

2.04 BUS

- A. Each structure shall contain a main horizontal tin-plated copper bus, with minimum ampacity of as shown on the drawings.
- B. Buses shall be braced for 100,000 amperes RMS symmetrical.

2.05 WIRING/TERMINATIONS

- A. Wiring shall be NEMA Class II Type B

2.06 MOTOR CONTROLLERS

- A. Combination starter units shall be full-voltage non-reversing (FVNR) NEMA Size 2 for motor horsepower below 20HP, and shall utilize HMCP Motor Circuit Protectors.

B. Motor Starters

- 1. FVNR starters through NEMA Size 1 and larger shall be equipped with double-break silver alloy contacts. The starter must have straight-through wiring. Each starter shall have a minimum of one (1) normally open auxiliary contact.
- 3. Solid-State Motor Management Relay- With Ethernet/IP Control
 - a. Where indicated on the drawings, provide a Solid-State Overload Relay (SSOL) in each starter and/or where indicated on the drawings for protection, control and monitoring of the motors.
 - b. The SSOL shall provide both protection and control functionality. SSOL shall provide pre-defined operation modes which define input and output behavior if used. The following functionality shall support protection and control.

1. NEMA Size 00 through 2 starters shall be suitable for the addition of at least six (6) external auxiliary contacts of any arrangement normally open or normally closed. Size 3 through 8 starters shall be suitable for the addition of up to eight (8) external auxiliary contacts of any arrangement normally open or normally closed.

- C. Each starter shall be equipped with a fused control power transformer, two (2) indicating lights, Hand-Off-Auto (HOA) selector switch, and two (2) normally open contacts, unless otherwise scheduled on the drawings. A unit-mounted device panel shall have space to accommodate six (6) 30 mm oil-tight pilot-control devices or indicating ammeters, voltmeters, or elapsed time meters. In order to improve maintenance capabilities, the device panel shall withdraw with the unit. Door-mounted pilot devices are not acceptable.

2.07 OVERCURRENT DEVICES

A. Circuit Breakers

- 1. Individual feeder breakers shall have a minimum interrupting capacity of 65 kAIC at rated voltage or as scheduled on the drawings.

B. ETHERNET/IP DEVICES

- 1. NEMA Starters Size 3 and larger shall be provided with a factory assembled EtherNet/IP field bus communications network providing direct connectivity between MCC devices and the system controller and/or HMI.

2. Ethernet 10/100 auto negotiate layer 2 managed industrial switches shall be provided as required in the MCC lineup. The Ethernet switch shall have sufficient ports available to connect to each EtherNet/IP device and have at least 2 open ports for a customer connection and a PC connection for maintenance. The Ethernet switch shall be mounted in the top removable unit of each vertical section or shipping split and not in the vertical wireway. If required by the application, the switch shall be capable of connecting to multiple sections.
3. The EtherNet/IP system installed in the MCC shall include a complete and tested cabling system. The cabling system shall be 600V Cat 5 and consist of home run connections from the device to a switch located in the MCC and in accordance with the ODVA specification. Non-standard, non-shielded cable will not be accepted.
4. It shall be permissible to daisy chain Ethernet/IP devices using a 2-port switch configuration in each device unit or bucket and not use the home run topology.
5. All cabling shall be securely supported and attached to the MCC structure in accordance with the contract drawings and the manufacturer's recommendations.
6. EtherNet/IP communications modules shall be provided at each device interfacing to the EtherNet/IP field bus. The communications modules shall be installed in the unit device compartment or bucket, and shall be direct-connected to the EtherNet/IP Ethernet cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated EtherNet/IP device.

2.08 ENCLOSURES

- A. The type of enclosure shall be in accordance with NEMA standards for type 1A with gasketed doors

2.09 NAMEPLATES

- A. Each unit will have a 1.0 x 2.5-inch engraved nameplate. The lettering shall be 3/16-inch high, black on a white background.

2.10 FINISH

- A. The control center shall be given a phosphatizing pretreatment. The paint coating shall be a polyester urethane, thermosetting powder paint. Manufacturer's standard color shall be used. All structural steel and panels will be painted.
- B. The control center finish shall pass 600 hours of corrosion-resistance testing per ASTM B 117.

PART 3 EXECUTION

3.01 FACTORY TESTING

- A. Representative motor control centers shall have been tested in a high-power laboratory to prove adequate mechanical and electrical capabilities.
- B. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed.
- C. A certified test report of all standard production tests shall be available to the Engineer upon request.

- D. The owner's representative shall witness factory tests as outlined above
 - 1. The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed.

3.02 FIELD QUALITY CONTROL

- A. Provide the services of a qualified factory-trained manufacturer's representative to perform startup of the equipment specified under this section.
- B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative:
 - 1. Rig the MCC assembly into final location and install on level surface
 - 2. Check all removable cells and starter units for easy removal and insertion
 - 3. Perform insulation tests on each phase and verify low-resistance ground connection on ground bus
 - 4. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.03 TRAINING

- A. The Contractor shall provide a training session for up to five (5) owner's representatives for 2 normal workdays at the job site or other office location chosen by the owner.
- B. A manufacturer's qualified representative shall conduct the training session.
- C. The training program shall consist of the following:
 - 1. Review of the MCC one-line drawings and schedules
 - 2. Review of the factory record shop drawings and placement of the various cells
 - 3. Review of each type of starter cell, components within, control, and power wiring
 - 4. Review contactor coil replacement and contact replacement procedures
 - 5. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program
 - 6. Provide three-ring binders to participants complete with copies of drawings and other course material covered

3.04 EXAMINATION

- A. Contractor shall fully inspect shipments for damage and report damage to manufacturer and file claim upon shipper, if necessary.
- B. Contractor shall supply overload relay heater ratings that are properly sized and coordinated for each motor starter unit.

3.05 INSTALLATION

- A. Contractor shall follow the installation instructions supplied by the manufacturer.
- B. Control wiring shall be as shown on the contract drawings except as modified by the approval and submittal process. Interface all local and remote devices into the control wiring and operational systems for each load.

- C. As Shown on the contract drawing, Contractor is to provide all DeviceNet trunk and drop cabling with threaded, sealed and keyed device taps external to the MCC.

3.06 FIELD ADJUSTMENTS

- A. The Contractor shall perform field adjustments of the short circuit and overload devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study, protective device coordination study, manufacturer's instruction leaflets, and the contract documents.

3.07 FIELD TESTING

- A. Contractor is responsible for generation of a field report on tests performed, test values experienced, etc., and make the report available to owner upon request.

END OF SECTION

**SECTION 262550
GENERATOR DOCKING STATION**

PART 1 GENERAL

- 1.1. GENERAL
- 1.2. QUALITY ASSURANCE
 - A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - B. ETL/UL LISTED to 1008 Standards
 - C. UL 50 LISTED
- 1.3. COORDINATION
 - A. Coordinate layout and installation of Generator Docking Station, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels
- 1.4. GUARANTEE/WARRANTY
 - A. Manufacturer Warranty shall be provided for a minimum of 1 Year,
 - B. The equipment installed under this contract shall be left in proper working order
 - C. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished.

PART 2 PRODUCTS

- 2.1. DOCKING STATION
 - A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. TRYSTAR or prior approved equal.
- 2.2. GENERAL REQUIREMENTS
 - A. Enclosure

1. NEMA 4X Rain-Tight Stainless Steel Enclosure
 - i. Pad-lockable front door shall include a hinged access plate at the bottom for entry of temporary cabling that prevents unauthorized tampering while in use.
 - ii. NEMA 4X Integrity shall be maintained while temporary cabling is connected during use
 - iii. Front and Side shall be accessible for maintenance
 - iv. Top, Side, and Bottom shall be accessible for permanent cabling
2. Powder coat
 - i. Paint after fabrication shall be Hammer tone Gray
- B. Phase, Neutral, and Ground Busbar
 1. Material: Silver-plated Copper
 2. Equipment Ground Bus: bonded to box.
 3. Isolated Ground Bus: insulated from box.
 4. Ground Bus: 50% of phase size.
 5. Neutral Bus: Neutral bus rated 100 percent of phase bus.
- C. Temporary generator and loadbank connectors shall be Camlok style mounted on gland plate.
 1. Temporary Generator Camloks shall be Male, 16 Series model and color coded according to system voltage requirements.
 2. Loadbank Camloks shall be Female, 16 Series model and color coded according to system voltage requirements
 3. Camlok connections shall be Bus Bar Style, Cabling or Double Set Screw is not acceptable
 4. Camlok connection shall be protected against accidental contact while not in use
- D. Permanent Connection shall be factory installed broad range set-screw mechanical type, located behind a physical barrier

- E. Short Circuit & Withstand Rating
 - 1. Shall be minimum 65 KAIC unless otherwise indicated on drawings
- F. Voltage & Amperage
 - 1. 480/277VAC Three-Phase, Four-Wire + Ground, 1600A
- G. Factory Installed Phase Rotation Monitor Device:
 - 1. Phase monitoring relay to be Siemens 3U4512-1AR20 or equal and factory installed.
- H. Additional accessories shall be included in submittal drawing as follows:
 - A: Two Wire Auto Start
 - C: Battery Charger Receptacle 20A GFCI 125V
 - D: Block Heater Receptacle 30A L5-30 125V
 - K#: Kirk Key Door Interlock
 - I: NEMA-4X
 - S: Silver-Plated Bus

PART 3 EXECUTION

3.1. EXAMINATION

- A. Examine elements and surfaces to receive Generator Docking Station for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2. INSTALLATION

- A. Surface, Flush or Base Mounted: Determined by Application
 - 1. Install anchor bolts to elevations required for proper attachment to Generator Docking Station.

3.3. IDENTIFICATION

- A. Comply with requirements in Division 26.

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

C. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4. FIELD QUALITY CONTROL

A. Third Party Tests and Inspections to include the following:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

B. Prepare test and inspection reports, including a certified report that identifies Generator Docking Station and that describes scanning results. Include notation

END OF SECTION

F. PLUMBING

SECTION 220500
BASIC PLUMBING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PE: Polyethylene plastic.
 - 4. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- C. All items provided under this Contract shall be of the latest model. No outdated and/or discontinued items will be permitted.
- D. No asbestos products will be permitted on the jobsite or within anything installed at the jobsite.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.6 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate requirements and provide access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.
- C. Any work that can result in an interruption to the operation of existing mechanical systems shall only be performed with the approval and coordination the Owner and/or Architect.

PART 2 - PRODUCTS

2.1 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- C. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

2.2 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:

- a. Eslon Thermoplastics.

2.3 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- C. Split-Plate, Stamped-Steel Type: With exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.

2.4 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.

- g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
- M. Sleeves and seals required for penetrations of vertical & horizontal wall planes adjacent to grade. Unless noted otherwise noted on the Structural or Mechanical sheets and specifications.
 - N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials per UL listed detail and firestop specification section. Refer to specification sections for "Through-Penetration Firestop Systems".
 - O. Verify final equipment locations for roughing-in.
 - P. Refer to equipment specifications in other Sections of these Specifications and Manufacturer's data sheets and Installation Operation Maintenance manual for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

3.3 PIPING CONNECTIONS

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

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

3.5 PAINTING

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

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic requirements for Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.
4. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
5. Use 4000-psi, 28-day compressive-strength concrete and reinforcement if not otherwise noted.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place miscellaneous primed or galvanized metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1.
- C. Painting: exposed steel and welds to be primed or repaired w/ galvanized zinc paint.

3.8 GROUTING

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

END OF SECTION 220500

SECTION 220517
SLEEVES AND SLEEVE SEALS FOR PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Grout.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Jay R. Smith
 - 2. Zurn Products

3. MiFab

- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.
- C. Not required for core drilled floor penetrations or structural sleeved locations. All penetrations shall have firestop per UL listed assembly detail match T & F assembly rating.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. GPT Industries
 - 2. Advance Products & Systems,
 - 3. Metraflex Company (The).
 - 4. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon Steel or Stainless Steel.
 - 3. Connecting Bolts and Nuts: Corrosion resistant coated carbon steel or stainless steel of length required to secure pressure plates to sealing elements.

2.4 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 4000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1" annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes above grade.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2" above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior CMU and/or Fire Rated partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide ¼" min ½" max annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- E. Penetrations in Fire Rated Assemblies: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements specified in project specification section covering Firestopping.

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide ¼" min ½" max annular clear space between sleeve and pipe or pipe insulation.

2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements specified in specification section "Waterproofing..."
 3. Install section of cast-iron soil pipe to extend sleeve to 2" above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using grout, seal the space around outside of stack-sleeve fittings.
- A. Penetrations in Fire Rated Assemblies: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements specified in project specification section covering Firestopping.

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size per manufacturer's installation instructions.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 8: Galvanized wall sleeves.
 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 10: Galvanized-steel wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 10: Galvanized-steel pipe sleeves with sleeve-seal system.

- 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 8: Stack-sleeve fittings.
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

END OF SECTION

SECTION 220519
METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Liquid-in-glass thermometers.
 - 2. Thermowells.
 - 3. Dial-type pressure gages.
 - 4. Gage attachments.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 - a. Miljoco Corporation.
 - b. Palmer Wahl Instrumentation Group.
 - c. Terice, H. O. Co.
 - d. Weiss Instruments, Inc.
 - e. Winters Instruments - U.S.
 - 2. Standard: ASME B40.200.
 - 3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
 - 4. Case Form: Adjustable angle.
 - 5. Tube: Glass with magnifying lens and blue organic liquid for cold water systems and red organic liquid for hot water systems.
 - 6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Window: Glass or plastic
 - 8. Stem: Aluminum and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

- A. Thermowells:
 1. Standard: ASME B40.200.
 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 3. Material for Use with Copper Tubing: CNR
 4. Material for Use with Steel Piping: CSA
 5. Type: Stepped shank unless straight or tapered shank is indicated.
 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
 7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
 8. Bore: Diameter required to match thermometer bulb or stem.
 9. Insertion Length: Length required to match thermometer bulb or stem.
 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

2.3 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Liquid-Fillable Pressure Gages:
 1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Miljoco Corporation.
 - c. Trerice, H. O. Co.
 - d. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - e. Weiss Instruments, Inc.
 - f. Winters Instruments - U.S.
 2. Standard: ASME B40.100.
 3. Case: Liquid-filled Sealed; min 3" nominal diameter.
 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 5. Pressure Connection: Brass, with NPS 1/4 ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 6. Movement: Mechanical, with link to pressure element and connection to pointer.
 7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi and kPa.
 8. Pointer: Dark-colored metal.

- 9. Window: Glass
- 10. Ring: Metal
- 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass ball with NPS 1/4 ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- E. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- F. Install valve and snubber in piping for each pressure gage for fluids.
- G. Install thermometers in the following locations:
 - 1. Inlet, outlet and circulation piping of each electric water heater.
 - 2. Inlets and outlets of each Boiler.
- H. Install pressure gages as shown in drawing details and in the following locations:
 - 1. Building water service entrance into building.
 - 2. Inlet and outlet of each pressure-reducing valve.
 - 3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe hangers and supports for Mechanical Piping.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Fastener systems.
 - 5. Equipment supports.
- B. See Division 21 Section "Fire-Suppression Piping" for fire protection piping.
- C. See Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

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

1.4 SUBMITTALS

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

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Equipment supports.

C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
1. AAA Technology & Specialties Co., Inc.
 2. Bergen-Power Pipe Supports.
 3. B-Line Systems, Inc.; a division of Cooper Industries.
 4. Carpenter & Paterson, Inc.
 5. Empire Industries, Inc.
 6. ERICO/Michigan Hanger Co.
 7. Globe Pipe Hanger Products, Inc.
 8. Grinnell Corp.
 9. GS Metals Corp.
 10. National Pipe Hanger Corporation.
 11. PHD Manufacturing, Inc.
 12. PHS Industries, Inc.
 13. Piping Technology & Products, Inc.

14. Tolco Inc.

- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.3 TRAPEZE PIPE HANGERS

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

2.4 FASTENER SYSTEMS

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

2.5 EQUIPMENT SUPPORTS

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

2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- B. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- D. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
 - 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
 - 3. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
 - 4. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
 - 5. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
- E. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
- F. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
- G. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 4. C-Clamps (MSS Type 23): For structural shapes.
 5. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- H. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- I. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- J. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- K. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- L. Insulated Piping: Comply with the following:
 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - 3.
 4. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 5.
 6. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.

- c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 7.
 - 8. Insert Material: Length at least as long as protective shield.
 - 9.
 - 10. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

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

3.4 METAL FABRICATIONS

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

3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 220533
IDENTIFICATION FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following mechanical identification materials and their installation:
 - 1. Equipment labels.
 - 2. Pipe markers.
 - 3. Valve tags.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 COORDINATION

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

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.
- B. All items provided under this Contract shall be of the latest model. No outdated and/or discontinued items will be permitted.
- C. No asbestos products will be permitted on the jobsite or within anything installed at the jobsite.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - a. All data on label shall be permanent and shall be either stamped or engraved into the metal. Engraving shall be machine applied. Hand engraving is not be acceptable.
4. Fasteners: Stainless-steel rivets or self-tapping screws.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Attachment: Stainless-steel self-tapping screws or contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 PIPING IDENTIFICATION DEVICES

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

1. Colors: Comply with ASME A13.1, unless otherwise indicated.

2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
 3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
 4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
 5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
- B. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.
- C. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 VALVE IDENTIFICATION DEVICES

- A. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: Black.
 3. Background Color: White.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

- A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.3 EQUIPMENT IDENTIFICATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible and not exposed to direct sunlight.
- C. Equipment label installation requirements:
 - 1. Plastic Labels:
 - a. Electric Water Heaters.
 - b. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - c. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

3.4 PIPING IDENTIFICATION

- A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
 - 1. Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, 1-1/2 inches wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
 - 2. Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.
- B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as furred wall chase and plenums; and exterior nonconcealed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

3.5 VALVE IDENTIFICATION

- A. Install manufactured markers on ceiling grid runner with self-tapping white screws indicating location of above ceiling valve.

3.6 ADJUSTING AND CLEANING

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.
- B. Clean faces of mechanical identification devices.

END OF SECTION

**SECTION 220719
PLUMBING INSULATION**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials & Accessories

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000 Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

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

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
2. Color: White.

2.3 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.4 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.5 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

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

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.

3.4 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather

mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 MINERAL-FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.6 FINISHES

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

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

- C. Do not field paint aluminum or stainless-steel jackets.

3.7 FIELD QUALITY CONTROL

- A. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 PIPING INSULATION SCHEDULE, GENERAL

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

3.9 INDOOR PIPING INSULATION SCHEDULE

- A. All sizes in Domestic Water Cold, Makeup Water, Roof Drainage Piping, and Hot(Potable) NPS 1.25" and smaller insulation shall be the following:
 - 1. Mineral-Fiber ASJ-SSL, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 2. Provide service label per plumbing identification specification.
- B. Domestic Water, Hot(Potable) NPS 1.5" and larger, shall be the following:
 - 1. Mineral-Fiber ASJ-SSL, Preformed Pipe Insulation, Type I: 2 inch thick.
 - 2. Provide service label per plumbing identification specification.
- C. Condensate: Insulation shall be the following:
 - 1. Flexible Elastomeric Thermal Insulation: 1 inch thick.
 - 2. Provide service label per plumbing identification specification.
- D. Plumbing Traps and Roof Drain Bodies in ceiling plenum areas insulation shall be the following:
 - 1. Flexible Elastomeric Thermal Insulation: 1 inch thick.
 - 2. Provide service label per plumbing identification specification.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Insulation shall be the following:
 - 1. Polyolefin, 1/2 inch thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Concealed Fittings:
 - 1. PVC: 20 mils thick fitting insulation covers.
- B. Exposed Piping & Fittings in exposed ceiling areas, mechanical and utility rooms:
 - 1. PVC: 30 mils thick pipe jacketing and fitting insulation covers.
 - 2. Color: As selected by the Architect from basic (standard) color chart.

END OF SECTION

SECTION 221116
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes domestic water piping from locations indicated to fixtures and equipment inside the building.

1.2 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing domestic water piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Domestic Water Distribution Piping: 125 psig.

1.3 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Sample of Water quality cleaning test reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Sample of Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Water quality cleaning test reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data for valves.
- B. Water quality cleaning test reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

1.6 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 CPVC CORZAN PIPING

- A. Plenum Rated Rigid CPVC (chlorinated polyvinyl chloride) CPVC Schedule 80 pipe that complies with the material requirements of ASTM D1784 and has a cell classification of 24448.
- B. Rigid CPVC used in the manufacturing of Schedule 80 Fittings shall meet the material requirements of ASTM D1784 and have a cell classification of 23447.
 - 1. Raw material used in the manufacturing shall contain the standard specified amounts of color pigment, stabilizers, and other additives. The compounds used are listed to the requirements of NSF 61 for use in potable water service.
 - 2. The compound must be Corzan grade. The pipe compound shall be listed and labelled as having a Flame Spread Index (FSI) of not more than 25 and a Smoke Developed Index (SDI) of not more than 50 when tested in general accordance with ASTM E84 or UL 723.
- C. Pipe, fittings and valves shall be compatible, manufactured using Corzan compound and be produced by one manufacturer

2.3 CPVC CORZAN FITTINGS

- A. Plenum Rated CPVC Schedule 80 pipe shall meet or exceed the requirements of ASTM F441. Physical dimensions and properties of CPVC Schedule 80 fittings socket type shall meet the requirements of ASTM F439. Physical dimensions and properties of CPVC special engineered fittings shall meet the requirements of ASTM F1970. CPVC fittings must be third party certified to NSF 14.

- B. All CPVC Schedule 80 fittings from 1/2" to 6" shall be made with a CPVC compound having a minimum cell classification of 23447.
- C. CPVC fitting compound shall be pressure rated in accordance with ASTM D2837 and have a hydrostatic design basis of 4000 psi at 72°F and 1000 psi at 180°F as listed in PPI publication TR-4. All CPVC Schedule 80 pipe and fittings shall be made from a 4000 psi HDB PPI rated compound.
- D. CPVC Schedule 80 socket fittings shall conform to ASTM F439.
- E. CPVC flanges shall have a 150-lbs bolt pattern as per ANSI B16.5 and conform to ASTM F1970 with pressure ratings of 150psi at 73°F.
- F. CPVC Schedule 80 unions socket shall conform to ASTM F439 and meet ASTM F1970 with pressure ratings of 150 psi at 73°F.

2.4 CPVC SDR 11 PIPING

- A. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.
 - 1. Manufacturers:
 - a. Lubrizol; FlowGuard Gold CPVC CTS Domestic Cold and Hot Water Service.

2.5 COPPER TUBING

- A. Soft Copper Tube: ASTM B 88, Types K, water tube, annealed temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.6 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. IPEX
 - b. GF Piping
 - c. Spears Manufacturing Company.
2. Description:
 - a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
 1. NPS 1/2 to 1 1/2 : CPVC SDR 11 CTS
 2. NPS 2 to NPS 6: CPVC Corzan Sch 80 socket type and flanged piping and fittings.
- B. Below Concrete Slab Domestic Water Piping: Use the following piping materials for each size range:
 1. NPS 2 and Smaller: Soft annealed copper tube, Type K; complying with ASTM B-75, B-88 and B-68. No joints below slab permitted.

3.2 PIPING INSTALLATION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping installation.
- B. Install copper tubing according to CDA's "Copper Tube Handbook.
- C. Install domestic water piping level and plumb unless otherwise indicated.

3.3 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Solvent welded, threaded and flanged system joints for the CPVC Potable System should be made using primers and CPVC heavy-bodied, medium setting cements that meet or

exceed the requirements of ASTM F656 and ASTM F493 respectively. Follow all solvent welding instructions provided by Manufacturer's CPVC Potable Water Piping System Technical Manual..

3.4 VALVE INSTALLATION

- A. Install sectional valve close to water main on each branch and riser serving plumbing fixtures or equipment.
- B. Specific valve duty, the following requirements apply:
 - 1. Shutoff Duty:
 - a. Use CPVC one piece valves for 1" and smaller.
 - b. Use threaded CPVC true union ball valve NPS 1 1/4" through 3" diameter.
 - c. Use lug-style lead free NSF 61 listed butterfly valves for NPS 4 and larger.
 - 2. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
 - 3. Drain Duty: Hose-end drain valves.
- C. Use check valves to maintain correct direction of domestic water flow to and from equipment.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Refer to Division 22 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
 - 1. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
- B. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
- C. CPVC Manufacturer's recommendations for recommended spacing should not be exceeded.
 - 1. At a minimum, install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - a. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
 - b. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
 - c. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
 - d. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 - e. NPS 6: 48 inches with 3/4-inch rod.
 - f. NPS 8: 48 inches with 7/8-inch rod.

- D. Install supports for vertical CPVC piping per manufacturer's IOM but no less than every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2- 2 1/2": 8 feet with 1/2-inch rod.
 - 4. NPS 3: 10 feet with 1/2-inch rod.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.

3.7 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
 - 1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of engineer and authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange for final inspection by engineer and authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If engineer and/or authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- B. Test domestic water piping as follows:
 - 1. Test per CPVC recommendations.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave uncovered and unconcealed new, altered, extended, or replaced domestic water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

3.8 CLEANING

- A. As work progresses, clean interior of domestic water piping system by removing dirt and debris.
 1. Clean and disinfect potable domestic water piping as follows:
- B. Purge new domestic water piping.
 1. Use purging and disinfecting procedures described in either AWWA C651 or AWWA C652.
 2. Take multiple samples in each building at dead-end legs after flushing procedures.
 3. Prepare and submit Laboratory Testing Reports of purging and disinfecting activities. Include copies of water-sample approvals from laboratory test for each sample, including chain of custody, to Engineer of Record.

END OF SECTION

SECTION 221119
PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following plumbing specialties:

1. Backflow preventers.
2. Water regulators.
3. Strainers.
4. Key-operation hydrants.
5. Drain valves.
6. Miscellaneous piping specialties.
7. Flashing materials.
8. Cleanouts.
9. Floor drains.

1.2 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:

1. Domestic Water Piping: 125 psig.
2. Sanitary Waste and Vent Piping: 10-foot head of water.

1.3 SUBMITTALS

A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:

1. Backflow preventers and water regulators.
2. Balancing valves, water filters, and strainers.
3. Water hammer arresters, air vents, and trap seal primer valves and systems.
4. Drain valves, hose bibbs, hydrants, and hose stations.
5. Outlet boxes and washer-supply outlets.
6. Cleanouts & floor drains.
7. Roof flashing assemblies.

- B. Field test reports.
- C. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:
 - 1. Backflow preventers
 - 2. Water regulators.
 - 3. Hose bibbs
 - 4. Hydrants
 - 5. Cleanouts
 - 6. Floor Drains.

1.4 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.
- E. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components. Include marking "NSF-pw" on plastic potable-water piping and "NSF-dwv" on plastic drain, waste, and vent piping.
 - 2. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Operating Key Handles: Equal to 100 percent of amount installed for each key-operated hose bibb and hydrant installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 BACKFLOW PREVENTERS

- A. Equal Manufacturers:
 1. Ames Co., Inc.
 2. Conbraco Industries, Inc.
 3. Mueller Co.; Hersey Meters Div.
 4. Watts Industries, Inc.; Water Products Div.
- B. General: ASSE standard, backflow preventers.
 1. NPS 2 and Smaller: Bronze body with threaded ends.
 2. Interior Components: Corrosion-resistant materials.
 3. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.
 4. Strainer: On inlet, if indicated.
 5. Shall be completely serviceable from the top.
- C. Hose-Connection Vacuum Breakers: ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7, garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.
- D. Intermediate Atmospheric-Vent Backflow Preventers: ASSE 1012, suitable for continuous pressure application. Include inlet screen and two independent check valves with intermediate atmospheric vent.
- E. Double-Check Backflow Prevention Assemblies: ASSE 1015, suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; test cocks; and two positive-seating check valves.

1. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

2.3 WATER REGULATORS

A. Equal Manufacturers:

1. Conbraco Industries, Inc.
2. Watts Industries, Inc.; Water Products Div.

B. General: ASSE 1003, water regulators, rated for initial working pressure of 150 psig minimum. Include integral factory-installed or separate field-installed, Y-pattern strainer.

1. NPS 3 and Smaller: Bronze body with threaded ends.
 - a. General-Duty Service: Single-seated, direct operated, unless otherwise indicated.
 - b. Boiler Heater Water Supply: Single-seated, direct operated with integral bypass.
2. Interior Components: Corrosion-resistant materials.
3. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.

2.4 STRAINERS

A. Equal Manufacturers:

1. Ames Co., Inc.
2. Conbraco Industries, Inc.
3. Mueller Co.; Hersey Meters Div.
4. Watts Industries, Inc.; Water Products Div.

B. Strainers: Y-pattern, unless otherwise indicated, and full size of connecting piping. Include ASTM A 666, Type 304, stainless-steel screens with 3/64-inch round perforations, unless otherwise indicated.

1. Pressure Rating: 125-psig minimum steam working pressure, unless otherwise indicated.
2. NPS 3 and Smaller: Bronze body, with female threaded ends.
3. NPS 4 and Larger: Cast-iron body, with interior AWWA C550 or FDA-approved, epoxy coating and flanged ends.
4. Y-Pattern Strainers: Screwed screen retainer with centered blowdown.

- a. Drain: Factory- or field-installed, hose-end drain valve.
- 5. T-Pattern Strainers: Malleable-iron or ductile-iron body with grooved ends; access end cap with drain plug and access coupling with rubber gasket.
- 6. Basket Strainers: Bolted flange or clamp cover, and basket with lift-out handle.
 - a. Type: Simplex with one basket.
 - b. Drain: Factory- or field-installed, hose-end drain valve.

2.5 KEY-OPERATION HYDRANTS

- A. Equal Manufacturers:
 - 1. Woodford Mfg
 - 2. JR Smith
 - 3. Watts Mfg
 - 4. Conbraco Industries
- B. General: ASME A112.21.3M, key-operation hydrant with pressure rating of 125 psig.
 - 1. Inlet: NPS 3/4 or NPS 1 threaded or solder joint.
 - 2. Outlet: ASME B1.20.7, garden-hose threads.
 - 3. Operating Keys: One with each key-operation hydrant.

2.6 DRAIN VALVES

- A. Hose-End Drain Valve: MSS SP-80, gate valve, Class 125, ASTM B 62 bronze body, with NPS 3/4 threaded or solder-joint inlet and ASME B1.20.7, garden-hose threads on outlet and cap. Hose bibbs are prohibited for this application.

2.7 MISCELLANEOUS PIPING SPECIALTIES

- A. Water Hammer Arresters: ASSE 1010 or PDI-WH 201, piston type with pressurized metal-tube cushioning chamber. Sizes indicated are based on ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.
- B. Roof Flashing Assemblies: Manufactured assembly made of 6-lb/sq. ft., 0.0938-inch- thick, lead flashing collar and skirt extending at least 10 inches from pipe with galvanized steel boot reinforcement, and counterflashing fitting. Coordinate with roofing manufacturer.

1. Open-Top Vent Cap: Without cap.

2.8 CLEANOUTS

- A. Equal Manufacturers:
 1. JR Smith
 2. MiFab
 3. Zurn Industries
 4. Watts
- B. See the Plumbing Schedule on drawings for variations.
- C. Cleanouts: Comply with ASME A112.36.2M.

2.9 FLOOR DRAINS

- A. Equal Manufacturers:
 1. JR Smith
 2. MiFab
 3. Zurn Industries
 4. Watts
- B. See the Plumbing Schedule & drawings for variations.
- C. Comply with ASME A112.21.1M.

PART 3 - EXECUTION

3.1 INSTALLATION

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

- B. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.
- C. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve.
- D. Install expansion joints on vertical risers, stacks, and conductors if indicated.
- E. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 80 feet for piping NPS 4 and smaller and 100 feet for larger piping.
- F. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors. Provide carpet markers for cleanout covers located in carpet areas.
- G. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.
- H. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the drainage area radii directed by the Architect:
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- I. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.
- J. Fasten recessed-type plumbing specialties to reinforcement built into walls.

- K. Install wood-blocking reinforcement for wall-mounting and recessed-type plumbing specialties.
- L. Install individual shutoff valve in each water supply to plumbing specialties. Install shutoff valves in accessible locations. Refer to Division 22 Section "Valves" for general-duty ball, butterfly, check, gate, and globe valves.
- M. Install air vents at piping high points. Include ball, gate, or globe valve in inlet and drain piping from outlet to floor drain.
- N. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- O. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Connect plumbing specialties to piping specified in other Division 22 Sections.
- D. Ground equipment.
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- F. Connect plumbing specialties and devices that require power according to Division 26 Sections.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each backflow preventer thermostatic water mixing valve trap seal primer system.
 - 1. Refer to Specification Section "Mechanical Identification" for nameplates and signs.

3.4 PROTECTION

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

3.5 DEMONSTRATION

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

END OF SECTION

SECTION 221316
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes soil and waste, sanitary drainage and vent piping inside the building and to locations indicated.

1.2 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Force-Main Piping: 50 psig above operating pressure.

1.3 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 PVC PIPING

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

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- B. Aboveground and underground Sanitary Sewer and Vent Piping: Use the following piping materials for each size range:
 - 1. NPS 2 to NPS 8: PVC solid wall pipe, PVC socket fittings, and solvent-cemented joints.
 - a. Install 10 gauge detection wire on all PVC piping installed underground.
 - b. Install warning utility tape, equal to Terra Tape, 6" above on underground piping.
 - 2. Assemble sizes with the correct manufacturer recommended cement for size.

3.3 PIPING INSTALLATION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping installation.
- B. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
- C. Use long radius bends at bottom of Sanitary Stacks and connections of horizontal fittings shall be a min. of 10x pipe diameters downstream of vertical stack.
- D. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on only vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- E. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- F. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain:
 - a. 2 percent downward in direction of flow for piping NPS 2 and smaller;
 - b. 1.1 percent downward in direction of flow for piping NPS 3 and larger.
 - c.
 - 2. Horizontal Sanitary Drainage Piping: 1.1 percent downward in direction of flow.
 - 3. Vent Piping: 1.1 percent down toward vertical fixture vent or toward vent stack.
- G. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- H. Install underground PVC soil and waste drainage piping according to ASTM D 2321. Install 10ga detection wire on PVC piping and install warning utility tape, equal to Terra Tape, 6" above underground piping.
- I. Do not enclose, cover, or put piping into operation until it is inspected and approved by engineer and authorities having jurisdiction.
- J. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- K. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- L. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- M. All underground piping shall be installed with utility warning tape, equal to Terra Tape with service name, 6" above underground services.

3.4 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

- A. For pipe hanger and support devices. Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- B. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- C. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 - 2. NPS 3: 48 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 - 4. NPS 6: 48 inches with 3/4-inch rod.
 - 5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.
- D. Install supports for vertical PVC piping every 48 inches.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod. Restrained joints on Stack and at bottom of Stack.
 - 4. NPS 6: 60 inches with 3/4-inch rod. Restrained joints on Stack and at bottom of Stack.
- F. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

3.7 FIELD QUALITY CONTROL

- A. During installation, notify engineer and authorities having jurisdiction at least 72 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
- B. Reinspection: If engineer and/or authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.

From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

3.8 CLEANING

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

3.9 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION

SECTION 223300
ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Commercial, electric, storage, domestic-water heaters.
 - 2. Commercial, light-duty, storage, electric, domestic-water heaters.
 - 3. Domestic-water heater accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated.
- B. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Five years.
 - b. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Five years.
 - c. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

- A. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Bradford White Corporation.
 - b. Lochinvar Corporation.

- c. Rheem Manufacturing Company.
 - d. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
- 3. Standard: UL 174.
- 4. Storage-Tank Construction: Steel, vertical arrangement.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Working Pressure Rating: 150 psig
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
- 5. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1
 - e. Jacket: Steel with enameled finish.
 - f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - g. Heating Elements: Two; electric, screw-in immersion type; wired for simultaneous operation unless otherwise indicated. Limited to 12 kW total.
 - h. Temperature Control: Adjustable thermostat.
 - i. Safety Control: High-temperature-limit cutoff device or system.
 - j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
- 6. Special Requirements: NSF 5 construction with legs for off-floor installation.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1
- D. Pressure-Reducing Valves: ASSE 1003 for water. Set at 60-psig- (172.5-kPa-) maximum outlet pressure unless otherwise indicated.

- E. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- F. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- G. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

2.2 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspection requirements and Section 017300 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base.
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 8. Anchor domestic-water heater accessories to substrate.
- B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping.
- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install thermometers on outlet piping of electric, domestic-water heaters.
- E. Provide and install pressure-reducing valve with integral bypass relief valve for electric domestic-water booster-heater supplied by Kitchen Equipment Vendor on inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of 25 psig.
- F. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- G. Fill electric, domestic-water heaters with water.
- H. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Prepare test and inspection reports.

END OF SECTION

SECTION 224213
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes plumbing fixtures and related components.

1.2 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

1.3 SUBMITTALS

- A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
- B. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities.
- C. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities.

- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Vitreous-China Fixtures: ASME A112.19.2M.
 - 2. Water-Closet, Flush Valve, Trim: ASME A112.19.5.
 - 3. Stainless-Steel Commercial: NSF 2 construction.
- H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 - 1. Faucets: ASME A112.18.1M.
 - 2. Hose-Connection Vacuum Breakers: ASSE 1011.
 - 3. NSF Materials: NSF 61.
 - 4. Pipe Threads: ASME B1.20.1.
 - 5. Supply and Drain Fittings: ASME A112.18.1M.
 - 6. Brass Waste Fittings: ASME A112.18.2.
 - 7. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 - 8. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - 9. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 - 10. Hose-Connection Vacuum Breakers: ASSE 1011.
 - 11. NSF Potable-Water Materials: NSF 61.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 - 1. Atmospheric Vacuum Breakers: ASSE 1001.
 - 2. Brass and Copper Supplies: ASME A112.18.1M.
 - 3. Plastic Tubular Fittings and Piping: ASTM F 409.
 - 4. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1M.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Disposers: ASSE 1008 and UL 430.
 - 2. Floor Drains & Floor Sinks: ASME A112.21.1M.
 - 3. Grab Bars: ASTM F 446.
 - 4. Hose-Coupling Threads: ASME B1.20.7.

5. Hot-Water Dispensers: ASSE 1023 and UL 499.
6. Off-Floor Fixture Supports: ASME A112.6.1M.
7. Pipe Threads: ASME B1.20.1.
8. Plastic Toilet Seats: ANSI Z124.5.
9. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 HAMMER ARRESTORS

- A. See Plumbing Schedule for manufacturer and model number specification. Provide equal product from approved manufacturer.
- B. Equal Manufacturers:
 1. Sioux Chief
 2. JR Smith
 3. Zurn

2.3 WALL HYDRANTS

- A. See Plumbing Schedule for manufacturer and model number specification. Provide equal product from approved manufacturer.
- B. Equal Manufacturers:
 1. Woodford
 2. Zurn
 3. JR Smith Company

2.4 FLOOR DRAINS, WALL CLEANOUTS, FLOOR CLEANOUTS & GROUND CLEANOUTS

- A. See Plumbing Schedule for manufacturer and model number specification. Provide equal product from approved manufacturer.

- B. Equal Manufacturers:
 - 1. JR Smith Company
 - 2. Zurn
 - 3. MiFab Industries

2.5 LAVATORY FAUCETS

- A. See Plumbing Schedule for manufacturer and model number specification.
- B. Equal Manufacturers:
 - 1. Delta Commercial
 - 2. Symmons Commercial
 - 3. Sloan
 - 4. American Standard
 - 5. TS Brass

2.6 SINK FAUCETS

- A. Coordinate rough-in requirements with countertop supplier/installer.
- B. Sink Faucet: Sink rim mounted pressure compensating single water inlet fitting with 0.5gpm laminar flow and lever handle w/ integral ASSE 1070 mixing valve. Include cold-water and hot-water indicators; coordinate faucet inlet with supplies and fixture hole and outlet with spout and fixture receptor. Chrome plated finish.
- C. Equal Manufacturers:
 - 1. Delta Commercial
 - 2. Symmons Commercial
 - 3. American Standard
 - 4. Moen
 - 5. Kohler
 - 6. TS Brass

2.7 TOILET SEATS

- A. Toilet Seat: Solid plastic.
 - 1. Equal Products
 - a. Bemis Commercial
 - b. Kohler Commercial
 - c. Centoco Commercial
 - 2. Configuration: Open front without cover.

3. Size: Elongated.
 4. Class: commercial antimicrobial
 5. Hinge Type: SSC, self-sustaining stainless steel check hinge.
- B. Color: White.
- C. See Plumbing Schedule for manufacturer and model number specification.

2.8 WATER CLOSETS

- A. Water Closets: Accessible, floor-mounting, floor-outlet, vitreous-china fixture designed for gravity tank operation.
1. Style: Tank type.
 - a. Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
 - b. Height: Standard & Accessible.
 - c. Design Consumption: as specified plumbing schedule but no greater than 1.6gpf
 - d. Color: White.
 2. Equal Manufacturers:
 - a. American Standard, Inc.
 - b. Kohler Co.
 - c. Sloan
- B. See Plumbing Schedule for manufacturer and model number specification.

2.9 LAVATORIES

- A. Lavatories: Wall Hung
1. Punched for faucet.
 2. Color: White.
 3. Supplies: NPS 3/8 chrome-plated copper with stops.
 4. Drain: Grid.
 5. Drain Piping: chrome-plated cast-brass trap with cleanout; NPS 1-1/4, thick tubular brass waste to wall; and wall escutcheon.
 6. Protective Shielding Guard
 7. Equal Manufacturers:
 - a. American Standard, Inc.

- b. Kohler Co.
 - c. Sloan
- B. See Plumbing Schedule for manufacturer and model number specification.

2.10 SINKS

- A. Self riming counter-mounting, seamless, type 304 18ga. stainless-steel fixtures, with non-porous satin finish and sound attenuation backing.
 - 1. Equal Manufacturers:
 - a. Elkay Manufacturing Co.
 - b. Just Manufacturing Co.
 - c. Kohler Co.
 - d. American Standard, Inc.
 - 2. Supplies: NPS 1/2 chrome-plated copper with stops.
 - 3. Drain Piping: Basket or Grid drain with NPS 1-1/2 chrome-plated cast-brass trap with cleanout, 0.045-inch- thick tubular brass waste to wall, and wall escutcheons.
 - 4. Punch for faucet.
 - 5. Drain punched center rear set.
- B. See Plumbing Schedule for manufacturer and model number specification, faucet spread etc.

PART 3 - EXECUTION

3.1 FIXTURE INSTALLATION

- A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- C. Install counter-mounting fixtures in and attached to casework.
- D. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.
- E. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces

behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball valve if stops are not specified with fixture.

- F. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- G. Install toilet seats on water closets.
- H. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- I. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
- J. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for escutcheons.
- K. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

3.3 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.4 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls. Operate and adjust. Replace damaged and malfunctioning units.
- B. Adjust water pressure at faucets to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.

3.5 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.6 PROTECTION

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

END OF SECTION

SECTION 226600
CHEMICAL-WASTE SYSTEMS FOR LABORATORY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Single-wall piping.
 - 2. Piping specialties.
 - 3. Neutralization tanks.

1.2 PERFORMANCE REQUIREMENTS

- A. Single-Wall Piping Pressure Rating: 10 feet head of water

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For chemical-waste specialties and neutralization tanks to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Neutralization-Tank Limestone: Equal to 100 percent of amount required for each tank sump initial charge. Furnish limestone in 50-lb (22.7-kg) bags.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 70, "National Electrical Code."

PART 2 - PRODUCTS

2.1 SINGLE-WALL PIPE AND FITTINGS

- A. PP Drainage Pipe and Fittings: ASTM F 1412, pipe extruded and drainage-pattern fittings molded, with Schedule 40 dimensions, from PP resin with fire-retardant additive complying with ASTM D 4101; with fusion-joint ends.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. IPEX Inc.
 - b. Indelco Plastics
 - c. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
 - d. Watts Industries (Canada) Inc.
- B. CPVC Chemical Resistant Drainage System Pipe and Fittings: ASTM F 2618, pipe and drainage-pattern fittings.
 - 1. Manufacturers: Subject to compliance with requirements:
 - a. Charlotte Pipe ChemDrain CPVC-CW System
 - b. Spears LabWaste CPVC Corrosive Waste Drainage System
 - 2. Pipe and fittings shall be manufactured as a system, be the product of one manufacturer and be manufactured in the United States.

2.2 JOINING MATERIALS

- A. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.

- B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.

2.3 PIPING SPECIALTIES

A. Plastic Dilution Traps:

1. Manufacturers: Subject to compliance with requirements
 - a. IPEX Inc.
 - b. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
 - c. Town & Country Plastics, Inc.
 - d. Watts Industries Inc.
 - e. Spears Industries
2. Material: Corrosion-resistant CPVC, with removable base.
3. Dilution Tanks: 1-gal. (3.8-L) capacity, with clear base unless colored base is indicated; with two NPS 1-1/2 (DN 40) top inlets and one NPS 1-1/2 (DN 40) side outlet.

B. Corrosion-Resistant Traps:

1. Type: P-trap or drum trap.
2. Size: NPS 1-1/2 or NPS 2 (DN 40 or DN 50), as required to match connected piping.
3. CPVC: ASTM F 2618, with socket connections.

2.4 NEUTRALIZATION TANKS

A. Plastic Neutralization Tanks

1. Manufacturers: Subject to compliance with requirements
 - a. IPEX Inc.
 - b. Orion Fittings, Inc.; a division of Watts Water Technologies, Inc.
 - c. Town & Country Plastics, Inc.
 - d. Watts Industries Inc.
 - e. Spears Industries
2. Description: Corrosion-resistant plastic materials; with removable, gastight cover; interior, sidewall, dip-tube inlet; outlet; vent; and threaded or flanged, sidewall pipe connections.

- a. Material: CPVC OR HDPE Lab waste certified
- b. Tank Capacity: 30 Gallon.
- c. Extension and Traffic Cover: ½" PP min heavy-duty pedestrian plastic, bolted.
- d. Limestone: Chips or lumps, with more than 95 percent calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in "Earth Moving" for excavating, trenching, and backfilling.

3.2 CONCRETE BASES

- A. Anchor neutralization tanks to concrete bases.
 - 1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be imbedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Construct concrete bases of dimensions indicated by manufacturer, but not less than 4 inches (100 mm) larger in both directions than supported unit.
 - 4. Use 3000-psi 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.3 PIPING INSTALLATION

- A. Chemical-Waste Sewerage Outside the Building:
 - 1. Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground chemical-waste sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
 - 2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

3. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
4. Install drainage piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
5. Install drainage piping with 36-inch minimum cover.
6. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.
7. Buried CPVC pipe shall be installed in accordance with ASTM D 2321 and ASTM F 1668. Solvent welded joints shall be made per Manufacturer's IOM, conforming to ASTM F 493.

B. Chemical-Waste Piping Inside the Building:

1. Install piping next to equipment, accessories, and specialties to allow service and maintenance.
2. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
3. Flanges may be used on aboveground piping unless otherwise indicated.
4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
5. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Verify final equipment locations for roughing-in.
11. Install sleeves for piping penetrations of walls, ceilings, and floors.
12. Install sleeve seals for piping penetrations of concrete walls and slabs.
13. Install escutcheons for piping penetrations of walls, ceilings, and floors.
14. Installation shall comply with the latest installation instructions published by the approved.
15. The system shall be protected from fire stopping materials, thread sealant, plasticized vinyl products or other aggressive chemical agents not compatible with CPVC compounds.

3.4 PIPING SPECIALTY INSTALLATION

- A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use fittings of same material as sewer pipe at branches for cleanouts and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.
 - 1. Set Hi-Silicon Iron cleanout bodies in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade. Set cleanout plugs in concrete pavement with tops flush with pavement surface.

3.5 JOINT CONSTRUCTION

- A. Chemical-Waste Sewerage Outside the Building:
 - 1. Buried PP pipe shall be installed in accordance with ASTM D 2321 and ASTM F 1668. Solvent welded joints shall be made per Manufacturer's IOM, conforming to ASTM F 493.
 - 2. Join dissimilar pipe materials with adapters compatible with pipe materials being joined.
- B. Chemical-Waste Piping Inside the Building:
 - 1. All pipe, fittings and solvent cement shall be supplied together as a system.
 - 2. Pipe and fittings shall conform to National Sanitation Foundation Standard (NSF) 14. Special drainage systems for corrosive chemical or acid waste shall be manufactured from fire retardant PP piping.
 - 3. All system components shall be certified by NSF International for use in chemical waste drain systems and bear the mark NSF-cw.
 - 4. All system piping shall be Schedule 40 PP produced to the dimensional requirements of ASTM F 2618 and the manufacturer's specifications. All pipe fittings shall be PP drainage patterns meeting the requirements of ASTM F 2618 and the manufacturer's specifications, as applicable.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Pipe sizes in this article refer to aboveground, single-wall piping
- B. Comply with requirements in Hangers and Supports for Plumbing Piping and Equipment for pipe hanger and support devices. Install the following:
 - 1. Vertical Piping: MSS Type 8 or MSS Type 42, riser clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

- b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
- C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- D. Support vertical piping and tubing at base and at each floor.
- E. Install vinyl-coated hangers for piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 2 (DN 50): 33 inches (840 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches (1067 mm) with 1/2-inch (13-mm) rod.
 - 3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1220 mm) with 5/8-inch (16-mm) rod.
 - 4. NPS 6 (DN 150): 48 inches (1220 mm) with 3/4-inch (19-mm) rod.
- F. Install supports for vertical CPVC piping every 72 inches (1830 mm).
- G. Support piping and tubing not listed above according to MSS SP-69.

3.7 NEUTRALIZATION TANK INSTALLATION

- A. Install interior neutralization tanks on smooth and level concrete base. Include full initial charge of limestone.

3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make connections to existing piping so finished Work complies as nearly as practical with requirements specified for new Work.
- C. Protect existing piping to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.
- D. Install piping adjacent to equipment to allow service and maintenance.

3.9 LABELING AND IDENTIFICATION

- A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for labeling of equipment and piping.

1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.10 FIELD QUALITY CONTROL

- A. Inspect interior of sewerage piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place and again at completion of Project.
- B. Replace leaking sewerage piping using new materials, and repeat testing until leakage is within allowances specified.
- C. Tests and Inspections:
 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Chemical-waste piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.11 CLEANING

- A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Clean piping by flushing with potable water.

3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.
- B. Single-Wall, Chemical-Waste Sewerage Piping: Use any of the following piping materials for each size range:
 1. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): PP Chemical Drainage System Pipe and Fittings

- C. Single-Wall, Chemical-Waste Vent Piping: Use any of the following piping materials for each size range:
 - 1. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): CPVC Chemical Drainage System Pipe and Fittings

END OF SECTION

G. MECHANICAL (HVAC)

SECTION 230500
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 2. CPVC: Chlorinated polyvinyl chloride plastic.
 - 3. PE: Polyethylene plastic.
 - 4. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- C. All items provided under this Contract shall be of the latest model. No outdated and/or discontinued items will be permitted.
- D. No asbestos products will be permitted on the jobsite or within anything installed at the jobsite.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.6 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.
- B. Coordinate requirements and provide access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."
- C. Any work that can result in an interruption to the operation of existing mechanical systems shall only be performed with the approval and coordination the Owner and/or Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include limited to the manufacturers specified.

2.2 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

- C. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

2.3 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. IPEX
 - b. GF Piping
 - c. Spears Manufacturing Company.

2.4 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- C. Split-Plate, Stamped-Steel Type: With exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.

2.5 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-

plated finish.

- c. Insulated Piping: One-piece, stamped-steel type with spring clips.
- d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
- e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
- f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
- g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
- h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
- i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.

M. Sleeves are not required for core-drilled holes.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

O. Verify final equipment locations for roughing-in.

P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

3.3 PIPING CONNECTIONS

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

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

3.5 PAINTING

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with

materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 3. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 4. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 5. Use 3000-psi, 28-day compressive-strength concrete and reinforcement if not otherwise noted.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

3.8 GROUTING

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

F. Place grout around anchors.

G. Cure placed grout.

END OF SECTION

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Metal framing systems.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe stands.
6. Equipment supports.

B. Related Sections:

1. Section 23 05 00 – Basic Mechanical Materials and Methods
2. Section 23 05 23 – General-Duty Valves for HVAC Piping
3. Section 23 05 33 – Heat Tracing for HVAC Piping
4. Section 23 05 53 – Identification for HVAC Duct, Piping, and Equipment
5. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
6. Section 23 07 13 – Duct Insulation
7. Section 23 07 19 – HVAC Piping Insulation
8. Section 23 21 13 – Hydronic Piping
9. Section 23 31 13 – Metal Ducts

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following: include Product Data for components:
 - 1. Metal framing systems.
 - 2. Pipe stands.
 - 3. Equipment supports.

1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steelstainless steel.

2.2 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-Line, Inc.
 - b. GS Metals Corp.
 - c. Thomas & Betts Corporation.
 - d. Unistrut Corporation; Tyco International, Ltd.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturred lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Paint Coating: Vinyl.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.
- D. For Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 PIPE STANDS

- A. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.6 EQUIPMENT SUPPORTS

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

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 – Roof Accessories for curbs.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

- H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - b. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 4. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

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

3.4 ADJUSTING

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

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
 3. Hangers on building exterior, shall be spring isolated from wall.

- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 5. C-Clamps (MSS Type 23): For structural shapes.
 6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 11. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Duct labels.
 - 4. Valve tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.4 COORDINATION

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number,

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.

- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 DUCT LABELS

- A. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- B. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Equipment located outdoors shall have metal equipment labels. Indoor equipment shall have metal or plastic equipment labels.
- B. Install or permanently fasten labels on each major item of mechanical equipment.

- C. Locate equipment labels where accessible and visible.

3.3 DUCT LABEL INSTALLATION

- A. A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Blue: For cold-air supply ducts.
 - 2. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 25 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION

SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau
- C. TAB: Testing, adjusting, and balancing.
- D. TAB Specialist: An entity engaged to perform TAB Work.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.

- E. Sample report forms.
- F. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: TAB entity shall be certified by AABC or NEBB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.
- B. TAB Conference: Meet with Engineer and Owner on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination with occupancy of spaces by owner.
 - d. Coordination and cooperation of trades and subcontractors.
 - e. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer and Owner.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data in Project Documents, and Sequence of Operation.
- E. Examine equipment performance data including fan curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's

"HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers.
- K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- L. Examine system to ensure absence of entrained air in the piping.
- M. Examine operating safety interlocks and controls on HVAC equipment.
- N. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Isolating and balancing valves are open and control valves are operational.
 - 5. Ceilings are installed and access to balancing devices is provided.
 - 6. Supply air blowoff equipment has been removed and ductwork properly sealed.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's Procedural Standards for Testing, Adjusting and Balancing and in this Section.
 - 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. Do not disturb the factory fabricated duct insulation system installed outdoors (no holes, cuts, etc.). All work involving these two duct runs shall be performed in a location outside of the insulation extents.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 – Air Duct Accessories.
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 – Duct Insulation, and Section 23 07 19 – HVAC Piping Insulation.
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.
- E. Final TAB shall be done at least four weeks prior to occupancy to allow time for review and for any corrections (damper operators, control replacements, etc.) needed to be made prior to occupancy.
- F. TAB will not be started until the building envelop is completed, ceilings installed, interior and exterior doors and windows are in place.
- G. Final TAB will not be considered a winter or summer seasonal TAB. There will be two additional seasonal TABs required to be included by contractor in their scope of work.
- H. Summer seasonal TAB should be performed while occupied during near peak seasonal conditions with minimum and maximum OA temperatures specified for summer and winter TABS.
- I. Occupancy is not required for the winter seasonal TAB.
- J. Notify the owner at least a week in advance of the seasonal TABs requesting that the filters be clean prior to the TAB and all the systems will be ready and operational for the seasonal TAB. Coordinate all TAB work with the CxA in order that the CxA can

perform his verification and sampling of units to retest during the last week of the final TAB in order to save time and costs.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection, where required.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.
- K. Verify that air duct system is sealed as specified in Section 23 31 13 – Metal Ducts.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.

- a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.

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

3.6 PROCEDURES FOR MOTORS

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

3.7 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each electric heating coil:
 - 1. Nameplate data.
 - 2. Airflow.
 - 3. Entering- and leaving-air temperature at full load.
 - 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 - 5. Calculated kilowatt at full load.
 - 6. Fuse or circuit-breaker rating for overload protection.

3.8 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
 - 3. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.9 REPORTING

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

3.10 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Fan curves.
 - 2. Manufacturers' test data.

3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB contractor.
 3. Project name.
 4. Project location.
 5. Engineer's name and address.
 6. Contractor's name and address.
 7. Report date.
 8. Signature of TAB supervisor who certifies the report.
 9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 10. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 11. Nomenclature sheets for each item of equipment.
 12. Data for terminal units, including manufacturer's name, type, size, and fittings.
 13. Notes to explain why certain final data in the body of reports vary from indicated values.
 14. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Fan drive settings including settings and percentage of maximum pitch diameter.
 - e. Settings for supply-air, static-pressure controller.
 - f. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.

6. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Cooling-coil static-pressure differential in inches wg.
 - g. Heating-coil static-pressure differential in inches wg.
 - h. Outdoor airflow in cfm.
 - i. Return airflow in cfm.
 - j. Outdoor-air damper position.
 - k. Return-air damper position.
 - l.
- F. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h & kW.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Air flow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Air flow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.

G. Fan Test Reports: For supply and exhaust fans, include the following:

1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Motor efficiency.
 - d. Volts, phase, and hertz.
 - e. Full-load amperage and service factor.
 - f. Sheave make, size in inches, and bore.

- g. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - h. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Indicated air flow rate in cfm.
 - f. Indicated velocity in fpm.
 - g. Actual air flow rate in cfm.
 - h. Actual average velocity in fpm.
 - i. Barometric pressure in psig.
- I. Air-Terminal-Device Reports:
 - 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm.

- f. Final velocity in fpm.
- g. Space temperature in deg F.

J. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.11 INSPECTIONS

A. Initial Inspection:

- 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
- 2. Check the following for each system:
 - a. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point. Calibrate thermostat/temperature sensor where discrepancy is 2°F or higher.
 - b. Verify that balancing devices are marked with final balance position.
 - c. Note deviations from the Contract Documents in the final report.

B. Prepare test and inspection reports.

END OF SECTION

SECTION 230713 HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply air.
 - 2. Indoor, concealed exhaust air.
- B. Related Sections:
 - 1. Section 233113 "Metal Ducts".

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
- B. All items provided under this Contract shall be of the latest model. No outdated and/or discontinued items will be permitted.
- C. No asbestos products will be permitted on the jobsite or within anything installed at the jobsite.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct Insulation Schedule," article for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Friendly Feel Duct Wrap.
 - d. Owens Corning; SOFTR All-Service Duct Wrap.
 - e. ADHESIVES

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- C. FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
 - d. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.

2.4 SEALANTS

- A. FSK Jacket Flashing Sealant:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Fire- and water-resistant, flexible, elastomeric sealant.
 - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 5. Color: Aluminum.
 - 6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 SECUREMENTS

A. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials and accessories with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. Apply vapor-barrier mastic over staples.
 4. Cover joints and seams with fabric tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

- A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. Seal jacket to wall flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Division 7 for firestopping and fire-resistive joint sealers.

3.4 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. Install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- applied jacket, adhesive, glass-fab cloth, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 DUCT INSULATION SCHEDULE, GENERAL

A. Ducts Requiring Insulation:

1. Indoor, concealed supply air.
2. Indoor, concealed return air.
3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:

1. Factory-insulated flexible ducts.
2. Flexible connectors.
3. Factory-insulated access panels and doors.

3.6 INDOOR DUCT INSULATION SCHEDULE

- A. Concealed, Supply-Air Duct Insulation: Mineral-fiber blanket, 3 inches thick and 0.75-lb/cu. ft nominal density, minimum R8 rating.
- B. Concealed, Exhaust-Air Duct Insulation: Mineral-fiber blanket, 3 inches thick and 0.75-lb/cu. ft nominal density, minimum R8 rating.

END OF SECTION

SECTION 233113
METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections:

1. Section 233300 "Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.
2. Section 230593 "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.

1.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Penetrations through fire-rated and other partitions.
2. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Any proposed changes to duct layout.
 - 2. Penetrations of smoke barriers and fire-rated construction.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS requirements.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- D. All items provided under this Contract shall be of the latest model. No outdated and/or discontinued items will be permitted.
- E. No asbestos products will be permitted on the jobsite or within anything installed at the jobsite.

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.

- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation; Insulation Group.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - 2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 3. Liner Adhesive: As recommended by insulation manufacturer and complying with latest adopted state version of the International Mechanical Code with Amendments.
 - a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Insulation Pins and Washers:
 - 1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 3 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 7. Service: Indoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel.

10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor.
9. Substrate: Compatible with galvanized sheet steel.

2.6 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated exterior walls, cover the opening between the partition and duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where indicated on drawings, install smoke dampers. Comply with requirements in Section 233300 "Duct Accessories."
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.3 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Structural-steel fasteners appropriate for construction materials to which hangers are being attached.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.4 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 - 1. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

2. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply-air ducts.
- E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
 2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 3. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.
- 3.6 START UP
- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing."
- 3.7 DUCT SCHEDULE
- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.
- B. Supply Ducts:
1. Ducts Connected to DOAS Units:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 3.
 - d. SMACNA Leakage Class for Round : 3.
- C. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

- a. Pressure Class: Positive 1-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round : 6.
- D. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
- E. Liner:
 - 1. Transfer Air Ducts: fiberglass, 1 inch thick.
- F. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - 2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - b. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.
- G. Branch Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
 - 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees."
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 233300
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Backdraft dampers.
 - 2. Manual volume dampers.
 - 3. Turning vanes.
 - 4. Duct-mounted access doors.
 - 5. Flexible connectors.
 - 6. Flexible ducts.
 - 7. Duct accessory hardware.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

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

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

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.
 - 1. Outdoor applications shall be hot-dipped galvanized.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Ruskin Company.
 - 3. Vent Products Company, Inc.
- B. Description: Gravity balanced.
- C. Maximum System Pressure: 3-inch wg.
- D. Frame: Hat-shaped, 0.094-inch- thick, galvanized sheet steel, with welded corners and mounting flange.
- E. Blades: Multiple single-piece blades, 0.050-inch- thick aluminum sheet with sealed edges.
- F. Blade Seals: Neoprene, mechanically locked.

2.4 MANUAL VOLUME DAMPERS

- A. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. McGill AirFlow LLC.
 - d. Nailor Industries Inc.
 - e. Pottorff.
 - f. Ruskin Company.
 - g. Trox USA Inc.
 - h. Vent Products Company, Inc.
2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:
 - a. Hat shaped.
 - b. 0.094-inch- thick, galvanized sheet steel.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized roll-formed steel, 0.064 inch thick.
7. Blade Axles: Galvanized steel.
8. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
9. Blade Seals: Vinyl.
10. Jamb Seals: Cambered stainless steel.
11. Tie Bars and Brackets: Galvanized steel.
12. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

2.5 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Elgen Manufacturing.
 - 4. METALAIRE, Inc.
 - 5. SEMCO Incorporated.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 36 inches wide and double wall for larger dimensions.

2.6 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - d. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.

- b. Access Doors up to 18 Inches Continuous and two sash locks.
- c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches.

2.7 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Elgen Manufacturing.
 - 4. Ventfabrics, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd..
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.8 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flexmaster U.S.A., Inc.
 2. McGill AirFlow LLC.
- B. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 210 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
- C. Flexible Duct Connectors:
 1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.9 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install fire and smoke dampers according to UL listing.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 2. Control and sensor devices requiring inspection.
 - 3. Elsewhere as indicated.
- H. Install access doors with swing against duct static pressure.
- I. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
- J. Label access doors to indicate the purpose of access door.

- K. Install flexible connectors to connect ducts to equipment.
- L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- M. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- N. Connect diffusers or light troffer boots to ducts with maximum 48-inch lengths of flexible duct clamped or strapped in place.
- O. Install duct test holes where required for testing and balancing purposes.
- P. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.

END OF SECTION

SECTION 233423
HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Centrifugal roof ventilators.
 - 2. Centrifugal wall ventilators.
 - 3. Propeller fans.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Hartzell Fan Incorporated.
 - 3. Loren Cook Company.
 - 4. PennBarry.
 - 5. Soler & Palau
- B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
 - 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 - 3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
 - 4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
 - 5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
- E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Built-in raised cant and mounting flange.
 - 2. Overall Height: 14 inches (400 mm).
 - 3. Metal Liner: Galvanized steel.

2.2 CENTRIFUGAL WALL VENTILATORS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide **product indicated on Drawings** or comparable product by one of the following:
 - 1. Aerovent; a division of Twin City Fan Companies, Ltd.
 - 2. Greenheck Fan Corporation.
 - 3. Hartzell Fan Incorporated.
 - 4. Loren Cook Company.
 - 5. PennBarry.
 - 6. Twin City Fans
- B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.
- C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
- D. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
 - 3. Bird Screens: Removable, **1/2-inch** mesh, aluminum or brass wire.
 - 4. Wall Grille: Ring type for flush mounting.
 - 5. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.

- 2.3 Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

2.4 PROPELLER FANS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide **product indicated on Drawings** or comparable product by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Hartzell Fan Incorporated.
 - 3. Loren Cook Company.
 - 4. PennBarry.
 - 5. Soler & Palau
- B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

- C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.
- D. Fan Wheel: Replaceable, [**cast**] [**extruded**]-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.
- E. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- F. Fan Drive:
 - 1. Resiliently mounted to housing.
 - 2. Statically and dynamically balanced.
 - 3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 - 4. Extend grease fitting to accessible location outside of unit.
 - 5. Service Factor Based on Fan Motor Size: 1.4.
 - 6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, [**L₁₀ of 100,000 hours**] <Insert life>.
 - 8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
 - 9. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <insert value> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 10. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
- G. Accessories:
 - 1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
 - 2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
 - 3. Wall Sleeve: Galvanized steel to match fan and accessory size.
 - 4. Weathershield Hood: Galvanized steel to match fan and accessory size.
 - 5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
 - 6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2.5 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Enclosure Type: Totally enclosed, fan cooled.

2.6 SOURCE QUALITY CONTROL

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

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.
- B. Install units with clearances for service and maintenance.
- C. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.

- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- C. Lubricate bearings.

END OF SECTION

**SECTION 233600
AIR TERMINAL UNITS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Shutoff, single-duct air terminal units.

1.3 SUBMITTALS

- A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
 - 1. Air terminal units.
 - 2. Liners and adhesives.
 - 3. Sealants and gaskets.
- B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
 - 3. Hangers and supports, including methods for duct and building attachment vibration isolation.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Size and location of initial access modules for acoustic tile.
 - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. Instructions for adjusting software set points.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Carrier
 2. Johnson Controls International
 3. Price Industries.
 4. Titus.
 5. Trane; a business of American Standard Companies.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: 0.032-inch galvanized steel double wall.
 1. Casing Lining: Adhesive attached, 3/4-inch-thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 3. Air Outlet: S-slip and drive connections.
 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
 2. Damper Position: Normally closed.
- E. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.

1. Access door interlocked disconnect switch.
 2. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable.)
 3. Nickel chrome 80/20 heating elements.
 4. Airflow switch for proof of airflow.
 5. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 6. Mercury contactors.
- F. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Section 230900 "Instrumentation and Control for HVAC" and shall have the following features:
1. Damper Actuator: 24 V, powered open.
 2. Terminal Unit Controller: Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
 - a. Remote reset of airflow or temperature set points.
 - b. Adjusting and monitoring with portable terminal.
 - c. Communication with temperature-control system specified in Section 230900 "Instrumentation and Control for HVAC."
 3. Room Sensor: Wall mounted with temperature set-point adjustment.

2.2 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

- A. Connect ducts to air terminal units according to Section 233113 "Metal Ducts." And Section 233116 "Nonmetal Ducts."
- B. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.4 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Air terminal unit will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 3. Verify that controls and control enclosure are accessible.
 4. Verify that control connections are complete.
 5. Verify that nameplate and identification tag are visible.
 6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION

SECTION 237433
DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes factory-packaged units capable of supplying up to 100 percent outdoor air and providing cooling and heating.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Prepare the following by or under the supervision of a qualified professional engineer:
 - a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - b. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Startup service reports.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One sets for each unit.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Five years from date of Substantial Completion.
 - 2. Warranty Period for Unit: 18 months from date of Substantial Completion

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. AAON.
 - 2. Greenheck
 - 3. Trane

2.2 PERFORMANCE REQUIREMENTS

- A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- B. Cabinet Surface Condensation:

1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
 2. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces. The thermal break shall not compromise the structural integrity of the cabinet.
- C. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

- A. Construction: Double wall.
- B. Exterior Casing Material: Galvanized steel with paint finish.
- C. Interior Casing Material: Galvanized steel.
- D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.
- E. Base Rails: Galvanized-steel rails for mounting on roof curb or pad as indicated.
- F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.
- G. Roof: Standing seam or membrane; sloped to drain water.
- H. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.
- I. Cabinet Insulation:
1. Type: Fibrous-glass duct lining complying with ASTM C 1071, Type II or flexible elastomeric insulation complying with ASTM C 534, Type II, sheet materials.
 2. Thickness: 2 inches.
 3. Insulation Adhesive: Comply with ASTM C 916, Type I.

4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

J. Condensate Drain Pans:

1. Shape: Rectangular, with slope in at least two planes to direct water toward drain connection.
2. Size: Large enough to collect condensate from cooling coils including coil piping connections, coil headers, and return bends.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Depth: A minimum of 2 inches deep.
3. Configuration: Double wall, with space between walls filled with foam insulation and moisture-tight seal.
4. Material: Stainless-steel sheet.

- K. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

2.4 SUPPLY FAN

A. Plenum Fan Type: Single width, non-overloading, with airfoil blades.

1. Fan Wheel Material: Aluminum; attached directly to motor shaft.
2. Fan Wheel Drive and Arrangement: Direct drive, AMCA Arrangement 4.
3. Fan panel and frame Material: Powder-coated steel, stainless steel, or aluminum.
4. Fan Enclosure: Easily removable enclosure around rotating parts.
5. Fan Balance: Precision balance fan below 0.08 inch/s at design speed with filter in.

B. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
2. Enclosure: Open dripproof or Totally enclosed.
3. Enclosure Materials: Cast iron.
4. Efficiency: Premium efficient.

5. Service Factor: 1.15.

- C. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with spring isolators.

2.5 COOLING COILS

- A. Capacity Ratings: Comply with ASHRAE 33 and ARI 410.
- B. Coil Casing Material: Manufacturer's standard material.
- C. Tube Material: Copper.
- D. Tube Header Material: Manufacturer's standard material.
- E. Fin Material: Aluminum.
- F. Fin and Tube Joints: Mechanical bond.
- G. Leak Test: Coils shall be leak tested with air underwater.
- H. Refrigerant Coil Suction and Distributor Header Materials: Seamless copper tube with brazed joints.
- I. Coating: Phenolic epoxy corrosion-protection coating after assembly.

2.6 REFRIGERATION SYSTEM

- A. Comply with requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
- B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.
- C. Compressors: Inverter scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief.
- D. Refrigerant: R-454B.
- E. Refrigeration System Specialties:
 - 1. Expansion valve with replaceable thermostatic element.
 - 2. Refrigerant dryer.
 - 3. High-pressure switch.
 - 4. Low-pressure switch.

5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
 6. Brass service valves installed in discharge and liquid lines.
- F. Capacity Control:
1. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification.
- G. Refrigerant condenser and reheat condenser coils:
1. Capacity Ratings: Complying with ASHRAE 33 and ARI 410.
 2. Tube Material: Copper.
 3. Fin Material: Aluminum.
 4. Fin and Tube Joint: Mechanical bond.
 5. Leak Test: Coils shall be leak tested with air underwater.
 6. Coating: Phenolic epoxy corrosion-protection coating after assembly.
- H. Condenser Fan Assembly:
1. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades.
 2. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Motor Enclosure: Totally enclosed non-ventilating (TENV) or totally enclosed air over (TEAO) enclosure.
 - c. Enclosure Materials: Cast iron.
 - d. Motor Bearings: Permanently lubricated bearings.
 - e. Built-in overcurrent and thermal-overload protection.
 - f. Efficiency: Premium efficient.
 3. Fan Safety Guards: Steel with corrosion-resistant coating.
- I. Safety Controls:
1. Compressor motor and condenser coil fan motor low ambient lockout.
 2. Overcurrent protection for compressor motor.

2.7 ELECTRIC-RESISTANCE HEATING COIL

- A. UL Compliance: Comply with requirements in UL 1995, "Heating and Cooling Equipment."

2.8 OUTDOOR-AIR INTAKE HOOD

- A. Type: Manufacturer's standard hood or louver.
- B. Materials: Match cabinet.
- C. Bird Screen: Comply with requirements in ASHRAE 62.1.
- D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.9 FILTERS

- A. Disposable Panel Filters:
 - 1. Comply with NFPA 90A.
 - 2. Factory-fabricated, viscous-coated, flat-panel type.
 - 3. Thickness: 2 inches.

2.10 ELECTRICAL POWER CONNECTIONS

- A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
- B. Factory-Mounted, Overcurrent-Protection Service: For each motor.
- C. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- D. Controls: Factory wire unit-mounted controls where indicated.
- E. Lights: Factory wire unit-mounted lights.
- F. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.
- G. Control Relays: Auxiliary and adjustable time-delay relays.

2.11 CONTROLS

- A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC."
- B. Control Dampers:
 - 1. Damper Location: Factory installed inside unit for ease of blade axle and bushing service. Arrange dampers located in a mixing box to achieve convergent airflow to minimize stratification.
 - 2. Damper Leakage: Comply with requirements in AMCA 500-D.
 - 3. Damper Rating: Rated for close-off pressure equal to the fan shutoff pressure.
 - 4. Damper Label: Bear the AMCA seal for both air leakage and performance.
 - 5. Blade Configuration: Unless otherwise indicated, use parallel blade configuration for two-position control and equipment isolation service and use modulating control when mixing two airstreams. For other applications, use an opposed-blade configuration.
 - 6. Damper Frame Material: Extruded aluminum or stainless steel.
 - 7. Blade Type: Single-thickness metal reinforced with multiple V-grooves or hollow-shaped airfoil.
 - 8. Blade Material: Extruded aluminum or stainless steel.
 - 9. Blade Seals: Replaceable, continuous perimeter vinyl seals and jambs with stainless-steel compression-type seals.
 - 10. Bearings: Thrust bearings for vertical blade axles.
- C. Damper Operators:
 - 1. Factory-installed electric operator for each damper assembly with one operator for each damper assembly mounted to the damper frame.
 - 2. Operator capable of shutoff against fan pressure and able to operate the damper with sufficient reserve power to achieve smooth modulating action and proper speed of response at the velocity and pressure conditions to which the damper is subjected.
 - 3. Position Indicator and Graduated Scale: Factory installed on each actuator with words "OPEN" and "CLOSED," or similar identification, at travel limits.
 - 4. Spring-return operator to fail-safe; either closed or open as required by application.
 - 5. Operator Type: Direct coupled, designed for minimum 60,000 full-stroke cycles at rated torque.
 - 6. Position feedback Signal: For remote monitoring of damper position.
 - 7. Coupling: V-bolt and V-shaped, toothed cradle.
 - 8. Circuitry: Electronic overload or digital rotation-sensing circuitry.

D. Refrigeration System Controls:

1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb (adj.) of dry air or outdoor-air temperature is less than 60 deg F (adj.).

E. Electric-Resistance Heat Controls:

1. Factory-mounted sensor in unit discharge with sensor adjustment located in control panel to control electric coil to maintain temperature.
2. Capacity Controls: Modulating SCR.

F. Damper Controls: Space pressure sensor modulates outdoor- and return-air dampers to maintain a positive pressure in space at a minimum of 0.05 inch wg with respect to outdoor reference.

G. DDC Temperature Control: Standalone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with control system specified in Section 230900 "Instrumentation and Control for HVAC." Links shall include the following:

1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
2. Hardware interface or additional sensors for the following:
 - a. Room temperature.
 - b. Discharge-air temperature.
 - c. Refrigeration system operating.
 - d. Furnace operating.
 - e. Constant and variable motor loads.
 - f. Variable-frequency-controller operation.
 - g. Cooling load.
 - h. Economizer cycles.
 - i. Air-distribution static pressure and ventilation-air volumes.

H. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display unit status and alarms.

1. Hardwired Points:

- a. Monitoring: On-off status, common trouble alarm.
- b. Control: On-off operation, space temperature set-point adjustment.

2. ASHRAE 135 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.

2.12 ACCESSORIES

- A. Service Lights and Switch: Factory installed in each accessible section with weatherproof cover. Factory wire lights to a single-point field connection.
- B. Duplex Receptacle: Factory mounted 20 amp 120 V GFI duplex receptacle and weatherproof cover.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- B. Equipment Mounting: Install floor or on-grade mounted units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases specified in Section 033000 "Cast-in-Place Concrete."
- C. Install separate devices furnished by manufacturer and not factory installed.

- D. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- E. Install drain pipes from unit drain pans to sanitary drain.
 - 1. Drain Piping: Drawn-temper copper water tubing complying with, with soldered joints.
 - 2. Pipe Size: Same size as condensate drain pan connection.

3.3 CONNECTIONS

- A. Where installing piping adjacent to units, allow space for service and maintenance.
- B. Duct Connections:
 - 1. Comply with requirements in Section 233113 "Metal Ducts."
 - 2. Drawings indicate the general arrangement of ducts.
 - 3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."
- C. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.
 - 1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
 - 3. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
 - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
 - c. Condenser coil entering-air dry-bulb temperature.
 - d. Condenser coil leaving-air dry-bulb temperature.

4. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
5. Inspect casing insulation for integrity, moisture content, and adhesion.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean coils and inspect for construction debris.
10. Inspect and adjust vibration isolators and seismic restraints.
11. Verify bearing lubrication.
12. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
13. Start unit.
14. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
15. Operate unit for run-in period.
16. Calibrate controls.
17. Adjust and inspect high-temperature limits.
18. Inspect outdoor-air dampers for proper stroke.
19. Verify operational sequence of controls.
20. Measure and record the following airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air flow.
 - c. Outdoor-air flow.
- B. After startup, change filters, verify bearing lubrication.
- C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- D. Prepare written report of the results of startup services.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied

conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

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

END OF SECTION

SECTION 238126
MINI-SPLIT AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. Filters: One set(s) for each air-handling unit.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. ASHRAE Compliance:

- 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."

- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

- a. For Compressor: Five years from date of Substantial Completion.
- b. For Parts: Five year(s) from date of Substantial Completion.
- c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
2. Daikin
3. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
4. Samsung
5. Trane; a business of American Standard companies.

2.2 CEILING SUSPENDED AND WALL-MOUNTED CASSETTE INDOOR UNITS

- A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to piping, power, and control board with field connections.

B. Cabinet:

1. Material: Galvanized steel frame with high-impact plastic chassis and fascia, UL 94 V-0 flammability rating.
2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Construction: Nonferrous construction, slit fins coated with hydrophilic paint on copper tubing.
2. Coil Tubes: Copper.
3. Internal Tubing: Copper tubing with brazed joints.
4. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
5. Field Piping Connections: Manufacturer's standard.
6. Factory Charge: Dehydrated air or nitrogen.
7. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Nonferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Unit-mounted condensate pump with check valve, with a minimum vertical lift of 29 inches.
3. Condensate Float Switch: Disable unit operation in the event of condensate overflow.
4. Field Piping Connection: Nonferrous material.

E. Fan and Motor Assembly:

1. Fan: Direct-drive turbo fan arrangement driven by a single motor statically and dynamically balanced.
2. Construction: Fabricated from nonferrous components.
3. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
5. Speed Settings and Control: Three or more speed settings with a speed range of least 50 percent.
6. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Included with fascia panel, to accommodate filter replacement without the need for tools.
2. Media: Washable, electrostatic filter.

G. Air Outlet Assembly: Fascia panel mounted in bottom of unit cabinet.

1. Discharge Pattern Adjustment: Fixed or auto-swing direction, 10 to 60 degree angle, with wireless, touch, or premium wired controller.

2. Independent Discharge Pattern: Independent air distribution control with wireless or premium wired controller (10 to 60 degree control range in three directions).
3. Return-Air Inlet: Manufacturer's standard grille in top of fascia panel.

H. Unit Accessories:

1. External Contact Control Module: Provides ON/OFF input connection and operation and error outputs (0V dry contacts).

I. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls, 208/230 V, single phase, 60 hertz.
3. Disconnecting Means: Circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard, factory installed.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor:
 - a. Compressor is the fully hermetic, inverter rotary type.
 - b. Compressor is equipped with an oil system, operating oil charge, and a motor.
 - c. Motor is NEMA rated class E, suitable for operation in a refrigerant atmosphere.
 - d. Compressor assembly is installed on rubber vibration isolators. Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - e. Compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - f. Refrigerant Charge: R-410A.

- g. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
- 3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
- 4. Fan: Aluminum-propeller type, directly connected to motor.
- 5. Motor: Permanently lubricated, with integral thermal-overload protection.
- 6. Mounting Base: Polyethylene.

2.4 ACCESSORIES

- A. Thermostat: 24V thermostat interface by system manufacturer. Controller provided by Controls Contractor.
- B. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounted, compressor-condenser components on 4-inch thick, reinforced concrete base that is 4 inches larger, on each side, than unit. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.
- D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

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

END OF SECTION

SECTION 238239 UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.2 SUBMITTALS

- A. Product Data:** Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. Shop Drawings:** Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Operation and maintenance data.**

1.3 QUALITY ASSURANCE

- A. All items provided under this Contract shall be of the latest model. No outdated and/or discontinued items will be permitted.**
- B. No asbestos products will be permitted on the jobsite or within anything installed at the jobsite.**

PART 2 - PRODUCTS

2.1 WALL HEATERS

- A. Basis-of-Design Product:** Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Indeeco.
 2. Markel.
 3. QMark Electric Heating; a division of Marley Engineered Products.
 4. Raywall.
- B. Thermostat:**
1. Locate thermostat on unit to sense space temperature and with setpoint knob inaccessible without removal of a unit panel or ceiling tile.
 2. Unit mounted and wired by manufacturer.

- C. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
- D. Cabinet:
 - 1. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
 - 2. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
 - 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- E. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.
- F. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.
- G. Fan: Aluminum propeller directly connected to motor.
- H. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install unit heaters to comply with NFPA 90A.
- B. Comply with safety requirements in UL 1995.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.2 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION