

## SECTION 11333

### FILTRATION EQUIPMENT

#### 1.2 RELATED SECTIONS

1.2.1 The specification sections listed below are an integral part of this equipment specification.

Section 09900 – Painting

Section 11378 – Multistage Centrifugal Blower

Section 15140 – Supports and Anchors

Section 15381 – Process Piping and Valves

1.2.2 All electrical equipment, control panels and wiring shall be in full conformance with Division 16 electrical of these specifications.

#### 1.3 DESIGN AND PERFORMANCE CRITERIA

1.3.1 The materials and equipment covered by this specification are intended to be standard materials and equipment of proven ability as manufactured by reputable concerns. Appurtenant equipment shall be designed and constructed in accordance with the best practice of the industry and shall be in accordance with the system manufacturer's recommendations and the Contract Documents. The specifications call attention to certain features, but it is not intended to cover all details entering into the construction of the equipment.

1.3.2 The filter underdrain system shall be designed and installed to ensure long term stability in its operating characteristics. It shall be resistant to changes in head loss, flow uniformity, and any other effects which would in time cause loss of efficiency or effectiveness in its operation.

1.3.3 The underdrain system shall allow for the uniform collection of filtered water and uniform distribution of backwash water and air over the total area of the filter floor.

1.3.4 The backwash system shall allow for separate air scouring and water backwashing and for the simultaneous use of air and water at the specified rates.

1.3.5 The system shall be designed to avoid localized areas of excessive flow (maldistribution) which may cause mounding, lateral displacement, or other deleterious disturbances in the filter media.

1.3.6 The filter system and equipment mentioned below shall be supplied by one manufacturer that shall assume total responsibility for the parts operating as a whole.

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1.3.7 The underdrain shall be manufactured by ITT Water & Wastewater Leopold, Inc. or approved equal.

1.3.8 All instrumentation shall meet ANSI, National Electrical Code, OSHA, and any other applicable code or local regulation. All panel instruments shall be of the same manufacturer and model type to provide uniform appearance and operation and maintenance requirements.

1.3.9 All hardware and controls necessary for a complete, functional and operating filtration system shall be included in the equipment package.

1.3.10 Media: The filter shall consist of 12 inches of silica sand media and 18 inches of anthracite media.

1.3.11 The existing wash water troughs shall be utilized.

1.3.12 A filter control system shall be provided for controlling and monitoring the operation of the filter system (2 Dual Consoles). The control consoles and filter instruments shall be supplied by the filter equipment supplier and shall include programming required for a complete and operational filter control system.

#### 1.3.13 PERFORMANCE

1.3.13.1 When subjected to a flow rate of 20 gpm/sf (48.9 m/h) of filter area the headloss through an underdrain lateral 40 feet (12.2 m) long shall not exceed 36 inches (910 mm) water column when the water temperature is approximately 60° F (16 °C). This does not include head losses for special feed arrangements.

1.3.13.2 To ensure the underdrain will control distribution (limit maldistribution) and not be over-powered by the media headloss, the minimum headloss through the orifices (primary and secondary) of an individual underdrain block shall not be less than 20 inches (510 mm) water column at a backwash flow rate of 20 gpm/sf (48.9 m/h) of filter area when the water temperature is approximately 60°F (16 °C).

1.3.13.3 An air scour rate of 5 scfm/sf shall be supplied to ensure optimum cleaning.

1.3.13.4 Design flow rates: The filter underdrain system shall be furnished and installed to perform satisfactorily and as specified when operated under the following conditions:

- Downflow of filtered water up to 10 gpm/sf (24.5 m/h).

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- Upflow of backwash air at a rate in the range of 1 to 5 scfm/sf (18.3 - 91.5 m/h).
- Upflow of backwash air, together with backwash water. Typical recommended combined air and water rates: 5 scfm/sf (73.2 m/h) and 5 gpm/sf (12.3 m/h).
- Upflow of backwash water up to 25 gpm/sf (61 m/h).

1.3.13.5 Flow Distribution: The filter underdrain system, as installed, shall provide acceptable flow uniformity. Maldistribution (MD) of air and water flows during backwash shall be as follows:

- Lateral Water MD: The maldistribution in a lateral 40 feet long or less shall not exceed +/- 3 percent of the average gpm/sf of filter for a backwash rate of 20 gpm/sf (48.9 m/h).
- Flume Water MD: Note, additional maldistribution, due to specific flume arrangement, entry conditions into both flume and underdrain laterals and flow velocities, must be considered.
- System Air MD: Visually, the air should show a uniform pattern.

#### 1.3.13.6 Structural Design Requirements:

1.3.13.6.1 General: The filter underdrain system, including anchorage, supports, etc. shall be designed to safely withstand loading for the specified conditions.

1.3.13.6.2 Internal Loading: The filter underdrain system, when installed, shall be designed for a net internal loading during backwash of the greater of either 600 psf (28.7 kpa) or 200 percent of the maximum pressure at maximum backwash rates. No credit shall be taken for the weight of gravel or filter media.

1.3.13.6.3 Downward Load: The filter underdrain system shall also be designed to withstand a net downward loading of not less than 1,400 psf (67 kpa).

1.3.13.7 During backwash with air, the underdrain shall be suitable to withstand a maximum air temperature of 200° F (93 °C).

1.3.14 The dual-parallel block units with integral flow metering elements and any specialties required for installation such as special anchorage, grout retaining strips, closures, gaskets, etc.,

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shall be the products of a single manufacturer/supplier.

#### 1.4 WARRANTY

1.4.1 Guarantee/Warranty: Warranty obligation starts on the date of the substantial completion of the installation contract as determined by Engineer. The warranty provides that the equipment designed, manufactured and/or used meets all applicable federal, state and local laws, rules and regulations, including applicable OSHA Standards. Guarantee for one year from the date of substantial completion as determined by the Engineer that the system, including all of its components, will be free from defects in design, materials and workmanship. Guarantees shall include all costs (parts and labor) to repair or replace defective components except for those normally consumed (e.g., pump seals, oil, grease).

#### 1.5 DOCUMENTATION

1.5.1 Complete ladder logic diagrams with addresses, labels, and remarks shall be provided.

1.5.2 Complete console shop drawings showing layouts, schematics, and interconnections among field mounted equipment and other systems shall be provided.

1.5.3 Manufacturer's standard instruction bulletins for all functional components shall be provided.

#### 1.6 FULLY AUTOMATED PROCESSES

1.6.1 The filtration system shall include all equipment and controls for automated operation of the system with operator override capabilities in the following modes:

- Filtration
- Air Scour Backwash
- Conventional Water Backwash (for emergency purposes only)
- Filter to Waste Sequence

#### 1.6.2 FILTRATION

1.6.2.1 The filtration mode of operation shall be the normal mode of operation. The filtration mode shall allow the operator to preset the desired flow rate for clean water production, and the system will automatically adjust the actuated control valve to deliver this rate of water from the system. The requested flow rate of all filters is to be automatically divided among the

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number of operating filters. Alternatively, the system shall vary production rate based on the availability of raw water upstream of the system, or level in the on-site water storage tank downstream of the system. The system shall alarm the operator of abnormal conditions, which may include:

- Blower failure
- Actuated control valve failure
- Low filtrate flow
- High water level in filter
- High headloss
- High turbidity on effluent

#### 1.6.3 AIR SCOUR BACKWASH

1.6.3.1 Backwash of the filters will be operator initiated, triggered by headloss termination.

1.6.3.2 The automated backwash system shall be capable of operator adjustments without the use of specialized electronic equipment.

1.6.3.3 Sequence of operations as follows:

1.6.3.3.1 Close the influent valve to allow filter to operate until water level is lowered to about 6-inches above the media surface.

1.6.3.3.2 Air Scour: A signal will be sent to the settled water actuated valve to close, ceasing flow into the filter. An electrically actuated valve at blower inlet auto-throttles open as the blower is turned on to a set point amperage reading. Once the set point amperage reading is obtained, the auto-throttling valve will cease opening, which will enable the blower to achieve the desired outlet pressure. Simultaneously, the electrically actuated filter isolation valve on the air supply line will throttle open, allowing water to be purged from the pipe. The time, flow, valve opening will need to be field determined and integrated into the controls. Once air begins to bubble through the media, the blower will begin to provide flow at 2,300 scfm for 1 to 2 minutes and the filter isolation valve will be fully opened.

1.6.3.3.3 Concurrent Wash: With air still being provided, the electrically actuated backwash water valve is to be opened, allowing 2,300 gpm into the filter. Once water reaches the bottom of the wash trough, both the electrically actuated filter isolation valve and the electrically actuated inlet throttling valve shall be closed. This time shall be field determined.

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1.6.3.3.4 Water Wash: The electrically actuated backwash water valve shall then be opened further to allow 6,900 gpm. The water wash will run for approximately 6-8 minutes; with the total time of the backwash not less than 15 minutes.

1.6.3.4 Control shut down of the backwash water time to assist filter bed stabilization and minimize the filter to waste requirements.

#### 1.6.4 FILTER TO WASTE SEQUENCE

1.6.4.1 Once the backwash water valve is closed, the electrically actuated influent valve will be opened and the filter will be allowed to fill. The electrically actuated filter-to-waste valve will be opened once the filter is full and will remain open until the turbidity level reaches 0.1 NTU. Once the turbidity reaches 0.1 NTU, the valve will be closed and the filter effluent valve opened. This commences normal filter operation.

#### 1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

1.7.1 All materials and equipment shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability or appearance. The equipment shall be stored in a clean, dry location, free from construction dust, precipitation and excess moisture by the Contractor. If stored for more than two weeks, the equipment shall receive all maintenance considerations required by the manufacturer for proper storage of the equipment. At no time shall the equipment and appurtenances, be stored outdoors, uncovered and/or unprotected.

1.7.2 The schedule of delivery shall be submitted to the Owner for approval prior to delivery.

1.7.3 The Supplier shall be responsible for coordinating the shipment of supplies of materials and equipment specified herein. Coordination will be required during demolition, construction, startup and/or testing.

1.7.4 Media materials will not be shipped until the submittal is approved by the Owner. Approval of the submittal, including the Quality Control Manual, samples and independent testing, shall constitute acceptance of the media.

1.7.5 The Contractor shall provide storage space for filter media and protect it from exposure to sunlight if stored for more than two weeks.

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1.7.6 All filter media will be shipped in "semi-bulk" containers having lifting loops and bottom discharge spout. Anthracite superbags are 60 cubic feet (1.7 cubic meters) weighing approximately 3,000 pounds (1,360 kg) each.

1.7.7 The Contractor shall be responsible for storage of the filter control system equipment. The storage area shall be indoors, reasonably dust-free and protected from exposure to water or any corrosive materials.

1.7.8 Place or store underdrains and specialties only in designated staging areas shown on the drawings and approved by the Engineer.

1.7.9 Store underdrains and specialties off the ground, under ultraviolet-resistant tarps from time of delivery on-site until final installation of the filters.

1.7.10 Replace, at no charge to Owner, underdrains and specialties damaged during storage and delivery.

1.7.11 Underdrains and specialties are subject to inspection at the Engineer's request if visual evidence of damage is observed.

1.7.12 Contractor shall be prepared to demonstrate that the materials can be handled and stored without contamination prior to delivery of "bulk" shipments.

### 1.8 RESPONSIBILITY FOR EQUIPMENT

1.8.1 The Contractor shall be responsible for installing, testing, and placing in satisfactory operation all mechanical equipment, instruments, monitoring devices, appurtenant process equipment, piping, automatically and manually operated valves, control instrumentation and equipment and accessories. The Contractor shall coordinate all work of the filtration system manufacturer to guarantee a complete, operational and satisfactory system.

1.8.2 The complete filtration system process equipment package including the main control panel instrumentation system, shall be provided by a single manufacturer, who shall bear sole responsibility for the system design and integration. The Contractor shall coordinate the work of the system supplier's service personnel during construction, testing, startup, calibration and acceptance of the system and also operator training.

1.8.3 The system manufacturer shall have in their steady employ, during the entire project period, capable personnel for administration, detailed engineering and drafting, coordination,

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procurement and expediting, scheduling, construction inspection, installation, testing and startup and final commissioning. The system supplier shall also have available capable personnel for all necessary administration, engineering and/or service.

1.8.4 The system shall provide for complete operation of all signals, from point to point, and shall assure complete compatibility of all instrumentation and equipment. It shall be the Contractor's sole responsibility to resolve any and all interconnecting or interfacing problems, in order to ensure a complete and acceptable operating system. The Contractor shall be responsible for all scheduling and ensuring that all necessary coordination take place between the filtration system manufacturer and others.

1.8.5 The supervisory service of a factory-trained service representative, specifically trained on the type of equipment specified herein, shall be provided during construction to assist the Contractor with the method of installing underdrains, mounting, piping and wiring of each type of device and the method of protecting all of the equipment prior to placing it into service.

#### 1.9 QUALITY ASSURANCE

1.9.1 The filter system shall be supplied by one manufacturer that shall assume total responsibility for the parts operating as a whole and shall be manufactured by ITT Water & Wastewater Leopold, Inc. or approved equal.

1.9.2 The filter system shall be a standard product of a filter manufacturer who has been actively providing dual-parallel lateral air/water underdrain equipment for at least 15 years. Upon request, the filter manufacturer will provide the Engineer with a list of installations of underdrain which totals not less than 200.

1.9.3 All materials used in contact with the water and backwash air shall meet National Sanitation Foundation (NSF) Standard 61 Drinking Water System Components - Health Effects.

1.9.4 The dual-parallel underdrain block units with integral flow metering elements and any specialties required for installation such as special anchorage, grout retaining strips, closures, gaskets, etc., shall be the products of a single manufacturer/supplier.

#### 1.9.5 Hydraulic Demonstration:

1.9.5.1 The filter manufacturer shall, at their own facilities, if requested by the Engineer, set up a test lateral run of equal length to that required by the project and provide an opportunity for the Engineer and/or Owner to visit the facility to witness a full scale demonstration of the

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headloss and flow distribution during backwash.

1.9.5.2 The test facility shall be capable of demonstrating concurrent air and water distribution in a submerged trough and water only distribution on a non-submerged test bench.

1.9.5.3 These demonstration services shall be provided by the filter manufacturer with reasonable notice and at no additional expense to the OWNER or ENGINEER

#### 1.9.6 Media:

1.9.6.1 The filter equipment manufacturer shall furnish a Quality Control Manual demonstrating that the filter media to be furnished will comply with the requirements of the contract specifications. The Quality Control Manual will define the following:

- Qualification of the raw feedstock
- Control procedures at the screening mill
- Independent testing laboratories
- Packaging definition
- Purchase orders
- Storage procedures

1.9.6.2 City DPW personnel shall remove existing filter media prior to the start of construction. An Alternate Bid Item No. 2 is included in the Bid Documents for the Contractor to remove existing filter media.

#### 1.9.7 Control System:

1.9.7.1 The filter control system shall be supplied by the filter system manufacturer and shall be a standard product of the manufacturer. The control system shall be the FilterWorx™

Automatic Control System as supplied by ITT Water & Wastewater Leopold, Inc. or approved equal.

#### 1.10 SUBMITTALS

1.10.1 Submit to the engineer complete shop drawings showing details of fabrication, materials of construction, installation and leveling data of all items furnished under this section.

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1.10.2 Details submitted shall include as a minimum, headloss data for air, water and combined air/water backwash, structural design calculations, installation details, flow distribution calculations, certification of compatibility of the underdrain system with the filter media specified in this section, details for installing reinforcing and other items to be embedded in concrete.

1.10.3 Testing Procedures: Detailed start-up, hydraulic, and air scour test procedures.

1.10.4 Proper documentation showing NSF-61 certification of all underdrain components.

1.10.5 The media submittal and technical information will be provided and approved by a licensed engineer regularly employed by the filter manufacturer. The engineer shall have at least 15 years experience in water treatment. All submittal shall include the following information as a minimum:

- Supplier's Name
- Resume of Engineer Providing Submittal
- Quality Control Manual
- Gradation of Each Media Type
- Date of Sampling/Lot Number
- Samples of Each Media Type (If Required)
- Representative Sample Analysis, (i.e. effective size, uniformity coefficient, specific gravity, acid solubility and MOH hardness for Anthracite only.)
- Material Quantities
- Diagram with Type of Material and Depth of Each
- Estimated Shipping Schedule
- Media Loading Procedure
- All testing shall conform to the requirements of the latest edition of AWWA B100.

All submittals shall be furnished in accordance with the requirements of this section.

1.10.6 Shop drawings and Submittals– submit manufacturer's data, order sheet or equivalent for all components, instruments, materials, devices, programming, software, PLC wiring diagrams and any other item integral to the design and operation of the system. The information shall include, but not be limited to, the model number, dimensions, exact scale of calibration range, type of enclosure and mounting, input/output and power data, specifications, illustrations, parts schedule identifying materials to be used for all the system components and accessories and the instrument tag number (or loop number for auxiliary equipment).

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1.10.7 Dimensioned mechanical drawings, process flow diagrams, schematic, input/output mapping of all control signals and process and instrumentation diagrams. All dimensional differences between specifications or contract drawings shall be identified in the shop drawing submittal.

1.10.8 Manufacturer's outline and mounting dimensions for all field mounted devices.

1.10.9 Complete operation and maintenance manuals shall be provided in written bound and electronic format. Specific operation and maintenance instructions shall be prepared for entire system by the system manufacturer for this project. Operation and maintenance instructions for individual components shall be included with the package, however, written instructions, drawings and schematics must cover the complete system, not just the specific components. Instructions shall clearly explain the operations of all processes of the equipment, including what conditions must be met for each function/step of the process, the status of all valves for each conditions and what actions/alarms will be transmitted if the condition is or is not met.

1.10.10 Record Drawings – Submit complete as-built wiring diagrams for all control panels furnished with this equipment. Diagrams shall show all electrical components within the panel and show wire color and numbering and terminal numbering as provided in the panel.

1.10.11 Manufacturer's Installation Certification – Upon completion of manufacturer's services, submit certification that the system installed meets the requirements of the manufacturer and conforms to or exceeds specified requirements herein. Include reports of all tests conducted with certification.

1.10.12 Spare parts shall be provided for each unit as follows:

- Ten (10) underdrain o-rings.
- Five (5) H.I.P.S bridging pieces.
- Five (5) Plastic end caps.
- Two (2) of each switch, push-button, light used.
- Two (2) of each type of relay used.
- One (1) of each type of PLC I/O card used.
- One (1) of each type of PLC power supply used.

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#### PART 2 - PRODUCTS

2.1 MANUFACTURERS: The acceptable system manufacturer for this project shall be ITT Water & Wastewater Leopold, Inc., or approved equal.

#### 2.2 UNDERDRAINS

2.2.1 The underdrain system for the filters shall be a dual parallel lateral type with an integral media support cap whereby feeder and compensating chambers are provided within the cross section of a single block. The cross section of the underdrain shall be so arranged that the feeder (or primary) chamber is adjacent and connected to the compensating (or secondary) chambers through a series of orifices. The orifices shall be located at four different elevations and sized to provide uniform distribution of air and water. All internal orifices shall be integrally molded to provide a smooth bore orifice. Underdrains requiring secondary drilling procedures will not be considered acceptable. The primary chamber should provide at least 50 square inches (320 square cm) of cross sectional area per block to reduce flow velocity during backwash.

2.2.2 The compensating chambers shall provide the essential uniform pressure and flow distribution from the top of the blocks. The discharge flow from the top of the blocks into the filter bed shall be provided by approximately twenty-three dispersion orifices per square foot of filter area. The orifices shall be not less than 7/32 inches (5.5 mm) diameter to prevent clogging and shall be recessed from the surface by approximately 1/8 inch (3.2 mm). The top of each orifice shall be encircled by a depression approximately 3/8 inch (9.5 mm) x 3/4 inch (19 mm), which shall act to prevent the gravel support media from resting directly on and thereby blocking the dispersion orifice.

2.2.3 The underdrain shall have a horizontal flat top discharge surface, so that the finished filter bottom is essentially flat, with above stated dispersion orifices for uniform energy intensity of air and water coverage which direct flow vertically for effective penetration and cleaning of the media.

2.2.4 A water recovery channel with return holes shall be incorporated into the top of the underdrain block to ensure uniform and continuous air flow from the top deck orifices and provide greater air stability. Underdrains without a water recovery channel will not be considered acceptable.

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2.2.5 The secondary chambers of the underdrain shall have baffles sized and located to provide effective air control and to reduce level sensitivity. Underdrains without baffles will not be considered acceptable.

2.2.6 Material: The individual blocks used in the system shall be of impervious high strength, completely corrosion-resistant, high-density polyethylene (HDPE) material. The blocks shall be resistant to erosion and corrosion and have uniform smooth surfaces.

2.2.7 Dimensions: The block size and weight shall permit ease of handling and installation. The block nominal dimensions shall be 12 inches (305 mm) high by 11 inches (279 mm) wide by 48 inches (1220 mm) long. The weight of the block shall be approximately 25 pounds (11 kg). One-piece extruded underdrain will not be considered acceptable.

2.2.8 Block Geometry: The blocks shall be essentially rectangular in shape with dispersion orifices located in the top flat surface. The blocks shall have ridges and pockets for structural rigidity. The sides of the block shall have grout lock-in lugs to key into surrounding grout so that the walls can bond with the grout.

2.2.9 Lateral Construction: The blocks shall be arranged end-to-end and mechanically joined to form continuous underdrain laterals approximately equivalent to the length of the filter cell. The joints shall be sealed utilizing only one (1) O-Ring seal, bell and spigot type with internal alignment tabs for proper joint alignment, and be air and water-tight. Joints shall be of snap-lock type so that the blocks are joined with integral interlocking snap lugs and lug receptors for ease of assembly and installation of the laterals. One-piece extruded underdrain will not be considered acceptable.

2.2.10 Media Support Cap: The media support cap shall be constructed of HDPE plastic beads sintered together and sealed to the top of the underdrain. The pore size and pore volume shall be sufficient to prevent the media from obstructing or passing through the underdrain. The media support cap shall replace the need for support gravel and shall not increase the underdrain height by more than 1 inch (25 mm). The cap shall be attached to the underdrain at the factory by type 316 stainless steel self-tapping screws and sealed with Leoflex™ caulking or approved equal.

### 2.3 AIR HEADER

2.3.1 Because the proper distribution of air into the underdrain has a significant effect upon operation, the filter manufacturer shall have the responsibility to design and provide the air distribution header for this underdrain.

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2.3.2 General: The air distribution system shall be generally comprised of a corrosion resistant header specially calibrated to evenly distribute air flow via properly located drop pipes to each underdrain lateral. Sufficient relative velocities shall be maintained in both the header and riser pipes to insure proper distribution of air.

2.3.3 Material: The air header piping shall be Sch. 5, type 304 stainless steel. The anchors and hardware for anchoring the air header shall be type 18-8 stainless steel.

#### 2.4 GROUT RETAINER

2.4.1 Grout retaining strips for bridging flumes shall be of high-impact polystyrene properly keyed to fit the underdrain blocks to allow adjustment of lateral center-to-center distance without difficulty. Retaining strips shall be supplied by the filter manufacturer.

#### 2.5 GROUT

2.5.1 Cement: Cement shall be standard brand Portland cement conforming to ASTM C150, Type II, for general use. Cement that has become "lumpy" shall not be used. Do not use non-shrink grout.

2.5.2 Water: Water for mixing and curing shall be clean and clear potable water. The water shall be considered potable if it meets the requirements of the local government agencies. Agriculture water with a total dissolved solids of 1000 mg/l or higher, shall not be used.

2.5.3 Sand: Sand shall be clean and washed masonry sand. When tested in accordance with ASTM D2419, the sand equivalency shall not be less than 90% for an average of three samples, or less than 85% for any individual sample. 100% of sand particles shall pass No. 4 sieve and not more than 4% of sand particles shall pass No. 200 sieve.

2.5.4 Chemical Admixtures: No chemical admixture is needed in most of the applications. The grout can be mixed in a small batch and used immediately.

2.5.5 Strength: The grout used in installing the blocks shall have a minimum compressive strength of 2500 psi (17240 kpa) after 30 days of curing. Normally, use a grout with one part Portland cement and two parts clean silica sand properly mixed and wetted with a maximum water-cement ratio by weight equal to 0.50 to 0.55 for the base grout and 0.61 to 0.67 for the fill grout.

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#### 2.6 EPOXY SYSTEM

2.6.1 Epoxy System used for installation of “L” rods shall be “Hilti Hit RE500,” “EPCON C6”, or approved equal.

#### 2.7 FILTER MEDIA

2.7.1 Filter sand shall be composed of hard, durable clean siliceous particles, free of all mica with an average specific gravity of 2.6 (+/-0.05) and shall be in strict accordance with AWWA B100, and have an effective size of 0.45 – 0.55 mm, and a uniformity coefficient of 1.40 or less, for a finished depth after backwashing and scraping and removal of fines and debris of 12 inches. For depths up to 12 inches (305 mm), a 1/2-inch (13 mm) skimming allowance shall be provided.

2.7.2 Filter anthracite shall be composed of specially selected and graded hard, durable anthracite coal particles. The anthracite shall be composed entirely of deep mined material. A quality control manual shall be included to show the source of the material and the quality of the material produced. The anthracite shall have an average specific gravity of 1.65 (+/-0.05) with a hardness (MOH scale) of 2.7 or more and shall be essentially free of iron, clay, shale, extraneous dirt, and excessive dust with moisture less than 4.0 percent as shipped. The anthracite shall be in accordance with AWWA B100, and have an effective size of 0.95-1.05 mm, and a uniformity coefficient of 1.40 or less for a finished depth after backwashing and scraping and removal of fines and debris of 18 inches. A skimming allowance of 1 inch (25mm) shall be provided.

#### 2.8 FILTER CONTROL SYSTEM

2.8.1 The control system shall be the FilterWorx™ Automatic Control System, or approved equal, and shall include all equipment and instrumentation required for a complete and operational filter system. As a minimum, the control system shall consist of two (2) consoles for four (4) dual cell filters and filter instrumentation as described in the following subsection.

##### 2.8.2 TWO DUAL FILTER CONTROL CONSOLES

2.8.2.1 Each filter control console shall be provided for controlling and monitoring the operation of two (2) dual cell filters.

2.8.2.2 Each console shall be a PLC-based system and shall be provided complete with the necessary control devices, equipment, and functional programming to perform the control and monitoring functions specified.

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2.8.2.3 The control console shall be an AFC 5000 as manufactured by ITT Water & Wastewater Leopold, Inc., or approved equal.

#### 2.8.2.4 Functional Description

2.8.2.4.1 Each console shall have the capability of controlling the filtration and backwash sequence for two dual cell filters. It shall have the capability for semi-automatic, automatic, and manual control.

2.8.2.4.2 In the automatic mode, the backwash sequence shall be initiated by high turbidity, high loss-of-head, or exhausted filter runtime unless there is an insufficient amount of water in the tank. The PLC shall perform the backwash sequence without operator intervention.

2.8.2.4.3 In the semi-automatic mode, the backwash sequence shall be manually initiated by the operator following a system alert based on the above mentioned conditions. Occurrence of any of these conditions shall illuminate the BACKWASH REQUIRED pilot light. The operator shall initiate the backwash sequence by pressing the START BACKWASH pushbutton. The PLC shall then perform the backwash sequence without further operator intervention. An ABORT BACKWASH pushbutton shall be provided to end the backwash sequence before its completion which will signal the filter to waste valve to open and run the filter to waste sequence. The console shall include an EXTEND HIGH BACKWASH pushbutton that will extend the high rate backwash for an adjustable amount of time.

2.8.2.4.4 In the manual mode, the backwash sequence shall be completely manual in operation, using the selector switches and indicators on the console. Manual operation shall be independent of the PLC.

2.8.2.4.5 An electronic valve actuator shall be provided for the effluent and backwash control valves. The valve actuator shall include AUTO/MANUAL and an INCREASE/DECREASE buttons. In AUTO mode, the unit shall accept a remote setpoint signal and position the flow control valve to maintain the flow setpoint. The remote effluent flow setpoint to each filter shall be generated by a common influent channel level transmitter. The remote backwash flow setpoint shall be generated from an output signal from the filter PLC based on the current backwash step. In MANUAL mode, the flow will be adjusted manually by pressing the appropriate INCREASE/DECREASE button. The unit shall have a dual LED display for indicating the flow setpoint and the actual flow in GPM.

2.8.2.4.6 The console shall have OPEN/HOLD/CLOSE selector switches for manual control

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of the effluent, backwash control and air scour vent valves. The console shall have OPEN/CLOSE selector switches for manual control of the influent, drain, backwash inlet, air scour inlet, and filter-to-waste valves. It shall also have START/STOP selector switches for the air scour blower.

2.8.2.4.7 The console shall include an operator interface touchpad to monitor the operation of the PLC and adjust the system setpoints.

2.8.2.4.8 The console shall provide dry-contact open and dry-contact close outputs for each valve controlled from the console. It shall accept dry-contact limit switch inputs from each valve and shall have pilot lights for indication of fully opened and fully closed position. Motors shall be controlled via a single maintained dry-contact that shall close when the motor is to run. The console shall accept a dry-contact running signal for proof that the motor is running.

2.8.2.4.9 Digital indicators shall be provided for loss of head and turbidity.

2.8.2.4.10 The Contractor shall be responsible for ensuring that equipment supplied by someone other than the filter system manufacturer includes the necessary and proper signal interface.

2.8.2.4.11 Refer to Contract Drawing E-2 (One Line Diagram – Control) for information regarding the PIC control panel/consolas and input/output I/O requirements.

#### 2.8.2.5 Components

2.8.2.5.1 The enclosure shall be a totally enclosed, sloped top console, 80" in width. It shall be manufactured of fiberglass reinforced plastic (FRP) having a minimum wall thickness of 1/8 inch (3.2 mm). The console enclosure shall be a model FCP as manufactured by ITT Water & Wastewater Leopold, Inc., or approved equal.

2.8.2.5.2 The operator interface touchpad shall be Magelis model XBT, or approved equal.

2.8.2.5.3 Selector switches, pushbuttons, and pilot lights shall be Square D, Type ZB4, or approved equal. Pilot lights and illuminated pushbuttons shall be LED type.

2.8.2.5.4 Digital indicators shall be Red Lion "IMP" series, Modutec 2000 series, or approved equal.

2.8.2.5.5 Control relays shall be general purpose, plug-in type with LED pilot indicator,

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Square D, Class 8501, Type K or Type R, or approved equal.

2.8.2.5.6 Terminal blocks shall be Weidmuller WDU 4 series, or approved equal.

2.8.2.5.7 Circuit breakers shall be Square D, Class 9080, Type GCB, or approved equal.

2.8.2.5.8 The PLC system shall be a modular type and shall be designed to have 10% active spare input/output terminations at each register or remote I/O rack. Spare I/O shall be wired to terminal blocks. The PLC shall have an Ethernet port for communications. The PLC system

hardware shall be Modicon M340 or Allen-Bradley Compactlogix series, or approved equal. Final PLC selection shall be coordinated with plant-wide system integrator.

#### 2.8.2.6 Wiring

2.8.2.6.1 The console shall be completely pre-wired except for wires to external devices, which shall be brought to lugless tubular screw with pressure plate terminal blocks. All wiring shall be in compliance with the National Electric Code (NEC).

2.8.2.6.2 Minimum wire size for 120 VAC power wiring shall be #16 AWG stranded copper conductor, 600V, 90 degrees C with thermoplastic insulation. Minimum wire size for 24 VDC power wiring shall be #18 AWG stranded copper conductor, with thermoplastic insulation. Minimum wire size for DC signal wiring shall be #18 AWG twisted, shielded pair with drain wire (Belden 8760 or equal), grounded in accordance with ISA Recommended Practice for signal wiring.

2.8.2.6.3 Wires shall be color coded as follows:

120 VAC, 2 wire, single phase:  
Phase - L1, Black  
Neutral-L2, White  
Externally powered circuit - Yellow  
120 VAC control - Red  
24 VDC Control - Blue  
Ground - Green, or green with yellow stripes.

#### 2.8.3 Flow Metering

2.8.3.1 Existing venturi flow meters are to be replaced in kind.

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2.8.3.2 Rate of flow transmitters shall be 2-wire type and shall generate a standard 4-20 mADC output signal. Each transmitter shall be supplied complete with three-valve manifold.

2.8.3.3 The transmitter shall be of compact design with external span and zero adjustments. Accuracy shall be  $\pm 0.25\%$  of calibrated span for a range of 20% to 100% of flow (4% to 100% of differential pressure).

2.8.3.4 The rate of flow transmitter shall be a Rosemount 3051 Smart DP, or approved equal.

#### 2.8.4 Filter Loss of Head Transmitters

2.8.4.1 A loss of head transmitter, complete with three-valve manifold, mudleg and strainer, shall be supplied to monitor the loss of head through each dual cell filter.

2.8.4.2 The transmitter shall be of compact design with external span and zero adjustments. Accuracy shall be  $\pm 0.25\%$  of calibrated span for a range of 20% to 100% of flow (4% to 100% of differential pressure).

2.8.4.3 The loss of head transmitter shall be the Rosemount 3051 Smart DP, or approved equal.

#### 2.8.5 Filter Continuous Level Sensors

2.8.5.1 A level transmitter shall be provided for each of the eight (8) filter cells.

2.8.5.2 The filter level sensing system shall be an ultrasonic-type, electronic continuous level transmitter, complete with sensing element and integral electronics. The sensor shall be powered by a nominal 24 VDC loop power supply and shall generate a standard 4-20 mADC output signal.

2.8.5.3 The level sensor shall be a Siemens SITRANS Probe LU Ultrasonic Level Transmitter, or approved equal.

#### 2.8.6 Effluent Turbidimeters

2.8.6.1 An effluent turbidity meter shall be provided for each filter of the four (4) filters and for the combined filtered water line. The turbidimeter shall be a HACH 1720E with SC200

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controller, or approved equal.

#### 2.8.7 Common Influent Channel Level Transmitter/DP Sensor

2.8.7.1 A differential pressure transmitter shall be supplied to monitor the common influent flow to all filters. This reading will translate to a common filter influent signal sent to the consoles for flow control purposes.

2.8.7.2 The transmitter shall be of compact design with external span and zero adjustments. Accuracy shall be  $\pm 0.25\%$  of calibrated span for a range of 20% to 100% of flow (4% to 100% of differential pressure).

2.8.7.3 The transmitter shall be the Rosemount 3051 Smart DP, or approved equal.

## PART 3 – EXECUTION

### 3.1 GENERAL

3.1.1 Installation of all equipment shall be completed in accordance with the manufacturer's instructions and recommendations, as outlined in the Contract Drawings and with the oral and written directions provided by the manufacturer's technical representative who is supervising and observing the installation.

#### 3.1.2 FLOOR PREPARATION

3.1.2.1 Care shall be exercised in preparing the filter floor slab and in setting the anchors to assure proper alignment and elevation. Steel anchor rods shall be furnished by the filter manufacturer and set in the floor slab on both sides of the distribution flume in accordance with the drawing provided. The floor slab shall be screeded into a flat level plane and be free of protrusions and depressions.

3.1.2.2 Do not paint the floor or wall area where it will come in contact with the grout surrounding the underdrain. The filter floor and filter wall extending thirteen (13) inches (330.2 mm) up from the filter floor is not to be painted.

3.1.2.3 No instrumentation or control system shall be energized prior to receipt of the filtration system manufacturer's authorization for energizing the system.

3.1.2.4 The proper storage of all materials shall be the responsibility of the Contractor, and

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the Owner assumes no responsibility for materials which are not properly protected from the weather by the Contractor until such time that the Contractor begins work utilizing the material.

3.1.2.5 Any filtration material which, in the opinion of the Engineer, becomes contaminated with dirt or other unsanitary materials shall be rejected.

#### 3.2 UNDERDRAIN LATERAL INSTALLATION

3.2.1 The underdrain laterals shall be set in relatively level rows on a bed of grout over the filter floor slab. Plates for closing the ends of each row of blocks shall be furnished and installed by the Contractor. After joining, aligning and setting the blocks, and the bed grout is set-up, as soon as possible, all spaces between the rows of blocks and walls shall be filled with grout so that the entire bed is totally sealed and held firmly in place. Once all grouting is complete, the grout shall be allowed to cure for at least 3 full days before any functional testing.

3.2.2 Anchor rods, if required as shown in the contract drawings, shall be supplied and installed by the Contractor. Installation of the anchor rods shall be in accordance with the manufacturer's approved installation drawings and instruction manual.

3.2.3 After the anchor rods have been installed and the epoxy has cured, a non-destructive vertical pull test shall be performed. Testing shall be performed on 100% of the anchor rods. The pull test shall be performed by the Contractor in accordance with the manufacturer's instruction manual.

3.2.3.1 Using the test equipment supplied by the underdrain manufacturer, each anchor rod shall be loaded to the vertical tension value and loading increments as specified in the manufacturer's instruction manual.

3.2.3.2 The specified tension shall be held for 2 minutes.

3.2.3.3 If an anchor rod fails to reach the specified tension or shows signs of slippage, the tested anchor rod installation shall be rejected. The Contractor shall remove all failed anchor rod(s), install new rod(s), and repeat the test on each new rod. These steps will be repeated until all rods pass the test.

3.2.3.4 All test results shall be documented and the results for a particular filter shall be approved in writing by the Contractor prior to proceeding with installation of the underdrain laterals in that filter.

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#### 3.3 CLEANING AND PROTECTION DURING INSTALLATION, TESTING, AND STARTUP

3.3.1 The Contractor shall take all precautions recommended by the underdrain manufacturer or specified herein to ensure that the filter underdrain system and any piping communicating therewith is completely clean and free of any debris, dirt, or other foreign materials which could clog the underdrain system or interfere with flow. Backwash air and water piping shall be thoroughly flushed clean. All loose debris and dirt within the filter cell and flume shall be removed by brooming down and vacuuming. Care shall be taken to keep grout from being deposited anywhere where it could interfere with flow. Any grout so deposited shall be removed. As installation progresses, partially completed portions of the work shall be protected with heavy plastic sheeting or other suitable material to maintain the cleanliness of the underdrain system. Such protection shall be maintained until the support gravel is installed.

3.3.2 Any time the underdrain laterals are to be used as a work surface, the underdrain block shall be overlaid with ½ inch minimum plywood sheeting where necessary, to distribute the load of yard buckets, wheel barrows, ladders, scaffolds, etc., to prevent damage to the underdrain.

#### 3.4 MEDIA

3.4.1 Marks shall be placed on the side of the filter designating the top elevation of each layer.

3.4.2 Carefully place each layer so as not to disturb the previous layers.

3.4.3 Complete the installation of each layer before the next layer above is started. Do not stand or walk directly upon the filter materials. Workers must stand or walk on boards that will sustain their weight without displacing the gravel and media.

3.4.4 Measure depth of each layer of media after it has been backwashed and skimmed as recommended by the filter equipment manufacturer.

3.4.5 Clean the filter tanks before any media is placed and keep them clean throughout the placing operation.

3.4.6 Filter Sand and Filter Anthracite: Place the filter sand and filter anthracite in the bed in the order of their respective specific gravities. Place and level the filter sand first. Then backwash the bed a minimum of three times, and remove the surface fines by scraping as

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required to the correct elevation. Place the filter anthracite and backwash the bed three times, and remove the surface fines by scraping as required to the correct elevation.

#### 3.5 FILTER CONTROLS AND INSTRUMENTATION

3.5.1 The Contract 1A shall be responsible for installation of the filter control consoles. All wiring from the console to field devices, instruments, and other systems shall be completed by Contract 1B.

3.5.2 Start-up shall be performed with all final elements, field devices, and instruments installed, calibrated, and wired in the circuit.

#### 3.6 SERVICES OF MANUFACTURER'S REPRESENTATIVE

##### 3.6.1 Mechanical Filter Equipment Services

3.6.1.1 All items are to be installed in accordance with the filter equipment manufacturer's recommendations.

3.6.1.2 Upon completion of installation, the technical director shall furnish a certificate of compliance detailing that the filtering materials have been installed in accordance with the manufacturer's instructions.

3.6.1.3 The underdrain manufacturer shall retain on its permanent staff, field service representatives with at least 10 years of experience in the placement of the underdrain. Such persons shall be available for additional, fee-paid basis to instruct the Contractor in the proper placement and testing of the underdrain.

3.6.1.4 The filter equipment manufacturer shall provide the services of the manufacturer's field services technical representative for not less than 16 working days (8 hours per day) to inspect and supervise the installation and testing of the filter underdrain system in 4 trips. Travel time shall not be included within the 8 hours per day.

3.6.1.5 Additional supervision for testing or other purposes in excess of that included above shall be made available by the manufacturer with reasonable notice.

##### 3.6.2 Controls and Instrumentation Services

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3.6.2.1 The control system manufacturer shall provide a technical representative to assist the Contractor's personnel with the startup for not less than 16 working days (8 hours per day) in 4 trips. The factory service technician shall have a minimum of five (5) years experience in the start up of air/water filter backwash systems. Travel time shall not be included within the 8 hours per day.

3.6.2.2 Onsite training of supervisors and shift operators shall be provided at the time of start-up to familiarize personnel with the hardware and to instruct them in day to day operations of the controls, preventative and regular maintenance, trouble shooting techniques, and system diagnostics. Contractor shall provide no less than 8 hours for onsite training.

3.6.2.3 Additional supervision for testing or other purposes in excess of that included above shall be made available by the manufacturer with reasonable notice.

#### 3.7 FIELD TESTING

##### 3.7.1 Underdrain Lateral Flow Distribution Test

3.7.1.1 The filter underdrain system in each filter cell shall be given a series of visual, qualitative, flow distribution tests to verify that orifices are not clogged with debris and that flow distribution is uniform. These tests shall be performed before the filter media is placed.

3.7.1.2 During each test, the underdrain laterals shall be visually inspected for uniform distribution of air and water and for any signs of quiescent zones and excessive surface turbulence.

#### 3.8 DISINFECTION

3.8.1 Upon completion of the work and before the filter is placed in service, the Contractor is to disinfect the entire filter by means of chlorination in accordance with AWWA Standard C-653.

### PART 4 – MEASUREMENT AND PAYMENT

#### 4.1 MEASUREMENT –FILTRATION EQUIPMENT:

4.1.1 Measurement for Filtration Equipment shall include the cost of all materials, equipment, labor, submittals and testing for the work indicated in this section.

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4.2 PAYMENT – FILTRATION EQUIPMENT:

4.2.1 Payment for Filtration Equipment, not included in other unit or lump sum price item, payment for filtration system will be made at the applicable price stated in the bid.

END OF SECTION

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### MULTISTAGE CENTRIFUGAL BLOWER

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION:

1.1.1 This section includes all labor, equipment, and materials required for furnishing, installing, controls programming, accessories, appurtenances, and testing multistage centrifugal blowers complete with all appurtenances as specified herein and in accordance with the requirements for the Contract Documents.

1.1.2 Each unit shall include, but is not limited to the following components:

- a. Premium efficiency electric motor
- b. Multistage centrifugal blower with cast aluminum impellers
- c. Local blower protection panel
- d. Instrumentation and controls
- e. Accessories as specified, containing inlet filter silencer, expansion joints, inlet butterfly valve, discharge check valve, etc.

1.1.3 The Contractor shall furnish install all Instrumentation and Control equipment and all ancillary equipment as specified herein, and other related sections, including power and control wiring between package mounted components, which is to be completed in the factory prior to shipping the equipment. All power, communication and control wiring between interrelated components or on separate packaged units, and other standardized components shall be by Contractor 1B.

1.1.4 To assure proper interfacing and reliable operation for all system components, the system supplier shall assume sole responsibility for the quantity and proper functioning of all components, including those not of his manufacture.

1.1.5 All wiring and terminations to equipment specified in this Section to be by Contract 1B with direct supervision of terminations by the Contract 1A. Contract 1A to coordinate with Contract 1B for all size and type for all equipment connections specified herein.

##### 1.2 QUALITY ASSURANCE:

1.2.1 Standards referenced in this section are listed below:

- a. American Society for Testing and Materials, (ASTM).
- b. National Electric Code, (NEC).
- c. National Electrical Manufacturers Association, (NEMA).
- d. Institute of Electrical and Electronic Engineers, (IEEE).

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### MULTISTAGE CENTRIFUGAL BLOWER

- e. American National Standards Institute, (ANSI).
- f. AFBMA
- g. ASME PTC 10–1997.
- h. ISO 5389-2005, Turbocompressors – Performance test code.
- i. ISO 3746-1995, Determination of sound power levels of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane
- j. ISO 3744-1994, Determination of sound power levels of noise sources using sound pressure – Engineering method in an essentially free field over a reflecting plane
- k. ISO 4871-1996. Declaration and verification of noise emission values of machinery and equipment

#### 1.2.2 General:

- a. Manufacturer's facility, where blowers will be manufactured and tested, shall be ISO 9001 certified. Manufacturer shall include a copy of the ISO 9001-2000 certificate with the submittals
- b. The engineer may witness all or part of the performance testing at the factory and/or the field.
- c. Tests shall be conducted using the actual model which will be supplied. Test results from previous models or similar sized model shall not be acceptable.

#### 1.2.3 Related Sections:

- a. Section 09900 - Painting
- b. Section 11333 - Filtration Equipment
- c. Section 15300 - Mechanical Piping System
- d. Section 15381 – Supports and Anchors

1.2.4 All electrical equipment, control panels, and wiring shall be in full conformance with Division 16 Electrical of these specifications.

1.2.5 The manufacturer of the multistage centrifugal blowers shall be completely responsible for the proper design of their system, including but not limited to; blowers, protection panels, discharge and control valves, and controls. All equipment shall perform as specified and the completed installation shall operate in accordance with the requirements of the plans and specifications. All components shall be provided to provide a complete and operable system.

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### MULTISTAGE CENTRIFUGAL BLOWER

#### 1.3 SUBMITTALS:

##### 1.3.1 Submit to Engineer the following:

- a. Proposed equipment supply list with electrical characteristics of motor driven equipment.
- b. Make, model number, and catalog information of all equipment, including, but not limited to blower, instrument and sensors, appurtenances.
- c. Manufacturer's Operation and Maintenance Manual.

##### 1.3.2 Submit shop drawings and project data as follows:

###### 1. Shop Drawings:

- a. Dimensional drawings of the unit assembly, including accessories
- b. Anchor bolt layout drawings if required.
- c. Drawings showing installation details including wiring diagrams, pipe layout, architectural and/or other mechanical work.
- d. Drawings of control panels (if required), including instruments, panel wiring, and Central Processing Unit (CPU) (if required) furnished in accordance with the requirements of this section.
- e. Complete description of wiring diagrams and functional operation.

1.3.3 Product Data: Submit data completely describing products and listings of all components and accessories with materials of construction including but not limited to the following:

- a. Proposed surface preparation and factory paint
- b. Multistage centrifugal blower operating characteristics and specifications
- c. Motor characteristics and specifications
- d. Datasheet on materials of Constructions for all major multistage centrifugal blower components and accessories
- e. Total system weight

##### 1.3.4 Performance Submittals:

- a. Performance test report of each blower signed by the manufacturer's test engineer using standard or equivalent test procedure
- b. Performance curve that includes rpm, power, characteristic lines for Rise To Surge and total efficiency curves based upon air flow rate and discharge pressure. Included shall be the noise levels dBA of each unit specified at operating conditions.

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1.3.5 Additional Submittal Data:

- a. Installation manual including storage, transportation, leveling, alignment, wiring, pre-start check list, and initial start up procedures
- b. Operating manual including local/remote operating method and error code
- c. Maintenance manual including daily, weekly, monthly, and annual inspection procedures
- d. Complete bill of materials

1.4 SERVICE FACILITY:

1.4.1 The name and address of an authorized repair and parts facility shall be provided with the above required information under "Submittals".

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

2.1.1 The listed manufacturers are believed to have the capability of producing equipment and/or materials meeting the requirements specified in this section. All blower systems shall be provided by one manufacturer.

2.1.2 Manufacturers:

- a. Gardner Denver Lamson
- b. Gardner Denver Hoffman

2.2 PERFORMANCE AND DESIGN CRITERIA – AIR SCOUR BACKWASH BLOWERS:

- a. Number of blowers: 1
- b. Site Conditions:
  - i. Elevation: 300 feet above Mean Sea Level
  - ii. Barometric pressure: 14.53 psia
  - iii. Inlet pressure (barometric minus 0.2 psia) 14.33 psia
  - iv. Inlet air temperature range: From 0 °F to 100 °F
  - v. Relative humidity: 36 %RH
- c. Discharge pressure: 2.89 psig

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### MULTISTAGE CENTRIFUGAL BLOWER

- d. Pressure loss through Inlet filter/silencer: 3” water gauge
- e. Air flow rate: 2300 scfm
- f. Inlet/Outlet Flange: 8-inch/8-inch
- g. Maximum Allowable Horsepower: 150 HP

#### 2.3 EQUIPMENT:

##### 2.3.1 Motor/Aerodynamic Parts:

2.3.1.1 The blower shall be provided with an electric motor. The motor shall be horizontal, two pole (3550 RPM ), 3 phase, 60 hertz, 460 volt, NEMA premium efficiency, 40 C ambient, class F insulation with class B temperature rise, TEFC enclosure. Motor shall be manufactured by Siemens, Baldor-Reliance, Toshiba, or approved equal.

2.3.1.2 Electric Standards shall conform to latest issue of IEEE, ANSI, and NEMA.

2.3.1.3 The motor shall have a 1.15 service factor. The motor shall be able to start under the starting conditions required. Blower manufacturer shall be responsible for coordinating the starting torque requirement of the blower and the motor. Certified tests shall be submitted to the Engineer prior to shipment of the equipment.

2.3.1.4 Nameplate: NEMA standard stainless steel. Shall also include NEMA efficiency rating, bearing information and number of starts per hour.

##### 2.3.2 Blowers:

2.3.2.1 The blower shall be high efficiency multistage centrifugal blower with integral horizontal, two pole (3550 RPM), 3 phase, 60 hertz, 460 volt input power.

2.3.2.2 Heated air from the motor and inverter shall not be mixed with intake fresh air.

2.3.2.3 The blower will be of the multi-stage centrifugal type with outboard mounted bearing construction in which the impellers are keyed to a heavy ground steel shaft and supported by anti-friction type bearings. To prevent shifting of the impellers while in operation, the hubs of all impellers shall butt together, either directly or through one-piece metal spacers. The entire assembly shall be secured with a lock washer and lock nut.

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2.3.2.4 The blower will be of the type in which the intermediate section is cast integrally with the casing to assure optimum operating efficiency.

2.3.2.5 Where the blower shaft passes through both the inlet and outlet heads, non-contact labyrinth seals will be provided to prevent leakage and to assure non-contamination of the bearing lubricant. Seals will be replaceable without having to disconnect inlet or discharge piping or removal of the blower.

2.3.2.6 Blower casing shall be rated for a pressure of 20 PSIG.

2.3.2.7 Blower Sections and Heads: Impeller housings shall consist of ASTM A48 class 30 cast iron intermediate sections (Class 25 is not acceptable) held securely between cast iron inlet and outlet heads with steel tie rods. The modular housing components shall be sealed by precision-machined rabbet joints and bonded with a sealant that can withstand the operating temperature of the blower. A tapped drain hole with a stainless steel pipe plug shall be provided in the bottom of each section. The inlet and outlet connections shall have an ANSI 125 pound drilled, tapped, and flanged pattern. The flanged connections shall be an integral part of the head castings.

2.3.2.8 Impellers: Impellers shall be of cast aluminum construction. Each impeller will be dynamically balanced to insure mechanical operation of not more than .235 IPS (peak to peak) vibration amplitude when measured on the bearing housing in the vertical and horizontal direction for direct driven packages. Vibration readings will be taken with the blower at operating speed.

2.3.2.9 Diffusers: Diffuser sections shall be provided between impellers. These sections shall receive air from one impeller and guide it into the next impeller. Diffuser vanes shall be an integral part of the intermediate section casting. Guide vanes shall be an integral part of the return channel in the intermediate casting.

2.3.2.10 Shaft: The blower shaft shall be of sufficient diameter and rigidity/strength to operate at least 20% below the first lateral critical speed and shall be fabricated from high strength carbon steel.

2.3.2.11 Bearing Housings: Bearings shall be mounted in ASTM A48 class 30 cast iron outboard bearing housings designed to isolate the bearing from the blower temperature. Each bearing housing shall have a bronze labyrinth, viton lip, or cast iron type insert in the area inboard of the bearing. This insert shall serve as a back-up bearing and protect the bearing from external contamination

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### MULTISTAGE CENTRIFUGAL BLOWER

2.3.2.12 Seals: No contact shall be allowed between the rotating element and the housing, except at the shaft bearings or when special contact seals are provided. Non-contact labyrinth seals shall be provided to minimize air/gas leakage.

2.3.2.13 Bearings: The blower shaft will be supported between two deep groove anti-friction ball bearings without filling slots. The bearings shall be able to be lubricated, inspected or replaced without disconnecting any piping or disassembling the blower. The blower bearings shall be grease lubricated. Bearings will be sized for extended  $L_{10}$  life, at the speeds and loads imposed by this application, in accord with AFBMA Standards for Ball and Roller bearings, Section 9. The Engineer reserves the right to require substantiating bearing life calculations.

2.3.2.14 Balance Piston: A balance piston will be integrally shaft mounted on the discharge end of the blower. Air leakage past the balance piston will be vented to atmosphere or returned to the inlet in an external return line. The balance piston will reduce the thrust load on the thrust bearing.

2.3.2.15 Base: Each motor-blower unit will be mounted on an ASTM A36 hot rolled structural steel fabricated base. Suitable resilient foundation mounting pads will be furnished and installed beneath the base.

2.3.2.16 Flexible Drive Coupling: The blower shall be connected to the driver with a suitable non-lubricated flexible coupling, with a minimum service factor of 1.35. The installing contractor shall check, and if necessary, adjust the alignment of the coupling(s) in accordance with the manufacturer's instructions. Each coupling shall be covered with a suitable coupling guard. During layout a factory laser alignment shall be conducted prior to shipment to facilitate alignment in the field. Coupling shall be Rexnord Omega non-spacer type.

2.3.2.17 The blower package vibration levels shall be low enough that it shall not require any floor grouting or anchoring for adequate operation.

2.3.2.18 No special foundations shall be required for installation.

2.3.2.19 The blower shall be certificated by NRTL (Nationally Recognized Testing Laboratory) with appropriate UL standards.

2.3.2.20 The blower shall be factory tested by the standard methods based upon ASME PTC-10:1997 and/or applicable test codes such as ISO 5389:2005, JIS B 8340. Acceptance criteria is 2% tolerance on power and flow.

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2.3.2.21 CFM flow is to be accurately measured by use of a bellmouth inlet design and use of a measured inlet and outlet pressure. Actual ambient and process temperatures should be measured using temperature instrumentation. No assumptions or calculations regarding flow, pressure, temperatures or relative humidity shall be made. All process and performance conditions shall be measured, not calculated.

2.3.2.22 The blower shall be supplied with built in vibration isolating mounts. Blower manufacture shall be responsible for attenuating noise and vibration in the blower package such that no special installation base shall be required nor shall any vibration from the blower package be transmitted to the floor or intake and discharge base or the piping.

#### 2.3.3 Local Blower Protection Panel

2.3.3.1 A local blower protection panel shall be provided for each blower to protect against blower surge and motor overload, and shall provide blower bearing vibration monitoring and protection. The panel shall be Gardner Denver "SmartMeter→" II digital solid state meter, in a NEMA 12 indoor rated enclosure, or approved equal.

2.3.3.2 The surge / overload monitor shall have four separate set points, each with a 5 amp, SPST, Form A, 240VAC rated relay contact. The following set points shall be pre-programmed and field adjustable:

- Impending Surge
- Surge
- Impending Overload
- Overload

2.3.3.3 The surge / overload monitor shall have three seven segment LED digital displays that provide current equipment status in a message format, digital readout of motor amperage, and digital readout of the blower air flow. Alarm LEDs shall be provided on the front of the SmartMeter→ II, visible through a plexiglass window in the panel door. The alarm LEDs shall provide indication when impending surge, surge, impending overload, and overload conditions exist. A manual reset pushbutton shall be provided that is accessible from the front panel exterior.

2.3.3.4 The surge / overload monitor shall be equipped to relay signals to both filter control panels such that all alarms and readouts can be seen at the control panels. Remote start/stop capabilities from both filter control panels shall be provided.

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2.3.3.5 Refer to Contract Drawings (One-Line Diagram – Control) for information regarding the controls and input/output required.

2.3.3.6 The panel shall include a solid state bearing vibration protection system with a face mounted digital indication of individual bearing vibration for both bearings displayed in inches per second. Vibration sensors shall be mounted directly on the bearing housings. Sensors shall be 2-wire, 4 to 20 mADC piezo-electrical velocity transmitters. The electrical contractor shall run electrical leads between the sensors and the panel in a single metal conduit. The conduit shall not contain any wires that carry AC current.

2.3.3.7 A front mounted light shall indicate vibration warning which will discontinue when the vibration level reaches a satisfactory level. Blower motor trip will occur when vibration reaches approximately 0.75 inches per second. Blower motor trip will be accompanied by a pilot light. It will be necessary to press a reset button in order to restart the blower motor following a high vibration trip.

2.3.3.8 When a vibration trip occurs, the vibration indicator shall hold the reading that existed when the trip occurred. Time delay relays shall be provided to disable the vibration protection while the motor is being started. Time delay relays shall also prevent vibration warnings and shutdowns caused by transient vibrations.

2.3.3.9 The vibration protection system will have the ability to detect when vibration transmitters are defective by detecting transmitters that contain a short or open circuit. The protection system will alert the operator through the displays when a velocity transmitter has failed in this manner.

#### 2.3.4. Accessories:

2.3.4.1 Operator shall not be required to reach over any component of the blower package to perform maintenance.

2.3.4.2 Inlet Filter Silencer: The Air Intake Filter Silencer shall have a minimum efficiency of 98% on 10 micron particles. The filter silencer shall be conical canister or panel type, designed for the max capacity flow (highest temperature) of the blower plus 20%. The filter media shall be cleanable and replaceable synthetic media. The filter unit shall be shipped loose for field installation. Pressure drop across the entire unit, with clean filter elements, shall not exceed 3.0" water gauge.

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2.3.4.3 Expansion Joints: Reinforced, flexible rubber expansion connectors shall be supplied to mate with the blower's outlet flanges. This will isolate the blower from the piping system. The connectors shall be reinforced EPDM, rated for 20 PSIG (20" Hg Vac) and 300 degrees F operation. The connectors shall be shipped loose for field installation.

2.3.4.4 Inlet Butterfly Valve: A wafer style butterfly valve for mounting on the blower inlet shall be provided and be of the same size as the blower inlet connection. Valve design shall have bi-directional flow, EPDM seat, 416 stainless steel shaft, and 200-PSI CWP rated. Valve shall be electrically actuated. Actuator is to be of the modulating type.

2.3.4.5 Discharge Check Valve: A check valve to prevent backflow shall be provided for installation in the discharge piping of each blower. The check valve shall be sized to match the blower discharge piping. It shall be of the positive sealing, springless, double leaf style with silicon seats suitable for 500 degrees F. The valve shall be shipped loose for field installation.

2.3.4.6 Discharge Isolation Butterfly Valve: Four (4) discharge butterfly valves shall be provided for installation in the downstream piping. They shall provide positive line shutoff during periods of blower maintenance. Valve design shall have bi-directional flow, EPDM seat, 416 stainless steel shaft, and 200-PSI rated. Valves shall be electrically actuated. Actuator is to be open/close and are specified in Article 2.2.2.5.1 of Section 11333.

2.3.4.7 Local Blower Protection Panel: A local blower protection panel shall be provided for each blower to protect against blower surge and motor overload, and shall provide blower bearing vibration monitoring and protection. The panel shall be Gardner Denver "SmartMeter→" II digital solid state meter, in a NEMA 12 indoor rated enclosure, or approved equal. A properly sized current transformer shall be provided loose, for installation in the MCC by others.

2.3.4.8 The General Contractor shall provide all air piping from the diffuser terminations at the basins to the blowers as shown on the Contract Drawings. Supply of electrical wiring and junction box/disconnects shall be furnished and installed under Contract No. 1B - Electrical.

#### 2.4 SPARE PARTS:

2.4.1 The following spare parts shall be provided:

- a. One (1) set of bearings per each blower supplied
- b. One (1) spare capacitor per each blower supplied
- c. One (1) set of gaskets per each blower supplied

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### MULTISTAGE CENTRIFUGAL BLOWER

#### PART 3 – EXECUTION

##### 3.1 DELIVERY, STORAGE AND HANDLING:

3.1.1 All equipment shall be properly crated and delivered to jobsite to protect against damage during shipment. Factory assembled parts and components shall not be dismantled for shipment. Contractor shall not be required to do any jobsite assembly of the blower and motor and shall not disassemble a factory assembled component without blower manufacturer's written approval. Assembly of accessories, as described in Part 2 of this section will be by the Contractor.

3.1.2 All exposed flanges shall be protected by wooden black flanges, strongly built and securely bolted thereto. Finished iron or steel surface not painted shall be properly protected to prevent rust and corrosion.

3.1.3 All equipment delivered to the site shall be stored in accordance with manufacturer's instruction.

3.1.4 Blower shall not, under any conditions, be allowed to sit out-of-doors unprotected. During actual installation of each unit, blower package shall be covered with a waterproof material in the event of any precipitation and also at all times that construction does not require exposure of the equipment. Covering shall be securely anchored.

##### 3.2 INSTALLATION:

3.2.1 Install and place in service the blower and all appurtenances in accordance with the manufacturer's recommendations.

3.2.2 The blower supplier shall supply blower and motor shipped completely pre-assembled.

3.2.3 Contractor shall, where required install anchor bolts per the Manufacturer's instructions and calculations.

3.2.4 The blower manufacturer shall include in his cost all assistance to be provided to the installing contractor to ensure proper installation, testing, start-up and training of the Owner's personnel.

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### MULTISTAGE CENTRIFUGAL BLOWER

#### 3.3 STARTUP:

##### 3.3.1 Manufacturer's Representative:

3.3.1.1 The manufacturer's representative shall inspect the installation of the equipment, make any necessary adjustments, test and place the equipment in satisfactory operating condition. The manufacturer's representative shall also instruct the plant operating personnel in the operation and maintenance of the equipment. The procedures below shall be followed to determine satisfactory operation.

- a. Following installation but prior to startup or testing, the Manufacturer shall send a representative to the job site to inspect the installation. Any deficiencies noted during the Manufacturer's inspection must be corrected prior to startup or testing. The manufacturer shall note his findings in a written Installation Deficiency Report to the Contractor, with a copy provided to the Engineer.
- b. The Contractor shall remedy the deficiencies noted by the Manufacturer in the Installation Deficiency Report. The Manufacturer shall re-inspect the installation and this process shall be repeated until the Manufacturer finds the equipment to be installed in accordance with its recommendations and requirements.
- c. Upon finding of satisfactory installation, and prior to startup or testing, the Manufacturer shall issue a Certificate of Proper Installation and provide a copy to the Engineer. Startup and testing may begin once the Engineer has received the Certificate of Proper Installation from the Manufacturer.

3.3.1.2 After installation of all work under Contract 1A has been completed for the first filter and as soon as conditions permit, the manufacturer's representative shall make one (1) trip (one 8-hour day) to conduct an acceptance test under actual operating conditions, to determine the operation is satisfactory and free from excessive vibration as defined by the blower manufacturer. The test shall consist of three (3) hours operation with readings taken and recorded as directed by the manufacturer. The acceptance test shall include field tests as described in paragraph 3.03. In addition to the above, the Manufacturer shall be present at the job site for a minimum of two 8-hour days, exclusive of travel time, to fully train the Owner's personnel in the proper operation and maintenance of the equipment.

3.3.1.3 In addition to the above, the manufacturer shall be present at the jobsite for a minimum of two (2) 8-hour days, exclusive of travel time, to fully train the owners' personnel in the proper operation and maintenance of the equipment.

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### MULTISTAGE CENTRIFUGAL BLOWER

3.3.1.4 After the equipment has been placed into operation by the owner for a minimum of forty-five (45) calendar days, the equipment manufacturer shall provide one (1) 8-hour day of equipment follow-up for equipment inspection and owner review. This visit shall be coordinated with the Owner.

#### 3.3.2 Field Testing:

3.3.2.1 After the installation of the units and all appurtenances, each unit shall be subjected to a field running test under actual operating conditions. The field tests shall be made by the Contractor in the presence of and as directed by the Manufacturer's Representative. The field tests shall demonstrate that under all conditions of operation each unit:

- a. Has not been damaged by transportation or installation.
- b. Has been properly installed.
- c. Has no mechanical defects.
- d. Is in proper alignment.
- e. Has been properly connected.
- f. Is free of overheating of any parts.
- g. Is free of all objectionable vibration.
- h. Is free of excessive noise.
- i. Is free of overloading of any parts.
- j. Shall operate as specified with the control system.
- k. Meets the performance requirements indicated in Section 2.2 in this specification. Calibrated external flowmeter(s), power meter(s), and pressure gauge(s) shall be used In order to prove performance in the field. Total efficiency shall be calculated by the ratio of the specific isentropic compression work (ISO 5389:2005, E.68, page 83) and total power measured by the calibrated external power meter(s).

3.3.2.2 Any defects in the equipment or failure to meet the requirements of the Specifications shall be promptly corrected by the Manufacturer.

#### 3.3 WARRANTY:

3.3.1 The contractor shall provide a warranty against defective or deficient materials and workmanship in accordance with the requirements of the section entitled "Warranties and Bonds" of these specifications.

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### MULTISTAGE CENTRIFUGAL BLOWER

3.3.2 The blower manufacturer shall furnish the Owner with a written warranty to cover the blower, including motors, control components, and all appurtenances included within this Section against defects in workmanship and material for a period of Eighteen (18) months from delivery or Twelve (12) months from completion of the project or from date of start-up and Engineer's acceptance of the equipment for permanent operation, whichever occurs first. The manufacturer's warranty shall be issued in the Owner's name.

#### PART 4 - MEASUREMENT & PAYMENT

##### 4.1 MEASUREMENT – MULTISTAGE CENTRIFUGAL BLOWERS:

4.1.1 Measurement for Multistage Centrifugal Blowers shall include the cost of all materials, equipment, labor, submittals and testing for the work indicated in this Section.

##### 4.2 PAYMENT – MULTISTAGE CENTRIFUGAL BLOWERS:

4.2.1 For Multistage Centrifugal Blowers not included in other unit or lump sum price items, payment for Multistage Centrifugal Blowers will be made at the applicable price stated in the Bid.

END OF SECTION

## SECTION 15011

### MECHANICAL GENERAL REQUIREMENTS

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Mechanical General Requirements, as shown on the Plans, as specified and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

##### 1.2.1 Code of Federal Regulations (CFR) Publications:

29-1910-SUBPART O Machinery and Machine Guarding

29-1910.219 Mechanical Power-Transmission Apparatus

1.3 RELATED REQUIREMENTS: All sections of Division 15, "Mechanical" of this Project Specification, unless specified otherwise in the individual section.

##### 1.4 SUBMITTALS:

1.4.1 Manufacturer's Data: Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts.

1.4.2 Shop Drawings: Drawings shall be a minimum of 8.5 inches by 11 inches in size, except as specified otherwise. Drawings shall include floor plans, sectional views, wiring diagrams, and installation details of equipment; and equipment spaces identifying and indicating proposed location, layout and arrangement of items of equipment, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals, and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.4.3 Manufacturer's Certificates of Compliance: Submit certification from manufacturer attesting that materials and equipment to be furnished for this project comply with the requirements of this specification and of the reference publications. Pre-printed certifications

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### MECHANICAL GENERAL REQUIREMENTS

will not be acceptable; certifications shall be the manufacturer's original; certifications shall be not more than one year old. The certification shall not contain statements that could be interpreted to imply that the product does not meet all requirements specified, such as "as good as"; "achieve the same end use and results as materials formulated in accordance with the referenced publications"; "equal or exceed the service and performance of the specified material". The certification shall simply state that the product conforms to the requirements specified. Certificates shall be signed by the manufacturer's official authorized to sign certificates of compliance.

1.4.4 Reference Standards Compliance: Where equipment or materials are specified to conform to industry and technical society reference standards of organizations such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), American Society of Mechanical Engineers (ASME), American Gas Association (AGA), American Refrigeration Institute (ARI), and Underwriters' Laboratories (UL), proof of such conformance shall be submitted. If an organization uses a label or listing to indicate compliance with a particular reference standard, the label or listing will be acceptable evidence, unless otherwise specified in the individual sections.

1.4.4.1 Independent Testing Organization Certificate: In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.5 OPERATION AND MAINTENANCE MANUAL: Furnish an operation and maintenance manual for each item of equipment. Furnish three copies of the manual bound in hardback binders or an approved equivalent. Furnish one complete manual to the Owner's Representative for review and approval not more than 90 calendar days after an item is approved, but at least 60 calendar days prior to field acceptance testing of the item. Furnish the remaining manuals at least 60 days prior to contract completion. Inscribe the following identification on the cover: the words "OPERATION AND MAINTENANCE MANUAL", the name and location of the equipment or the building, the name of the Contractor, and the contract number. The manual shall include the names, addresses, and telephone numbers of each subcontractor installing equipment, and of the local representatives for each item of equipment. The manual shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in. The manual shall include: wiring and control diagrams with

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### MECHANICAL GENERAL REQUIREMENTS

data to explain detailed operation and control of each item of equipment; a control sequence describing start-up, operation and shut-down; description of the function of each principal item of equipment; the procedure for starting; the procedure for operating; shut-down instructions; installation instructions; maintenance instructions; lubrication schedule including type, grade, temperature range, and frequency; safety precautions, diagrams, and illustrations; test procedures; performance data; and parts list. The parts lists for equipment shall indicate the sources of supply, recommended spare parts, and the service organization which is reasonably convenient to the project site. The manual shall be complete in all respects for equipment, controls, accessories, and associated appurtenances provided.

**1.6 POSTED OPERATING INSTRUCTIONS:** Provide for each system and principal item of equipment as specified in the technical sections for the use of the operation and maintenance personnel. The operating instructions shall include the following:

- a. **System Descriptive Information:** Wiring diagrams, control diagrams, piping diagrams, control sequence and operating points for each principal system and item of equipment. Post instructions where directed.
- b. **Equipment Instructions:** Attach to or post adjacent to each principal item of equipment and include directions.
  - (1) Start up, proper adjustment, operating, lubrication, and shutdown procedures.
  - (2) Safety precautions, procedure in the event of equipment failure.
  - (3) Other areas as recommended by the manufacturer of each system or item of equipment.

Print or engrave, and frame under glass or in approved laminated plastic. Operating instructions exposed to the weather shall be made of weatherproof materials or enclosed to be weather protected. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

**1.7 CATALOGED PRODUCTS:** Materials and equipment shall be cataloged products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer's latest design that complies with the specification requirements. Materials and equipment shall duplicate items that have been in satisfactory commercial or industrial use. Where two or more items of the same class of equipment are required, these items shall be

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### MECHANICAL GENERAL REQUIREMENTS

products of a single manufacturer; however, the component parts of the items need not be the products of the same manufacturer. Each item of equipment shall have the manufacturer's name, address, model number and serial number on the nameplate securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.8 LAYOUT OF THE WORK: Coordinate the proper relation of the work to the building structure, existing utilities and to the work of all trades. The Contractor shall advise the Owner's Representative of any discrepancy before performing any work.

1.8.1 Contract Drawings: The Contract Drawings represent the general intent as to piping and equipment arrangements. All locations and dimensions shown shall be field verified and minor alterations made if so required. Where dimensions are not given for the location and arrangement of mechanical systems, locations may be assumed to be approximate, and may be altered if required. Major modifications to the indicated arrangements shall be approved by the Owner's Representative prior to the installation of mechanical systems. Schematic diagrams represent the overall system requirements and do not necessarily indicate the physical orientation, location or dimensions of that system.

1.8.2 Record Drawings: The Contractor shall maintain a record of the progress of the work and shall submit three (3) sets of As-Built Drawings upon completion of the project.

1.9 MANUFACTURER'S RECOMMENDATIONS: Unless otherwise stated in the Contract Specifications, all new equipment items, and specialties shall be installed in strict accordance with the recommendations of the manufacturer of the items being installed. Prior to the installation of new items, the Contractor shall submit to the Owner's representative printed copies of the manufacturer's installation recommendations. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material. Failure to install items in accordance with manufacturer's recommendations can be cause for rejection of the work items installed.

1.10 DELIVERY, STORAGE, AND HANDLING: Properly store, adequately protect, and carefully handle equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Engineer. Replace damaged or defective items.

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### MECHANICAL GENERAL REQUIREMENTS

#### 1.11 SAFETY REQUIREMENTS:

1.11.1 Equipment Safety: Fully enclose or properly guard in accordance with 29 CFR 1910.219 belts, pulleys, chains, gears, couplings, projecting setscrews, keys, rotating parts, and other power transmission apparatus, located where persons can come in close proximity thereto. Points of operation, ingoing nip points, and machinery producing flying chips and sparks shall be guarded in accordance with the applicable portions of 29 CFR 1910-SUBPART O. Provide positive means of locking out equipment so that equipment cannot be accidentally started during maintenance procedures. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be properly guarded or covered with insulation of the type specified. Provide catwalks, maintenance platforms, and guardrails where required for safe operation and maintenance of equipment. Provide ladders or stairways to reach catwalks and maintenance platforms. Ensure that access openings leading to equipment are large enough to carry through routine maintenance items such as filters and tools.

1.11.2 Warning Sign: Provide a permanent placard or sign at the entrance to confined spaces contained in the equipment. The sign shall warn personnel not to enter the space until the atmosphere inside has been tested and systems have been de-energized.

1.12 ELECTRICAL REQUIREMENTS: Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors shall conform to and have electrical connections provided under Section 16402, "Interior Wiring Systems". Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120 volt control circuits, and shall have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work shall be included under this Section. Power wiring and conduit for field installed equipment shall be provided under and conform to the requirements of Section 16402, "Interior Wiring Systems".

1.13 SPECIAL CONDITIONS: The Contractor shall be performing work within active plant manufacturing areas and shall be responsible to coordinate with the Owner regarding planned interruptions to mechanical and electrical services.

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### MECHANICAL GENERAL REQUIREMENTS

1.13.1 Protection of Existing Work: The Contractor shall take all necessary precautions to insure against damage to existing work to remain in place, or to be reused. The Contractor shall insure that structural elements are not overloaded and additional structural supports required as a result of any cutting, removal or demolition work performed under any part of this Contract are added. The Contractor shall minimize disruption of existing non-contract work areas as much as possible.

1.13.2 Upon damage to existing equipment, buildings and/or structures, the Contractor shall immediately notify the Owner. All damages shall be repaired by the Contractor, or shall be replaced if beyond repair to match the existing to the Owner's satisfaction.

1.13.3 Protection of Buildings from the Weather: The interior of the buildings and all materials and equipment shall be protected from the weather at all times.

1.13.4 Protection of Personnel: Where the safety of non-contractor personnel is endangered in the area of the work, barricades shall be used. Additional protection shall be provided, if required, to preserve the safety of non-contractor personnel in the immediate area of the work.

1.14 INSTRUCTION TO OWNER'S PERSONNEL: When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Owner's personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. The number of days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the Contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

## PART 2 - PRODUCTS

Not Used.

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MECHANICAL GENERAL REQUIREMENTS

PART 3 - EXECUTION

3.1 FIELD PAINTING: Conform to Section 09900, "Painting."

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - MECHANICAL GENERAL REQUIREMENTS:

4.1.1 Measurement for Mechanical General Requirements shall include the cost of all materials, equipment, labor, submittals and testing for the work indicated in this Section.

4.2 PAYMENT - MECHANICAL GENERAL REQUIREMENTS:

4.2.1 For Mechanical General Requirements, not included in other unit or lump sum price items, payment for Mechanical General Requirements will be made at the applicable price stated in the Bid.

END OF SECTION

## SECTION 15140

### ANCHORS AND SUPPORTS

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Anchors and Supports of pipe, conduit, equipment hangers, bases and supports.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in text by the basic designation only.

##### 1.2.1 American National Standards Institute (ANSI) Publication:

B31.1 Pipe Hangers & Supports

##### 1.2.2 Manufacturer's Standardization Society of the Valves & Fittings Industry (MSS):

SP 58 Pipe Hangers & Supports - Materials, Design & Manufacture

SP 69 Pipe Hangers & Supports - Selection & Application

##### 1.3 RELATED WORK SPECIFIED ELSEWHERE:

- Piping
- Valves
- Conduit

##### 1.4 SUBMITTALS:

1.4.1 Submit shop drawings for substitutions or other deviations from the Specifications. Shop drawings are not required to be submitted for specified manufacturer's and equipment that do not deviate from the Specifications.

1.4.2 Design Data: Indicate load carrying capacity of trapeze, unistrut, multiple pipe, and riser support hangers.

1.4.3 Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

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### ANCHORS AND SUPPORTS

#### 1.5 REGULATORY REQUIREMENTS:

1.5.1 Conform to applicable code for support of hydronic piping.

1.5.2 Supports for Electrical Conduit and Enclosures: In conformance with NFPA 70.

#### PART 2 - PRODUCTS

##### 2.1 GENERAL:

2.1.1 All hangers and supports shall be manufactured or fabricated from materials suitable for the particular area in which they are installed.

2.1.2 The Contractor shall install hanger supports that are similar in material construction, regardless of piping or conduit application within a given area. Therefore, pipe hangers and supports for process pipe, conduit, heating and ventilating piping and plumbing piping shall be constructed of similar materials.

2.1.3 Where applicable, fasteners, brackets and supports shall be fabricated as specified herein.

##### 2.2 MATERIALS:

2.2.1 Stainless Steel: For the purpose of this Section, all stainless steel (S.S.) shall be Type 316.

2.2.2 Polyvinyl Chloride (PVC) Coated Materials: PVC coated hangers and supports shall be installed where applicable for chemical and corrosion resistant applications as required in the specified areas, or as specifically called out in other sections of these Specifications. PVC coating process shall be as follows:

- a. Hanger or support shall be hot-dipped galvanized including the threads.
- b. The zinc surface shall be treated with chromic acid prior to coating to enhance the bond between metal and plastic.
- c. All surfaces shall be coated with an epoxy acrylic primer of approximately .0005-inch thickness.

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### ANCHORS AND SUPPORTS

- d. The coating shall be applied by the liquid plastisol method. Both the plastisol and galvanized conduit shall be manufactured by the manufacturer applying the coating.
- e. The plastisol shall be compounded of pure materials and shall be free of any fillers or secondary plastisizers.
- f. A Polyvinyl Chloride (PVC) coating shall be bonded to the galvanized outer surface of the product. The bond between the PVC coating and the product surface shall be greater than the tensile strength of the plastic. The thickness of the PVC coating shall be a minimum of .040-inch (40 mil).
- g. Coating system shall be OCAL-40 as provided by Occidental Coating Company, Van Nuys, CA; Plasti-Bond Red as provided by Robroy Industries, Verona, PA; or equal.

2.2.3 Steel, Steel Alloys: Steel or steel alloy hangers and supports shall conform to ANSI B31.10 and MSS Standard Practice SP-58.

#### 2.3 MANUFACTURERS:

2.3.1 Hangers and supports shall be as manufactured by ITT Grinnell, Providence, RI; Basic Engineering (B.E.), Pittsburgh, PA; Carpenter & Patterson, Lakeport, NH; Unistrut Corporation; B-Line Systems; Globe Division of United States Gypsum; Robroy Industries; OCAL; or equal.

#### 2.4 FASTENING DEVICES AND MOUNTING HARDWARE:

2.4.1 All pipe supports in wet, corrosive, hazardous or exterior locations shall have stainless steel support rods, stainless steel (S.S.) mounting hardware, S.S. fasteners and S.S. concrete inserts. S.S. shall be Type 316.

2.4.2 All other areas shall have cadmium plated appurtenances unless specified otherwise.

### PART 3 - EXECUTION

#### 3.1 GENERAL:

3.1.1 All piping to be supported from floors, concrete slabs, ceilings or walls shall have supports and parts required for the installation of the piping systems which conform to the

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### ANCHORS AND SUPPORTS

requirements of Chapter 1, Section 6 of the ANSI Code for Pressure Piping (B31.1), except as modified and supplemented by the requirements set forth in these Specifications.

#### 3.2 SUPPORT INTERVALS:

3.2.1 At a minimum, additional supports or anchors will be required at:

- a. All bends on pump discharge line to prevent vertical or horizontal movement resulting from pressure thrusts.
- b. Each side of all couplings in the horizontal plane to eliminate vertical force on couplings.
- c. All branch connections to eliminate vertical and horizontal movement.
- d. Both sides of expansion joints to prevent horizontal movement.
- e. All pipe joints subject to torque along centerline of pipe. Piping shall be supported so that pumps and other equipment may be removed without providing additional pipe support.

3.2.2 Flanged Ductile Iron Pipe: Supports and hangers for flanged ductile iron and steel pipe 1-1/4 inches and larger shall not be more than 10 feet on center.

- a. Additional supports and hangers will be required for grooved end ductile iron pipe and fittings at the Contractor's expense.

3.2.3 Plastic Pipe: Supports and hangers and/or braces for plastic piping shall be used at all bends and at not more than 4 feet on centers horizontally and vertically, except non-metallic electrical conduit spacing shall be 3 feet on centers.

- a. Supports and hangers for plastic piping shall include saddles and bands to distribute load and thus avoid localized deformation of the pipe.
- b. All necessary inserts or appurtenances shall be furnished and installed in the concrete or structures for adequately securing these supports to the structure.

3.2.4 Stainless Steel Pipe: Hangers and supports for stainless steel pipe 1-1/4 inches and larger shall not exceed 20'-0" maximum.

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3.2.5 Copper Pipe: Copper pipe 1/2 inch to 1 inch, 6'-0" maximum support spacing; 1-1/4 inch and over 10'-0" maximum.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - ANCHORS AND SUPPORTS:

4.1.1 The quantity of Anchors and Supports measured for payment shall be the total number of Anchors and Supports furnished and installed.

4.2 PAYMENT - ANCHORS AND SUPPORTS:

4.2.1 For Anchors and Supports, not included in other unit or lump sum price items, payment for Anchors and Supports will be made at the applicable price stated in the Bid.

END OF SECTION

SECTION 15999

PAYMENT ITEM FOR CONTRACT NO. 1A  
GENERAL CONSTRUCTION FOR  
WATER TREATMENT PLANT FILTER REHABILITATION

PART 1 - DESCRIPTION:

1.1 Under this Item, the Contractor shall furnish all labor, materials and equipment for the completion of Contract No. 1A - General Construction for City of Saratoga Springs Water Treatment Plant Filter Rehabilitation.

In addition to the applicable provisions of Sections 00100 thru and including 01640, and other Divisions of this project, the following sections describe the principal items of work to be performed under this payment item:

SECTION

02050	Demolition and Removal
02080	Removal and Disposal of Asbestos
03302	Cast-In-Place Concrete (Minor Construction)
09900	Painting
11333	Filtration Equipment
11378	Multistage Centrifugal Blowers
15011	Mechanical General Requirements
15140	Anchors and Supports
15300	Mechanical Piping Systems
15381	Process Piping and Valves

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - PAYMENT

4.1 Payment for Contract No. Contract No. 1A - General Construction for Water Treatment Plant Filter Rehabilitation, will be included in the lump sum price items stated in the Bid.

END OF SECTION

SECTION 16011

ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Electrical General Requirements, as shown on the Plans, as specified and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.2.1 Federal Specification (Fed. Spec.):

L-P-387A Plastic Sheet, Laminated, Thermosetting (for Design Plates)

1.2.2 American National Standards Institute (ANSI) Publications:

C37.20 Switchgear Assemblies, Including  
Metal-Enclosed Bus

Z35.1 Accident Prevention Signs

1.2.3 Institute of Electrical and Electronics Engineers (IEEE) Publication:

100 Standard Dictionary of Electrical and Electronics Terms

1.2.4 National Electrical Manufacturers Association (NEMA) Publication:

ICS 6 Enclosures for Industrial Controls and  
Systems

1.2.5 National Fire Protection Association (NFPA) Publication:

70E Standard for Electrical Safety in the Workplace

70B Electrical Equipment Maintenance

70 National Electrical Code

## SECTION 16011

### ELECTRICAL GENERAL REQUIREMENTS

1.3 APPLICATION: This Section applies to all sections of Division 16, "Electrical", of this Project except as specified otherwise in each individual section.

1.4 DEFINITION OF ELECTRICAL TERMS: Unless otherwise specified or indicated, electrical terms used in these Specifications, and on the drawings, shall be as defined in IEEE Standard No. 100.

1.5 SUBMITTALS: Obtain approval before procurement, fabrication, or delivery of items to the job site. Partial submittals will not be acceptable and will be returned without review. Submittals shall include the manufacturer's name, trade name, place of manufacture, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable Federal, Military, industry, and technical society publication references, and other information necessary to establish contract compliance of each item to be furnished. Furnish a minimum of six (6) copies of shop drawings for each major device specified.

1.5.1 Shop Drawings: In addition to the requirements specified elsewhere, shop drawings shall meet the following requirements. Drawings shall be a minimum of 8.5 inches by 11 inches in size, except as specified otherwise. Drawings shall include complete ratings information, wiring diagrams, and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to assure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If equipment is disapproved, revise drawings to show acceptable equipment and resubmit.

1.5.2 Manufacturer's Data: Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts.

1.5.3 Publication Compliance: Where equipment or materials are specified to conform to industry and technical society publications of organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), and Underwriters' Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears. In lieu of the label or listing, submit a certificate

## SECTION 16011

### ELECTRICAL GENERAL REQUIREMENTS

from an approved independent testing organization, adequately equipped and competent to perform such services, stating that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's publication.

1.5.4 Submittals Required: Supply shop drawing submittal information on the equipment as noted in each individual Section.

1.6 OPERATION AND MAINTENANCE MANUAL: Submit as required for systems and equipment indicated in the technical sections. Furnish three copies, bound in hardback binders or an approved equivalent. Furnish one complete manual prior to performance of systems or equipment tests, and furnish the remaining manuals prior to contract completion. Inscribe the following identification on the cover: the words "OPERATION AND MAINTENANCE MANUAL", the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment. Include a table of contents and assemble the manual to conform to the table of contents, with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in. The manual shall include:

- a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the system or equipment.
- b. A control sequence describing startup, operation, and shutdown.
- c. Description of the function of each principal item of equipment.
- d. Installation and maintenance instructions.
- e. Safety precautions.
- f. Diagrams and illustrations.
- g. Testing methods.
- h. Performance data.
- i. Lubrication schedule including type, grade, temperature range, and frequency.

## SECTION 16011

### ELECTRICAL GENERAL REQUIREMENTS

- j. Parts list. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
- k. Appendix: List qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.

1.7 SPARE PARTS: Provide the following spare parts for all equipment installed under this Contract, unless indicated otherwise elsewhere.

- a. Three (3) power fuses for each different size and type used.
- b. Five (5) control fuses for each different size and type used.
- c. Five (5) pilot lights for each different size and type used.

1.8 LAYOUT OF THE WORK: Coordinate the proper relation of the work to the building structure, existing utilities and to the work of all trades. The Contractor shall advise the Owner's Representative of any discrepancy before performing any work.

1.8.1 Contract Drawings: The Contract Drawings represent the general intent as to layout and equipment arrangements. All locations and dimensions shown shall be field verified and minor alterations made if so required. Where dimensions are not given for the location and arrangement of mechanical systems, locations may be assumed to be approximate, and may be altered if required. Major modifications to the indicated arrangements shall be approved by the Owner's Representative prior to the installation of mechanical systems. Schematic diagrams represent the overall system requirements and do not necessarily indicate the physical orientation, location or dimensions of that system.

1.8.1.1 The Owner or Engineer does not warranty the accuracy of any background drawings provided and the Contractor shall be responsible to field verify all background drawings.

1.8.2 Record Drawings: The Contractor shall maintain a record of the progress of the work and shall submit three (3) sets of As-Built Drawings upon completion of the project.

1.9 POSTED OPERATING INSTRUCTIONS: Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions as directed.

## SECTION 16011

### ELECTRICAL GENERAL REQUIREMENTS

Attach or post operating instructions adjacent to each principal system and equipment including startup, proper adjustment, operating, lubrication, shutdown, safety precautions, procedure in the event of equipment failure, and other items of instruction as recommended by the manufacturer of each system or equipment. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

**1.10 INSTRUCTION TO OWNER'S PERSONNEL:** Where indicated in the technical sections, furnish the services of competent instructors to give full instruction to Owner's personnel in the adjustment, operation, and maintenance of systems and equipment, including pertinent safety requirements as required. Each instructor shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Owner for regular operation. The number of man days (8 hours) of instruction furnished shall be as specified in each individual section.

**1.11 DELIVERY AND STORAGE:** Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B, Appendix I, titled "Equipment Storage and Maintenance During Construction". Replace damaged or defective items with new items.

**1.11.1 Protection of Personnel:** Where the safety of non-contractor personnel is endangered in the area of the work, barricades shall be used. Additional protection shall be provided if required, to preserve the safety of non-contractor personnel in the immediate area of the work.

**1.12 CATALOGED PRODUCTS/SERVICE AVAILABILITY:** Materials and equipment shall be current products by manufacturers regularly engaged in the production of such products. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The 2-year period shall be satisfactorily completed by a product for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the Contract.

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### ELECTRICAL GENERAL REQUIREMENTS

1.13 MANUFACTURER'S RECOMMENDATIONS: Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material. Obtain manufacturer's recommendations from the Owner for equipment and/or material provided by the Owner.

1.14 MOTORS AND MOTOR CONTROLS FOR MECHANICAL EQUIPMENT: The electrical components of mechanical equipment, such as motors, motor starters, control or push button stations, float or pressure switches, solenoid valves, and other devices functioning to control mechanical equipment, and control wiring and conduit for circuits rated 100 volts or less, are specified in the section covering the associated mechanical equipment, rather than in Division 16, unless otherwise shown. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, and the electrical power circuits shall be furnished and installed under Division 16.

#### PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT: All materials, equipment, and devices shall, as a minimum, meet the requirements of UL where UL standards are established for those items, and the requirements of NFPA 70. All items shall be new unless specified or indicated otherwise.

2.2 NAMEPLATES: Fed. Spec. L-P-387. Provide laminated plastic nameplates for each panelboard, equipment enclosure, relay, switch, and device. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125-inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the black core. Minimum size of nameplates shall be 1.0 inch by 2.5 inches. Lettering shall be a minimum of 0.25-inch high normal block style.

2.3 ARC FLASH HAZARD MARKING: Provide Arc flash warning labels for all new or modified electrical equipment. Electrical equipment shall include VFDs, panelboards, control panels, automatic transfer switches, generator main breakers, switches, and any other devices which are likely to require examination. Arc flash warning labels shall be provided in compliance with Article 110.16 of the NEC (2008). Labels shall be catalog No. 94913 as manufactured by Brady, or approved equal. Labels shall be a minimum of 3"H x 4"W and approved for indoor use. Labels affixed to equipment enclosures rated NEMA 3R, 4, 4X, 6, or 8 shall be rated for outdoor use.

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### ELECTRICAL GENERAL REQUIREMENTS

#### PART 3 - EXECUTION

3.1 NAMEPLATE MOUNTING: Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

#### 3.2 PAINTING OF EQUIPMENT:

3.2.1 Factory Applied: Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.

#### 3.3 TESTS:

3.3.1 General: Perform and record all tests in the presence of the Owner's authorized representative and/or the Engineer. Furnish all instruments and personnel. Perform preliminary tests and correct all defective material and/or workmanship prior to witness of tests. Perform tests as indicated and as otherwise noted in other Sections of the 16000 Division.

#### 3.3.2 Conduct field tests in the sequence listed below:

3.3.2.1 Insulation Resistance Tests: Make tests after all wiring is completed and connected ready for the attachment of fixture and/or equipment. Repeat test when all fixtures and/or equipment are connected ready for use. Make tests with an instrument capable of measuring the resistance involved at a voltage of at least 500 volts DC for equipment rated 100 to 500 volts AC, 1500 volts DC for equipment rated 151 to 600 volts AC. Apply voltage continuously for one minute prior to taking reading. Measure insulation resistance between each pair of insulated conductor separately and between each insulated conductor and ground. Make tests at each panelboard distribution panel, and switchboard on every circuit with the circuit protective device open but connected. The minimum acceptable measured insulation resistance for wiring completed and ready for connection of fixtures and/or equipment is 1,000,000 ohms.

3.3.3 Load Balance Test: Make test by energizing all lighting, motors and other electrical equipment simultaneously for a three hour period. Alter fuses, circuit breakers, circuit connections, etc., as required for satisfactory performance. Take voltage and amperage readings on each circuit at all panels.

## SECTION 16011

### ELECTRICAL GENERAL REQUIREMENTS

3.3.4 Check the amperage draw, voltage and direction of rotation of each motor in the presence of the equipment contractor and the Owner's representative. Make all necessary changes to obtain proper rotation, motor terminal voltage, motor protection, etc. Revise heater elements as necessary for proper motor protection. Similarly check all other electrically connected equipment.

Make the test at a time during the day or night that is mutually satisfactory to the Owner at least one week prior to substantial completion. Make all arrangements and notify all parties in writing at least seventy-two hours prior to the test.

3.3.5 Equipment Operation Test - Show by demonstration in service that all circuits are in good operating condition. Cycle all control equipment under load at least five times.

3.3.6 Equipment and apparatus factory tests - Manufacturer's normal quality control tests are acceptable, unless specific factory witnessed tests are specified in other sections.

#### 3.4 CLEANING:

3.4.1 Just prior to final acceptance clean all equipment including, but not limited to, the following:

- Lighting fixtures, panelboards, receptacles and switch plates – Remove all tags and labels; leave ready for use – All equipment to be painted, removing all rust, etc., and leave ready for painting – Building by removing all debris, conduits, wire, insulation, cartons, etc., left as a result of this work.

#### 3.5 UTILITY COORDINATION:

3.5.1 Contractor shall provide and pay for inspection of electrical work by the New York Board of Fire Underwriters or other approved electrical inspection agency prior to connection to the utility service.

3.5.2 Contractor shall coordinate with utility regarding electric services.

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ELECTRICAL GENERAL REQUIREMENTS

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - ELECTRICAL GENERAL REQUIREMENTS:

4.1.1 Measurement for Electrical General Requirements shall include the cost of all materials, equipment, labor, submittals and testing for the work indicated in this Section.

4.2 PAYMENT - ELECTRICAL GENERAL REQUIREMENTS:

4.2.1 For Electrical General Requirements, not included in other unit or lump sum price items, payment for Electrical General Requirements will be made at the applicable price stated in the Bid.

END OF SECTION

## SECTION 16060

### MINOR ELECTRICAL DEMOLITION FOR REMODELING

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION:

1.1.1 Interior demolition, removal and abandonment of interior electrical systems.

1.1.2 Cleaning and repair of existing equipment to remain.

#### PART 2 - PRODUCTS

##### 2.1 MATERIALS AND EQUIPMENT:

2.1.1 Materials and equipment for patching work: As specified in individual sections.

#### PART 3 - EXECUTION

##### 3.1 EXAMINATION:

3.1.1 Verify field measurements and circuiting arrangements are as shown on drawings.

3.1.2 Verify that abandoned wiring and equipment serve only abandoned facilities.

3.1.3 Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Engineer before disturbing existing installation.

3.1.4 Beginning of demolition means installer accepts existing conditions.

##### 3.2 PREPARATION:

3.2.1 Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

3.2.2 Provide temporary wiring and connections to maintain existing systems in service during construction.

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### MINOR ELECTRICAL DEMOLITION FOR REMODELING

3.2.3 Maintain existing systems in service until new systems are complete and ready for operation. Disable systems only to make switchovers and connections. Closely coordinate interruptions with Owner, providing at least 48 hours notice prior to outages. Minimize outage durations. Such work will normally be performed nights, weekends, or other times when building is not occupied for normal operations.

#### 3.3 DEMOLITION EXISTING ELECTRICAL WORK:

3.3.1 Remove existing installations to accommodate requirements for new construction.

3.3.2 Remove abandoned conductors to source of supply.

3.3.3 Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

3.3.4 Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

3.3.5 Disconnect and remove abandoned panelboards and distribution equipment.

3.3.6 Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

3.3.7 Repair adjacent construction and finishes damaged during demolition work.

3.3.8 Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

#### 3.4 CLEANING AND REPAIR:

3.4.1 Clean and repair existing materials and equipment which remain or are to be reused.

3.4.2 Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

SECTION 16060

MINOR ELECTRICAL DEMOLITION FOR REMODELING

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT – MINOR ELECTRICAL DEMOLITION FOR REMODELING:

4.1.1 Measurement for Minor Electrical Demolition For Remodeling shall include the cost of all materials, equipment, labor, submittals and testing for the work indicated in this Section.

4.2 PAYMENT – MINOR ELECTRICAL DEMOLITION FOR REMODELING:

4.2.1 For Minor Electrical Demolition For Remodeling, not included in other unit or lump sum price items, payment for Minor Electrical Demolition For Remodeling will be made at the applicable price stated in the Bid.

END OF SECTION

## SECTION 16321

### INTERIOR TRANSFORMERS

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Interior Transformers, as shown on the Plans, as specified, and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

##### 1.2.1 American National Standards Institute, Inc. (ANSI) Publications:

C57.12.00	General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
C57.12.01	General Requirements for Dry-Type Distribution and Power Transformers
C57.12.90	Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers
C57.12.91	Test Code for Dry-Type Distribution and Power Transformers
C57.94	Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers
Z35.1	Accident Prevention Signs

##### 1.2.2 American Society For Testing and Materials (ASTM) Publications:

D92	Flash and Fire Points by Cleveland Open Cup
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INTERIOR TRANSFORMERS

D117	Electrical Insulating Oils of Petroleum Origin
D877	Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
D3487	Mineral Insulating Oil Used in Electrical Apparatus

1.2.3 Factory Mutual Engineering and Research Corporation (FM) Publication:

P7825	Approval Guide
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1.2.4 National Electrical Manufacturers' Association (NEMA) Publications:

NEMA ICS6	Enclosures for Industrial Controls and Systems
NEMA ST20	Dry-Type Transformers for General Applications
TR1	Transformers, Regulators and Reactors

1.2.5 National Fire Protection Association (NFPA) Publications:

NFPA 70	National Electrical Code
70B	Electrical Equipment Maintenance

1.2.6 Underwriters Laboratories, Inc. (UL) Publication:

UL 467	Grounding and Bonding Equipment
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1.3 GENERAL REQUIREMENTS: Section 16011, "Electrical General Requirements", applies to this section, with the additions and modifications specified herein.

1.4 DESCRIPTION OF WORK: The work includes providing new transformers for indoor use.

## SECTION 16321

### INTERIOR TRANSFORMERS

#### 1.5 SUBMITTALS:

1.5.1 Detail Drawings: Shop Drawings: Shop drawings for dry-type transformers shall indicate, but shall not be limited to, the following:

- a. Complete overall dimensions

#### 1.5.2 Manufacturers Catalog Data:

- a. Dry-Type Transformers

#### 1.5.3 Test Reports:

- a. Transformer Tests: ANSI C57.12.91, as applicable, including the following:
  - (1) Routine Tests: Performed by the manufacturer on each transformer to ensure that design performance is maintained in production.
  - (2) Design Tests: Test reports will be accepted as proof of compliance with design test requirements.

#### 1.5.4 Certificates of Compliance:

- a. Comply with NEMA ST20

#### 1.5.5 Operation and Maintenance Manuals:

- a. Dry-type transformers

## PART 2 - PRODUCTS

2.1 TRANSFORMERS: ANSI C57.12.01. The kVA rating shall be conspicuously displayed on each transformer enclosure. Refer to Contract Drawings for KVA ratings.

2.1.1 Dry-Type: Transformer shall have 180 degrees C insulation system for transformers rated 15 KVA and more, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient of 40 degrees C. Transformer of 150 degrees C under full-rated load in maximum ambient of 40 degrees C. Transformer of 150 degrees C temperature rise shall be capable of carrying continuously 100 percent of nameplate KVA without exceeding insulation

## SECTION 16321

### INTERIOR TRANSFORMERS

rating. Transformer of 115 degrees C temperature rise shall be capable of carrying continuously 115 percent of nameplate KVA without exceeding insulation 130 percent of nameplate KVA without exceeding insulation rating. Provide with 2-1/2% full capacity taps (2 above normal and 4 below normal).

2.1.2 Voltage Rating: Shall be per transformer schedule on contract drawings.

2.1.2.1 Sound Level: Shall be an average of 3 dB lower than NEMA TR1 standard sound levels for the transformer size indicated ANSI C57.12.91.

2.1.2.1 Sound Level: Shall be an average of 3 dB lower than NEMA TR1 standard sound levels for the transformer size indicated ANSI C57.12.91.

### PART 3 - EXECUTION

3.1 INSTALLATION: NFPA 70, and to the requirements specified herein.

3.2 FOUNDATION FOR TRANSFORMERS: Mount transformers on concrete slab. Top of concrete slab shall be approximately 4 inches above the finished floor unless otherwise indicated on contract drawings. Edges above floor shall have 1/2-inch chamfer and the slab shall project at least 8 inches beyond the transformers unless otherwise indicated on contract drawings. Concrete work shall be as specified in Section 03300.

3.3 GROUNDING AND BONDING EQUIPMENT: UL 467, except as indicated or specified otherwise.

3.4 FIELD TESTS AND INSPECTIONS:

3.4.1 Acceptance Checks and Tests: Perform in accordance with the manufacturer's recommendations and NFPA 70B, Appendix I and ANSI C57.94. Perform work in a careful and safe manner so as not to endanger personnel or equipment. Acceptance checks and test shall include, but not be limited to, the following:

- a. Inspect devices, equipment, etc. for damage or maladjustment caused by shipment or installation.

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### INTERIOR TRANSFORMERS

- b. Remove wedges, ties, and blocks installed by the manufacturer to prevent damage during shipment.
- c. Verify minimum resistance to ground of grounding lugs and grounding connections.

3.4.2 Transformer Test: Test transformer secondary voltages and adjust the voltage at the transformer to provide a secondary voltage of 208/120.

3.4.3 Final Testing: Upon completion of acceptance checks and tests, show by demonstration in service that transformers and devices are in good operating condition and properly performing the intended function. As an exception to requirements that may be stated elsewhere in the contract, the Engineer shall be given 5 working days advance notice of the dates and times for checks, settings, and tests.

END OF SECTION

## SECTION 16402

### INTERIOR WIRING SYSTEMS

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Interior Wiring Systems, as shown on the Plans, as specified, and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

##### 1.2.1 American National Standards Institute, Inc. (ANSI) Publications:

C80.1	Rigid Steel Conduit, Zinc Coated
C80.3	Electrical Metallic Tubing, Zinc Coated
C80.5	Rigid Aluminum Conduit

##### 1.2.2 American Society for Testing and Materials (ASTM) Publications:

B1	Hard-Drawn Copper Wire
B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
E814	Fire Tests of Through-Penetration Fire Stops

##### 1.2.3 Federal Specifications (FS):

L-P-387	Plastic Sheet, Laminated, Thermosetting (for Design Plates)
W-C-375	Circuit Breakers, Molded Case, Branch Circuit and Service
W-S-896	Switches, Toggle (Toggle and Lock), Flush Mounted

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### INTERIOR WIRING SYSTEMS

#### 1.2.4 National Electrical Manufacturers Association (NEMA) Publications:

BU1	Busways
FU1	Low Voltage Cartridge Fuses
ICS1	Industrial Control and Systems
ICS2	Industrial Control Devices, Controllers and Assemblies
ICS4	Terminal Blocks for Industrial Use
ICS6	Enclosures for Industrial Controls and Systems
KS1	Enclosed Switches
MG1	Motors and Generators
RN1	Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
ST20	Dry-Type Transformers for General Applications
TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
TC3	PVC Fittings for Use with Rigid PVC Conduit and Tubing
TC13	Electrical Nonmetallic Tubing (ENT)
TC14	Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings
VE1	Metallic Cable Tray Systems
WD1	Wiring Devices

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### INTERIOR WIRING SYSTEMS

#### 1.2.5 National Fire Protection Association (NFPA) Publication:

70 National Electrical Code

#### 1.2.6 Underwriters Laboratories, Inc. (UL) Publications:

1 Flexible Metal Conduit

4 Armored Cable

5 Surface Metal Raceways and Fittings

6 Rigid Metal Conduit

50 Cabinets and Boxes, Electrical

67 Panelboards

83 Thermoplastic-Insulated Wires and Cables

198C High-Interrupting-Capacity Fuses, Current-Limiting Types

198E Class R Fuses

198H Class T Fuses

360 Liquid-Tight Flexible Steel Conduit

467 Grounding and Bonding Equipment

486A Wire Connector and Soldering Lugs for Use with Copper Conductors

486B Wire Connectors for Use with Aluminum Conductors

486C Splicing Wire Connectors

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### INTERIOR WIRING SYSTEMS

489	Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
498	Attachment Plugs and Receptacles
506	Specialty Transformers
508	Industrial Control Equipment
510	Insulating Tape
514A	Metallic Outlet Boxes
514B	Fittings for Conduit and Outlet Boxes
514C	Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
719	Nonmetallic-Sheathed Cables
797	Electrical Metallic Tubing
845	Motor Control Centers
854	Service-Entrance Cables
857	Busways and Associated Fittings
869	Service Equipment
886	Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
943	Ground-Fault Circuit Interrupters
984	Hermetic Refrigerant Motor-Compressors

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### INTERIOR WIRING SYSTEMS

1242 Intermediate Metal Conduit

1569 Metal-Clad Cables

1.3 RELATED REQUIREMENTS: Section 16011, "Electrical General Requirements", applies to this Section with additions and modifications specified herein.

1.4 SUBMITTALS: Submit the following:

1.4.1 Manufacturer's Catalog Data:

- a. Switches
- b. Ground rods
- c. Device plates
- d. Insulated conductors
- e. Panelboards
- f. Circuit breakers
- g. Conduit and fittings
- h. Soft Starter
- i. Transformer

1.4.2 Drawings:

- a. Switches

1.4.3 Statements:

- a. Fuses

Submit coordination data as specified in article entitled, "Fuses" of this Section.

1.4.4 Field Test Reports:

- a. 600-volt wiring test
- b. Grounding system test

1.4.4.1 Format: Submit test results for approval in report form.

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### INTERIOR WIRING SYSTEMS

1.5 QUALITY ASSURANCE: In each standard referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" has been substituted for "should" wherever it appears.

#### PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT: Materials, equipment, and devices shall, as a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70.

2.2 CONDUIT AND FITTINGS: Conduit type shall be as indicated on the Contract Drawings conforming to the following:

2.2.1 Rigid Steel Conduit (Zinc-coated): ANSI C80.1, UL 6.

2.2.2 Rigid Nonmetallic Conduit: PVC Type EPC-40, in accordance with NEMA TC2, or fiberglass conduit in accordance with NEMA TC14.

2.2.3 Plastic-coated Rigid Steel Conduit: NEMA RN1, Type 40 (40 mils thick).

2.2.4 Flexible Metal Conduit: UL 1.

2.2.4.1 Liquid-tight Flexible Metal Conduit, Steel: UL 360.

2.2.5 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit: UL 514B. Ferrous fittings shall be cadmium- or zinc-coated in accordance with UL 514B.

2.2.5.1 Fittings for Rigid Metal Conduit: Threaded-type. Split couplings unacceptable.

2.2.6 Fittings for Rigid Nonmetallic Conduit: NEMA TC3.

2.3 OUTLET BOXES AND COVERS: UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

2.3.1 Outlet Boxes in Hazardous Locations: UL 886.

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2.4 CABINETS, JUNCTION BOXES, AND PULL BOXES: Volume greater than 100 cubic inches, UL 50, hot dip, zinc-coated, if sheet steel.

2.5 WIRES AND CABLES: Wires and cables shall meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.

2.5.1 Conductors: All conductors shall be stranded. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. Conductors shall be copper.

2.5.1.1 Minimum Conductor Sizes: Minimum size for branch circuits shall be No. 12 AWG; for Class 1 remote-control and signal circuits, No. 14 AWG; and for Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.

2.5.2 Color Coding: Provide for service, feeder, branch, control, and signaling circuit conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutral shall be white with colored (not green) stripe. Color of ungrounded conductors in different voltage systems shall be as follows:

- a. 480Y/277 volt, 3-phase:
  - (1) Phase A – Black
  - (2) Phase B – Red
  - (3) Phase C – Blue

2.5.3 Insulation: Unless specified or indicated otherwise or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN, except that grounding wire may be Type TW; remote-control, and signal circuits shall be Type TW, THW, or TF. Conductors shall conform to UL 83. Where lighting fixtures require 90-degree C conductors, provide only conductors with 90-degree C insulation or better.

2.5.4 Bonding Conductors: ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.6 SPLICES AND TERMINATION COMPONENTS: UL 486A and UL 486B, as applicable, for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG

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and smaller diameter wires shall be insulated, pressure-type in accordance with UL 486A or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

2.7 DEVICE PLATES: Provide UL listed, one-piece device plates for outlets and fittings to suit the devices installed. For metal outlets and fittings, plates on unfinished walls and on fittings shall be of zinc-coated sheet steel or cast metal having round or beveled edges. For nonmetallic boxes and fittings, other suitable plates may be used. Plates on finished walls shall be urea or phenolic, minimum 0.10-inch wall thickness. Plates shall be same color as receptacle or toggle switch with which they are mounted. Screws shall be machine-type with countersunk heads in color to match finish of plate. Use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and UL listed for "wet locations".

#### 2.8 SWITCHES:

2.8.1 Toggle Switches: FS W-S-896, totally enclosed specification grade with bodies of thermosetting plastic and mounting strap. Handles shall be brown. Wiring terminals shall be screw-type, side-wired. Switches shall be rated quiet-type ac only, 120/277 volts, with 20 ampere rating and number of poles indicated.

2.8.2 Pilot Lights: Provide yoke-mounted, candelabra-base sockets rated 125 volts and fitted with glass or plastic jewels. Provide LED type lamp in each pilot switch. Jewels for use with switches controlling motors shall be green; jewels for other purposes shall be red.

2.8.3 Disconnect Switches: NEMA KS1. Switches serving as motor-disconnect means shall be horsepower rated. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches.

Fused switches shall utilize Class R fuseholders and fuses, unless indicated otherwise. Provide switches in NEMA 3R enclosure, per NEMA ICS6.

2.8.4 Breakers Used as Switches: For 120- and 277-Volt fluorescent fixtures, mark breakers "SWD" in accordance with UL 489.

2.9 RECEPTACLES: UL 498 and NEMA WD1, heavy-duty, specification grade, grounding-type. Twenty ampere rated and configurations shall be as indicated. Wiring terminals shall be screw-type, side-wired. Connect grounding pole to mounting strap.

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2.9.1 Weatherproof Receptacles: Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. Caps shall be provided with a spring-hinged flap. Receptacle shall be UL listed for use in "wet locations".

2.9.2 Ground-fault Circuit Interrupter (GFCI) Receptacles: UL 943, duplex type for mounting in standard outlet box. Device shall be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFCI devices.

2.9.3 Circuit Breakers: FS W-C-375 thermal magnetic-type with interrupting capacity of 10,000 amperes symmetrical minimum. Breaker terminals shall be UL listed as suitable for type of conductor provided. Plug-in circuit breakers unacceptable.

2.9.3.1 Multipole Breakers: Provide common trip-type with single operating handle. Breaker design shall be such that overload in one pole automatically causes poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.9.3.2 Circuit Breaker With GFCI: UL 943 and NFPA 70. Provide with "push-to-test" button, visible indication of tripped condition, and ability to detect and trip on current imbalance of 6 milliamperes or greater per requirements of UL 943 for Class A GFCI devices.

2.10 ENCLOSED CIRCUIT BREAKERS: UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit interrupting rating as indicated. Enclosure type as indicated.

2.11 FUSES: NEMA FU1. Provide complete set of fuses for each fusible switch. Time-current characteristics curves of fuses serving motors or connected in series with circuit breakers or other circuit protective devices shall be coordinated for proper operation. Fuses shall have voltage rating not less than circuit voltage.

2.11.1 Cartridge Fuses, Current Limiting Type (Class R): UL 198E, Class RK-5 time delay-type. Associated fuse holders shall be Class R only.

2.12 TRANSFORMERS: NEMA ST20, general purpose, copper windings, dry-type self-cooled, ventilated. Transformer shall be contained in NEMA 4X enclosure and provided with manufacturer's wall mount kit to mount to exterior wall as shown on Plans. Provide all necessary hardware for complete installation to exterior wall. Transformer shall have 220 degrees C insulation system for transformers rated 10 KVA and less, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient of 40 degrees C.

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Transformer of 150 degrees C under full-rated load in maximum ambient of 40 degrees C. Transformer of 150 degrees C temperature rise shall be capable of carrying continuously 100 percent of nameplate KVA without exceeding insulation rating. Transformer of 115 degrees C temperature rise shall be capable of carrying continuously 115 percent of nameplate KVA without exceeding insulation 130 percent of nameplate KVA without exceeding insulation rating. Transformers shall be quiet type with maximum sound level of minimum 3 decibels less than NEMA standard level for transformer ratings indicated.

2.13 GROUNDING AND BONDING EQUIPMENT: UL 467. Ground rods shall be copper-clad steel, with minimum diameter of 3/4 inch and minimum length of 10 feet.

2.14 HAZARDOUS LOCATIONS: Electrical materials, equipment, and devices for installation in hazardous locations, as defined by NFPA 70, shall be specifically approved by Underwriters Laboratories, Inc., or Factory Mutual for particular "Class", "Division", and "Group" of hazardous locations involved. Boundaries and classifications of hazardous locations shall be as indicated.

2.15 NAMEPLATES: FS L-P-387. Provide as specified in Section 16011, "Electrical General Requirements".

2.16 SOURCE QUALITY CONTROL: Test opening around electrical penetrations through fire resistive-rated walls, partitions, floor or ceiling for fire resistive integrity in accordance with ASTM E814.

2.17 PANELBOARD: UL 67 and UL 50. Panelboard for use as service disconnecting means shall additionally conform to UL 869. Panelboard shall be circuit breaker equipped. Design shall be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. Where "space only" is indicated, make provisions for future installation of breaker sized as indicated. Panelboard locks shall be keyed same. Directories shall be typed to indicate load served by each circuit and mounted in holder behind transparent protective covering.

2.17.1 Panelboard Buses: Provide copper bus bar. Support bus bars on bases independent of circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus

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per UL 67 for connecting grounding conductors; bond to steel cabinet. In addition to equipment grounding bus, provide second "isolated" ground bus, where indicated.

#### 2.18 SOLID STATE SOFT STARTER:

2.18.1 Blower starting equipment shall be three phase, six (6) thyristor, solid state torque controlled type sized as necessary for the connected motor load. The unit shall have an integral keypad on which all the programmable features may be easily adjusted and on which the operating parameters can be viewed. The starter shall be equipped with a bypass contact. The bypass contact will close once the motor is up and running at 100% full load. The starter shall have an adjustable current limit start mode which shall limit motor current during starting from 150% to 700% of the motor full load current. A soft start mode shall be provided that shall initially raise the motor torque to a value between 40% and 130% of the motor's nominal nameplate torque. The motor voltage is then gradually increased during a 0 to 60 second programmable ramp time. Motor protection features of the solid state starter shall include line fault detection, power loss, phase reversal, undervoltage, overvoltage, overtemperature, stall, overload, under load and excessive starts per hour. The parameters of each protection feature shall be programmable. The unit shall monitor the three phase motor current, three phase voltage, power in Kw, power in KwH, power factor, motor thermal capacity usage and elapsed operation time. All parameters shall be viewable on the integral keypad display. Unit shall have a built-in communications port capable of connecting to the specified PLC. All monitored items and drive status shall be accessible through the communications port.

### PART 3 - EXECUTION

3.1 INSTALLATION: Electrical installations shall conform to requirements of NFPA 70 and to requirements specified herein.

3.1.1 Underground Service: Underground service conductors and associated conduit shall be continuous from service entrance equipment to outdoor power system connection.

3.1.2 Hazardous Locations: Work in hazardous locations, as defined by NFPA 70, shall be performed in strict accordance with NFPA 70 for particular "Class", "Division", and "Group" of hazardous locations involved. Provide conduit and cable seals where required by NFPA 70. Conduit shall have tapered threads.

3.1.3 Service Entrance Identification: Service entrance disconnect devices, switches, or enclosures shall be labeled or identified as such.

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3.1.3.1 Labels: Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, each enclosure, new and existing, shall be labeled as one of several enclosures containing service entrance disconnect devices. Label, at minimum, shall indicate number of service disconnect devices housed by enclosure and shall indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels. Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure shall be provided only as permitted by NFPA 70.

3.1.4 Wiring Methods: Provide insulated conductors installed in conduit, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Provide insulated, green equipment grounding conductor in feeder and branch circuits, including lighting circuits. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated, green conductor for grounding conductors installed in conduit or raceways. Minimum conduit size shall be 1/2 inch in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings shall be made with metal conduit in fire-rated shafts. Metal conduit shall extend through shafts for minimum distance of 6 inches. Conduit which penetrates fire walls, fire partitions, or floors shall be metallic on both sides of fire walls, fire partitions, or floors for minimum distance of 6 inches.

3.1.4.1 Refer to Conduit Schedule on Contract Drawings for installation types.

3.1.5 Conduit Installation: Unless indicated otherwise, conceal surface mount on conduit exposed on walls, ceilings. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.

3.1.5.1 Conduit Through Floor Slabs: Where conduits rise through floor slabs, curved portion of bends shall not be visible above finish slab.

3.1.5.2 Conduit Support: Support conduit by pipe straps, wall brackets, hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Load applied to fasteners shall not exceed one-fourth proof test load. Fasteners attached to concrete ceiling shall be vibration-resistant and shock-resistant. Holes cut to depth of more than 1-1/2 inches in reinforced concrete

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beams or to depth of more than 3/4 inch in concrete joints shall not cut main reinforcing bars. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Where conduit crosses building expansion joints, provide suitable watertight expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means.

3.1.5.3 Pull Wire: Install pull wires in empty conduits in which wire is to be installed by others. Pull wire shall be plastic having minimum 200-pound tensile strength. Leave minimum 12 inches of slack at each end of pull wire.

3.1.5.4 Telephone and Signal System Conduits: Install in accordance with specified requirements for conduit and with additional requirement that no length of run shall exceed 150 feet for trade sizes 2 inches and smaller and shall not contain more than two 90-degree bends or equivalent. Provide pull or junction boxes where necessary to comply with these requirements. Inside radii of bends in conduits one-inch trade size and larger shall be minimum five times nominal diameter. Terminate conduit at bottom edge of backboard.

3.1.5.5 Conduit Installed in Concrete Floor Slabs: Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab. Space conduits horizontally minimum three diameters, except at cabinet locations. Curved portions of bends shall not be visible above finish slab. Increase slab thickness as necessary to provide minimum one-inch cover over conduit. Where embedded conduits cross expansion joints, provide suitable watertight expansion fittings and bonding jumpers. Conduit larger than one-inch trade size shall be parallel with or at right angles to main reinforcement; when at right angles to reinforcement, conduit shall be close to one of supports of slab. Where nonmetallic conduit is used, raceway must be converted to rigid steel or steel IMC before rising above floor, unless specifically indicated otherwise.

3.1.5.6 Locknuts and Bushings: Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use minimum single locknut and bushing. Locknuts shall have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

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3.1.5.7 Stub-ups: Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 6 inches above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.5.8 Flexible Connections: Provide flexible connections of short length, 6-foot maximum, for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Provide liquid-tight flexible conduit in wet locations. Provide separate ground conductor across flexible connections.

3.1.6 Boxes, Outlets, and Supports: Provide boxes in wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when installed exposed up to 7 feet above interior floors and walkways, or when installed in hazardous areas. Boxes in other locations shall be sheet steel, except that aluminum boxes may be used with aluminum conduit; nonmetallic boxes may be used with nonmetallic sheathed cable conduit system. Each box shall have volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures shall be minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; fixtures shall be readily removable for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports, or make adequate provisions for distributing load over ceiling support members. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with bushing. Locknuts shall have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

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3.1.6.1 Boxes: Boxes for use with raceway systems shall be minimum 1-1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets shall be minimum 4 inches square, except that 4-by-2-inch boxes may be used where only one raceway enters outlet. Telephone outlets shall be minimum of 4 inches square by 1-1/2 inches deep.

3.1.6.2 Pull Boxes: Construct of at least minimum size required by NFPA 70 of code-gauge aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified herein. Furnish boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.1.7 Mounting Heights: Mount panelboards, circuit breakers, and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount lighting switches 48 inches above finished floor, receptacles 18 inches above finished floor, and other devices as indicated. Measure mounting heights of wiring devices and outlets to center of device or outlet.

3.1.8 Conductor Identification: Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, color coding shall be by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, color coding shall be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations.

3.1.9 Splices: Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.9.1 Splices of Aluminum Conductors: Make with solderless circumferential compression-type, aluminum-bodied connectors UL listed for AL/CU. Remove surface oxides from aluminum conductors by wire brushing and immediately apply oxide-inhibiting joint compound and insert in connector. After joint is made, wipe away excess joint compound, and insulate splice.

3.1.10 Covers and Device Plates: Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Plates shall be installed with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Plates installed in wet locations shall be gasketed.

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3.1.11 Electrical Penetrations: Openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings shall be sealed to maintain fire resistive integrity as tested per ASTM E814.

3.1.12 Grounding and Bonding: In accordance with NFPA 70. Ground-exposed, noncurrent-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, and neutral conductor of wiring systems. Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70. Make ground connection to driven ground rods on exterior of building. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.12.1 Grounding Conductor: Provide insulated, green equipment grounding conductor in feeder and branch circuits, including lighting circuits. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated, green conductor for grounding conductors installed in conduit or raceways.

3.1.12.2 Resistance: Maximum resistance-to-ground of grounding system shall not exceed 25 ohms under dry conditions. Where resistance obtained exceeds 25 ohms, contact Engineer for further instructions.

3.1.13 Owner-furnished Equipment: Contractor shall rough-in for Owner-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

3.2 FIELD QUALITY CONTROL: Furnish test equipment and personnel and submit written copies of test results. Give Engineer 5 working days notice prior to each test.

3.2.1 Devices Subject to Manual Operation: Each device subject to manual operation shall be operated at least five times, demonstrating satisfactory operation each time.

3.2.2 Test on 600-volt Wiring: Test 600-volt wiring to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance shall be 1,000,000 ohms.

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3.2.3 Grounding System Test: Test grounding system to ensure continuity and resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Engineer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

#### PART 4 - MEASUREMENT & PAYMENT

##### 4.1 MEASUREMENT - INTERIOR WIRING SYSTEMS:

4.1.1 Measurement for Interior Wiring Systems shall include the cost of all materials, equipment, labor, submittals and testing for the work indicated in this Section.

##### 4.2 PAYMENT - INTERIOR WIRING SYSTEMS:

4.2.1 For Interior Wiring Systems, not included in other unit or lump sum price items, payment for Interior Wiring Systems will be made at the applicable price stated in the Bid.

END OF SECTION

## SECTION 16450

### GROUNDING

#### PART 1 - GENERAL

1.1 DESCRIPTION: Under this Section, the Contractor shall furnish all labor, materials and equipment for Grounding and Bonding of electrical installations as shown on the Plans, as specified and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.2.1 National Fire Protection Association (NFPA) Publication:

70 National Electrical Code (NEC)

1.2.2 Underwriters Laboratories, Inc. (UL) Publications:

83 Thermoplastic-Insulated Wires and Cables

44 Rubber-Insulated Wires and Cables

467 Grounding and Bonding Equipment

1.3 RELATED SECTIONS:

1.3.1 Section 16011, Electrical General Requirements.

1.4 SUBMITTALS:

1.4.1 Submit the following:

1.4.2 Submit test reports in accordance with Section 16011, "Electrical General Requirements".

1.4.2.1 Certified test reports of ground resistance.

1.4.2.2 Certifications: Two weeks prior to final inspection, deliver to the Engineer four copies of the certification that the material and installation is in accordance with the drawings and specifications and has been properly installed.

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### GROUNDING

#### PART 2 - PRODUCTS

##### 2.1 GROUNDING WIRES:

2.1.1 General Purpose: UL and NEC approved types, copper, with TW, THW, XHHW or dual rated THHN-THWN insulation color identified green.

2.1.2 Isolated Power System: Type XHHW insulation with a dielectric constant of 3.5 or less.

2.1.3 Size wire not less than what is shown and not less than required by the NEC.

##### 2.2 GROUND RODS:

2.2.1 Copper clad steel, 3/4-inch diameter by 10 feet long.

#### PART 3 - EXECUTION

##### 3.1 INSTALLATION:

3.1.1 Ground as shown and as hereinafter specified in accordance with the NEC.

##### 3.1.2 System Grounding:

3.1.2.1 Secondary service neutrals ground at the supply side of the secondary disconnecting means and at the related transformers.

3.1.2.2 Separately derived systems (transformers downstream from the service entrance) ground the secondary neutral.

3.1.2.3 Isolation transformers and isolated power systems shall not be system grounded.

##### 3.1.3 Equipment Grounding:

3.1.3.1 Metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be grounded for personnel safety and to provide a low impedance path for possible ground fault currents.

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### GROUNDING

#### 3.2 SECONDARY EQUIPMENT AND CIRCUITS:

3.2.1 Main Bonding Jumper: Connect the secondary service neutral to the ground bus in the service equipment.

#### 3.2.2 Water Pipe and Supplemental Electrode:

3.2.2.1 Provide a ground conductor connection between the service equipment ground bus and the metallic water pipe system. Jumper insulating joints in the water pipe.

3.2.2.2 Provide a supplemental ground electrode and bond to the water pipe ground, or connect to the service equipment ground bus.

#### 3.2.3 Conduit Systems:

3.2.3.1 Ground all metallic conduit systems.

3.2.3.2 Non-metallic conduit systems shall contain a grounding conductor.

3.2.3.3 Conduit provided for mechanical protection containing only a grounding conductor, bond to that conductor at the entrance and exit from the conduit.

3.2.4 Feeders and Branch Circuits: Install green grounding conductors with feeders and branch circuits as follows:

- a. Feeders
- b. Branch Circuits
- c. Receptacle Outlets
- d. Directly Connected Equipment, Appliances and Devices
- e. Motors and Motor Controllers
- f. Fixed Equipment and Appurtenances
- g. Items of equipment where the final connection is made with flexible metal conduit shall have a grounding wire.
- h. Additional locations and systems as shown

#### 3.2.5 Boxes, Cabinets, Enclosures and Panelboards:

3.2.5.1 Bond the grounding wires to each pull box, junction box, outlet box, cabinets, and other enclosures through which the ground wires pass.

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### GROUNDING

3.2.5.2 Provide lugs in each box and enclosure for ground wire termination.

3.2.5.3 Provide ground bars in panelboards, bolted to the housing, with sufficient lugs for terminating the ground wires.

3.2.6 Motors and Starters:

3.2.6.1 Provide lugs in motor terminal box and starter housing for ground wire termination.

3.2.6.2 Make ground wire connections to ground bus in motor control centers.

3.2.7 Receptacles are not approved for grounding through their mounting screws. Ground with a ground wire from green ground terminal on the receptacle to the outlet box ground screw.

3.2.8 Ground lighting fixtures to the green grounding conductor of the wiring system. During renovation, provide the green ground if it is not part of the system, or ground the fixtures through the conduit systems per means acceptable under the NEC. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

3.2.9 Fixed electrical appliances and equipment shall have a ground lug installed for termination of the green ground conductor.

3.3 CONDUCTIVE PIPING:

3.3.1 Bond all conductive piping systems in the building to the electrical system ground. Bonding connections shall be made as close as practical to the water pipe ground or service equipment ground bus.

3.4 GROUND RESISTANCE:

3.4.1 Grounding system ground resistance must comply with NEC.

3.4.2 Services at power company interface points shall comply with the power company ground resistance requirements.

3.4.3 Make necessary modifications to the ground electrodes for compliance that is needed without additional cost to the Owner, including the provisions of a multi-rod system.

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### GROUNDING

#### 3.5 GROUND ROD INSTALLATION:

3.5.1 Drive each rod vertically in the earth for not less than ten feet in depth.

3.5.2 Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.

3.5.3 Where rock prevents the driving of vertical ground rods, install grounding electrodes in horizontal trenches to achieve the specified resistance.

#### PART 4 - MEASUREMENT & PAYMENT

##### 4.1 MEASUREMENT - GROUNDING:

4.1.1 The quantity of Grounding for which payment will be made will include all that equipment, accessories, appurtenances or other work as specified herein and required for a complete operating control system.

##### 4.2 PAYMENT - GROUNDING:

4.2.1 For Grounding, not included in other unit or lump sum price items, payment for Grounding will be made at the applicable price stated in the Bid.

END OF SECTION

SECTION 16999

PAYMENT ITEM FOR CONTRACT NO.1B -  
ELECTRICAL CONSTRUCTION FOR  
WATER TREATMENT PLANT FILTER REHABILITATION

PART 1 - DESCRIPTION

1.1 Under this Item, the Contractor shall furnish all labor, materials and equipment for the completion of Contract No. 1B - Electrical Construction for Water Treatment Plant Filter Rehabilitation.

In addition to the applicable provisions of Sections 00100 thru and including 01640, and other Divisions of this project, the following sections describe the principal items of work to be performed under this payment item:

SECTION

16011	Electrical General Requirements
16060	Minor Electrical Demolition For Remodeling
16321	Interior Transformers
16402	Interior Wiring Systems
16450	Grounding

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - PAYMENT

4.1 Payment for Contract No. 1B - Electrical Construction for City of Saratoga Springs Water Treatment Plant Filter Rehabilitation, will be included in the lump sum price items stated in the Bid.

END OF SECTION