Otter River Water Treatment Plant
Finished Water Pump Upgrades

Campbell County
Utilities and Service Authority

Project Manual

Bid Documents

December 2025

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Responsive People | Creative Solutions

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GENERAL REQUIREMENTS

PART 1 – GENERAL

1.01 USE OF GENERAL REQUIREMENTS

A. These General Requirements of the Special Provisions are hereby made a part of the Contract.

1.02 DESCRIPTION OF WORK

A. WORK COVERED BY CONTRACT DOCUMENTS

1. The work to be done under this contract includes furnishing all labor, materials and equipment and performing all work required for Otter River Water Treatment Plant Finished Water Pump Upgrades project complete in place, and ready to operate.

2. The work under this Contract generally includes, but is not limited to:

- Piping modifications to facilitate the removal of the existing angled flow control valves and installation of the proposed check valves on Finished Water Pumps No. 1 and No. 2;
- Installation of third finished water pump (pump and motor to be provided by CCUSA) at the spare space reserved in the finished water pump station, and associated piping modifications;
- Replacement of the existing MCC-D with proposed MCC-D (proposed MCC-D has been prepurchased by CCUSA);
- Temporary electrical systems and controls while replacing MCC-D
- All other work required to complete the water treatment plant improvements identified in the contract drawings and specifications.

3. The work includes all requirements to provide a fully finished and operable facility including miscellaneous items and operations as shall be indicated, shown, specified or required to complete the work in strict conformity with the Contract Documents. The work also includes all specified, indicated and shown mechanical and electrical equipment, appliances, appurtenances, furnishings, instrumentation and controls, accessories, tests and sundry parts and material as shall be necessary and required for a completely operable installation satisfactory to the Engineer.

4. The Drawings and written Contract Documents are intended to indicate as clearly as practicable the work to be done. The Contractor must realize, however, that construction details cannot always be accurately anticipated and that in executing the work, field conditions may require reasonable modifications in the details of the Drawings and the work involved. Work under the Contract shall be carried out to meet these field conditions to the

satisfaction of the Engineer and in strict conformance with his instructions, the Drawings, the Specifications, and conditions and covenants of the Contract Documents in accordance with their true intent and full meaning.

5. The Contract includes installation, connection, and startup of pre-purchased equipment. These items are included in the Contract Specification Appendices as approved shop drawings. The Contractor shall be responsible for familiarizing themselves with the information included in the appendices and installing the equipment per the manufacturer's instructions and recommendations. The Contractor shall be responsible for coordinating with the Owner for transporting the pre-purchased equipment from its storage location onsite to the installation location, as required.

6. The Contractor is responsible for coordinating start-up with the manufacturer's for all equipment, including the equipment pre-purchased by the Owner. Contact information for the manufacturer's is provided in the Appendices.

1.03 EXISTING FACILITIES OVERVIEW

A. The Campbell County Utilities and Service Authority (CCUSA) owns and operates the Otter River Water Treatment Plant (ORWTP) constructed in approximately 1989 that treats surface water from Big Otter River. The ORWTP is located at 9625 Leesville Road, Evington, VA. The ORWTP has a design capacity of 4.18 million gallons per day (mgd). The two existing 300 HP finished water pumps are Verti-line 16 KHM Series 1110 vertical turbine high service pumps, each rated at 3,125 gallons per minute (GPM) at 300 feet Total Dynamic Head. The two existing finished water pumps draw water from the finished water clearwell and fill the Evington Water Storage Tank and is sent throughout the distribution system. The finished water reservoir has capacity of approximately 800,000 gallons, and the clearwell has a capacity of approximately 55,000 gallons. The piping on each pump discharge is equipped with angled Ross valves that throttle the flow during startup and shutdown.

1.04 NOT USED

1.05 INTERFACE WITH EXISTING FACILITIES

A. The Contractor's attention is directed to the fact that the existing facilities are integral components of the Water Treatment Plant. The treatment plant must be maintained in continuous operation at all times during the course of work under this contract, except for the shutdown periods permitted under the conditions described in this section.

B. When the Contractor desires certain electrical and/or mechanical functions to be interfaced, he shall inform the Engineer in writing a minimum of 14 calendar days prior to the date he desires those interfaces to be made. Only authorized CCUSA operations personnel will be allowed to operate or alter settings on existing electrical and/or mechanical equipment.

1.06 COORDINATION OF TRADES

A. **The Owner's Systems Integrator will be programming, starting up, and commissioning the plant control system. The Contractor shall provide wiring to the existing control panel and terminate the wires. The Contractor shall coordinate with the Owner's Systems Integrator for start-up and commissioning. The Contractor is responsible for allowing adequate time in the schedule for the Owner's Systems Integrator to test their program.**

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B. Where the work of any trade will be installed in close proximity to the work of other trades, or where there is evidence that the work of any trade will interfere with the work of other trades, the Contractor shall work out space allocations to make satisfactory adjustment. If so ordered by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale, not less than ¼-inch equals one foot, clearly showing how work is to be installed in relation to the work of other trades. If the Contractor permits any work to be installed before coordinating with the various trades or so as to cause interference with the work of other trades, he shall make necessary changes in the work to correct the condition without extra cost to the Owner.

C. The Contractor shall arrange that each trade determine the location, size, and arrangement of all chases and openings and shall establish clearances in concealed spaces required for the proper installation of its work and shall see that such are provided.

1.07 PRECONSTRUCTION CONFERENCE

A. Before starting the work, a conference will be held to establish procedures for coordination/interfaces, handling shop drawings and other submissions, and for the processing of applications for payment. Among those present at the conference will be the Contractor and his Superintendent, CCUSA Representatives, and the Engineer.

B. The Engineer will arrange for and organize the preconstruction conference.

C. The purpose of the conference is to designate responsible personnel and establish lines of communication. Matters requiring coordination will be discussed and procedures for handling such matters established. The preliminary agenda will include:

1. Contractor's Progress Schedule and Schedule of Values
2. Transmittal, review and distribution of Contractor's submittals
3. Maintaining record documents
4. Critical work sequencing

5. Field decisions and change orders
6. Use of premises, office and storage areas, security, housekeeping and CCUSA's needs
7. Major equipment deliveries and priorities
8. Contractor's assignments for safety and first aid

D. The Engineer will preside at the conference and will arrange for keeping the minutes and distributing the minutes to all persons in attendance.

1.08 PROGRESS MEETINGS

A. Project progress meetings will be held monthly to review the progress and schedule of the work. The Contractor shall make his Project Manager and Field Superintendent available for said progress meetings and to meet CCUSA and Engineer on-site.

1.09 AUTHORITY OF FACILITY SUPERINTENDENT

A. The ORWTP Superintendent is responsible for the public health and safety of CCUSA plant personnel, the security of the plant property and compliance with the facility. He exercises sole authority over plant personnel and, may as required, control the conduct of the Contractor's forces by request to the Engineer.

B. The ORWTP Superintendent has the authority to modify or stop operations of the Contractor's work forces which might cause contamination of the plant water supply or interfere with plant processes. Such orders will be relayed through the Engineer except in case of an emergency.

C. The ORWTP Superintendent will not direct the Contractor or his work forces in areas of the Contractor's responsibility for construction, workmanship and progress of work or changes in contract scope. Such direction if and as appropriate will be provided solely by the Engineer.

D. All requests by the Contractor for operation of valves, gates, pumps or other plant equipment will be coordinated by the ORWTP Superintendent or his designated representative through the Engineer.

1.10 ADDITIONAL MATERIAL AND/OR EQUIPMENT

A. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The Contractor shall carefully investigate the structural and finish conditions affecting his work and shall arrange his work accordingly, providing such fittings, valves, transitions, pull or junction boxes, and accessories as may be required to meet such conditions, at no additional cost to the Owner.

1.11 SINGULAR NUMBER

A. Where material, a device, or part of the equipment is referred to in the singular number, it is intended that such reference shall apply to as many items of material, devices or parts of equipment as are required to complete the installation.

1.12 EQUIPMENT UNIFORMITY

A. All pumps, valves and other multiple-unit equipment within its use category shall be the product of a single manufacturer.

1.13 SPARE PARTS AND TOOLS

A. Spare parts shall be provided as specified in the various sections of the Special Provisions. Spare parts lists and books shall be included in the Operation and Maintenance Manuals.

B. Special tools required for the normal maintenance of each piece of equipment shall be provided and shall be identified with the tool number corresponding to the number in the Operation and Maintenance Manuals.

C. The Contractor shall provide the Engineer a consolidated list of all spare parts, special tools and lubricants furnished.

D. The Contractor shall deliver spare parts, special tools and lubricants to the site for inventory by CCUSA, and shall place them in the storage areas designated by the CCUSA. The manufacturer shall prepare all items for storage including necessary packaging and shall clearly label the unit for which the items are intended, using the equipment nomenclature employed in the Contract. The manufacturer shall provide any special written instructions necessary for the proper care of spare parts in storage.

1.14 AS-BUILT DRAWINGS

A. Provide the as-built drawings in electronic format.

B. As-built drawings shall be completed, submitted, and approved

1.15 CERTIFICATION OF MATERIALS AND INSTALLATIONS

A. The Contractor shall furnish certification from each manufacturer, or from an approved testing laboratory, that all material used in the work is in accordance with these and all referenced specifications. Upon completion of the work, and before acceptance by CCUSA, the Contractor shall furnish CCUSA with a certificate from each of the manufacturers that the equipment and material furnished by him has been erected and installed in a satisfactory manner and is ready for continuous service and operation.

B. Machinery and equipment for which manufacturer certification is specified will not be accepted, nor payment made therefore, without such certification. The Engineer reserves the right, however, to reject such certification when in his judgment,

equipment and materials have been improperly installed or show evidence of unsatisfactory operation.

C. Certification shall be prepared as follows:

"Having inspected the following items of equipment (Insert here serial number and complete description of equipment) at rest and in operation, and having made all requisite service adjustments and calibrations, I hereby certify that the above listed items have been properly installed, serviced, adjusted and calibrated and are ready for continuous operation under specified conditions of service when maintained in accordance with the manufacturer's published instructions attached hereto."

_____ _____

Date Name

D. Certification shall be provided on the manufacturer's letterhead.

1.16 FACILITY START-UP, DEMONSTRATION PERIOD AND OPERATOR TRAINING

A. When specified in individual sections of these Special Provisions, upon completion of all work for a particular section, the Contractor shall furnish at no extra cost to CCUSA the necessary manufacturer's engineers, representatives, technicians, skilled labor and helpers and shall perform all startup activities as required. During startup, the manufacturer's designated personnel shall fully inspect, test, calibrate, lubricate, operate and certify the equipment for which they are responsible.

B. When a manufacturer's representative is not required to perform startup activities for a particular piece of equipment, the Contractor shall perform any required startup activities in strict accordance with the manufacturer's instructions.

C. If the Operation and Maintenance Manuals specified hereinafter are not available at the time of the startup, the Contractor shall provide one copy of the manufacturer's operating literature for each system or item of equipment. Installation and operating sheets or booklets normally shipped with equipment may be used for this purpose.

D. Prior to starting up and operating any and all equipment installed, the Contractor shall notify CCUSA. All lubrication and starting up of the equipment shall be done in the presence of and to the complete satisfaction of authorized representatives of CCUSA, and in accordance with all manufacturer's recommendations.

E. The Contractor shall schedule the startup for a time mutually agreeable with the Engineer and CCUSA and shall provide a minimum of two weeks notice prior to the desired date.

F. Prior to beginning the 30-day demonstration period, the Contractor shall complete the following:

1. All shop drawings shall be submitted and approved.

2. All equipment Warranty and Certification Forms and manufacturer's certifications shall be completed and submitted, and all witness testing conducted and completed as required.
3. All startup activities shall be completed.
4. All test reports shall be submitted and approved.
5. All project photographs shall be submitted.
6. All Operation and Maintenance Manuals shall be submitted and approved.
7. A final walk-through of the facility shall be conducted by the Contractor with CCUSA and Engineer in order to generate the Deficiency List for the project. Provide CCUSA and Engineer two week notice prior to the desired date.
8. Any items on the Deficiency List that are designated as requiring completion prior to the 30-day demonstration period shall be completed.
9. Any item on the Deficiency List not designated as requiring completion prior to the 30-day demonstration period shall be completed prior to the end of the 30 –day demonstration period.
10. All spare parts shall be delivered to CCUSA, and signed receipts submitted for record.
11. All SCADA communications associated with the project shall be installed and fully operational.
12. The site shall be thoroughly cleaned, and any finishes requiring touchup shall be completed.
13. The 14-day reliability test specified in Division 16 shall be completed and approved by CCUSA and the Engineer.

G. After all the above items have been successfully completed, the Contractor shall receive notice from CCUSA that he may begin the 30-day demonstration period.

H. During the 30-day demonstration period, the Contractor shall conduct all required training for the newly installed equipment. Training activities shall be performed separately from manufacturer's startup activities, and shall be held on separate days unless approved otherwise. Coordinate schedule of training with CCUSA and provide a minimum of two week notice for each session.

I. If problems occur during the 30-day demonstration period that are designated by CCUSA and Engineer to be of significant magnitude, the problems shall be satisfactorily corrected, and the 30-day demonstration period shall restart from the beginning.

J. After Successful completion of the 30-day demonstration period, as shall be at the sole discretion of the Engineer, all required training, all Deficiency List work, and all final cleanup, the Contractor shall schedule a follow up walk-through with CCUSA and Engineer to verify compliance with all requirements.

1.17 MATERIAL SAFETY DATA SHEETS

A. The Contractor shall submit to the Engineer a Material Safety Data Sheet (MSDS) for all materials brought onto the site. All MSDS sheets will be in a clearly labeled binder (MSDS Sheets) in alphabetical order and turned over to the Engineer. The Engineer will place the MSDS Sheets in a location so that all personnel have access to the information.

1.18 WORKING AREA

A. The Contractor shall not occupy with men, tools, equipment, or materials any part of the ORWTP property outside of the designated areas shown on the Drawings or established by the Engineer and CCUSA.

1.19 CONTRACTOR STORAGE AREA

A. A storage area has been assigned on the plant site, as generally shown on the Drawings, for use by the Contractor for storage of his materials, tools, equipment, and other items necessary for construction. The exact limits of the areas will be designated in the field by the Engineer. The Contractor shall be fully responsible for the security of this area, including fencing, watchmen, and other means of security. Under no circumstances will CCUSA be responsible for the security of any property belonging to the Contractor, his subcontractors, or any of his work force.

B. The Contractor shall not use any portion of the plant site for storage of his property, except as specified.

C. The Contractor shall grade and stabilize a portion of the assigned storage area for a temporary mobilization and parking area for his use during the contract period and shall restore the entire storage area to its original condition upon completion of the project.

1.20 TEMPORARY SERVICES

A. The Contractor shall provide, subject to the approval of the Engineer, and pay for the acquisition, maintenance and removal of such temporary water, heat, light, power, telephone, fence around excavated area and enclosed storage, watchman and all other temporary services as may be required in the prosecution of this Contract.

B. The Contractor shall provide and maintain one temporary portable chemical toilet on the site for the full term of the Contract. The Contractor will not be allowed to use plant restrooms.

C. The cost of any temporary electric and telephone service installation or use for the completion of this Contract and the testing of all electrical and mechanical equipment and other related work shall be borne by the Contractor up to and including the date of the final acceptance.

1.21 CONFINED SPACE REQUIREMENTS

A. The Contractor shall follow all confined space procedures in accordance with the Contractor’s confined space program.

B. A copy of the Contractor’s confined space program shall be submitted to the Engineer for information purposes at the pre-construction meeting.

1.22 WORKING HOURS

A. Work shall be performed according to and completed within the contract time stipulated in the Proposal, including weekends and holidays. The contract time stated herein shall include the time needed by the Contractor for preparation and approval of shop drawings and procurement and assembly of equipment and materials as well as construction Work.

B. Work shall be limited to weekdays (Monday through Friday) and shall commence no earlier than 7:00 A.M. nor proceed later than 5:00 P.M. The Contractor shall obtain prior written approval from the Engineer to conduct work outside this timeframe for Work that requires existing plant shutdown. During plant shutdown periods, the Contractor may work modified periods and times as approved by the Engineer to complete the Work within the limited shutdown duration.Work is subject to other limitations in this contract.

C. No work requiring the presence of the Engineer or an Inspector will be permitted on Sunday, on legal County holidays, or on County designated Service Reduction Days, except in cases of emergency, and then only to such extent as is absolutely necessary and with written permission of the Engineer.

D. In case the Contractor desires to work on any Saturday, Sunday or legal holiday, he shall so inform the Engineer in writing at least two full work days in advance. He shall indicate the nature of the emergency, his desire to work and the location at which work will be conducted.

1.23 SCHEDULE OF VALUES

A. In order to determine the amount of the monthly estimate, the successful Contractor shall furnish a complete breakdown of his total bid, also referred to as a Schedule of Values. The Contractor shall furnish this information within ten (10) days after receipt of Notice-to-Proceed. The breakdown will, in general, follow the outline of the specification items. Upon approval by the Engineer, the breakdown shall be the basis for calculating the amount of monthly estimates specified in the Standard Specifications.

1.24 CONSTRUCTION SEQUENCING, COORDINATION AND SCHEDULING

A. Construction shall interfere to the least extent possible with the operation of the Water Treatment Plant. As the plant is essential to the treatment of drinking water supply, changes or disruption to the plants normal operational procedures and schedule must be avoided whenever possible to ensure compliance with water quality and production requirements.

B. Shutdown periods permitted for connection of new equipment and facilities to existing equipment and facilities shall be as described herein. Shutdown durations shall be mutually agreed upon by the ORWTP Superintendent and the Contractor.

C. The ORWTP is operational typically 14 to 16-hours every day generally between the hours of 6:00 am and 9:00 pm. The water treatment plant must remain in service during these times. A shutdown is acceptable for relocating the MCC Section. The shutdown duration shall be limited to 8 hours prior to April 1st and 5 hours after April 1st. The backwash pump shall not be out of service for more than 1 day. All plant shutdowns shall be subject to CCUSA approval based on system operating conditions at the time of construction.

D. The Contractor shall submit a written request for each plant shutdown for Engineer and CCUSA approval at least two (2) weeks in advance. The Contractor submitted requests for plant shutdown shall include a schedule and written detailed description of the proposed construction procedures to occur during the shutdown period. Information submitted to the Engineer shall include a complete inventory of materials and equipment needed to perform the work. No shutdown of a facility or operation will be permitted until the Engineer has reviewed and approved in writing the proposed construction plans and procedures.

E. In order to reduce each shutdown period to a minimum, the Contractor shall, prior to each shutdown request expedite the completion of the work to the fullest extent. The Contractor shall have completed all necessary preparatory work including testing and shall have adequate personnel available to keep each shutdown period to a minimum. All equipment and materials required to complete the work during a shutdown period shall be on the job site before the shutdown is commenced.

F. Insofar as possible, equipment and facilities shall be tested and in operating condition before the final tie-ins are made which connect new equipment and facilities to existing equipment and facilities.

G. If work during any shutdown period is not done satisfactorily, or as planned, or within the maximum time allocated, or if operation is adversely affected, CCUSA may order the Contractor to place the facility or operation back in service and reschedule the work. CCUSA may order the work required to place the facility or operation back in service to be completed with other forces at the Contractor’s expense.

H. The Contractor shall prepare a project schedule in Gantt Chart format which indicates the critical path. The schedule shall indicate when the shop drawing submittal list will be submitted. The schedule shall reflect the described

requirements and constraints, which was developed to enable water treatment to be maintained to the maximum extent possible during construction.

1.25 PROPOSED SEQUENCE OF CONSTRUCTION

A. The Contractor is responsible for developing a sequence of construction for inclusion in the schedule and submit to the Engineer for approval. Contractor's sequence of construction shall fit schedule requirements and meet all the conditions of the specification defined herein as well as all other requirements of the Contract Documents. Contractor shall provide additional specific details related to planning and implementation as required in development of the schedule. Any suggested sequence of construction or other suggested procedures may be used by the Contractor; however, the Contractor is solely responsible for the planning and successful execution of all aspects of construction. The suggested construction sequencing is provided to assist the Contractor to schedule the work with minimal impact on existing facility operation and is not included to define the methods of construction.

B. **Proposed Sequence of Construction for MCC Replacement**

As part of this project, the Motor Control Center (MCC) will be replaced. The motor starters for the finished water pumps and the backwash pump are currently located within the MCC being replaced. These pumps are critical to plant operations. During the MCC replacement, at least one finished water pump and the backwash pump must remain operational. Short-duration outages of no more than four (4) hours are permitted and must be coordinated with the Owner. The following sequence has been developed to maintain continuous operation of this critical process equipment during the MCC replacement. Refer to the Contract Drawings for demolition and construction limits.

1. **Coordinate with CCUSA** to initiate a backwash sequence.
2. **De-energize the MCC** and temporarily relocate the RVAT MCC section for Finished Water Pump No. 2 within the finished water pump room.
3. **Re-energize the remaining MCC sections** to allow operation of the backwash pump and Finished Water Pump No. 1.
4. **Provide temporary wiring** to the relocated MCC section and establish control signals to the plant's SCADA system for operation of Finished Water Pump No. 2.
5. **Install a motor starter** mounted on a backboard for the backwash pump.
6. **Coordinate with CCUSA** to initiate a backwash sequence.
7. **Temporarily wire the backwash pump motor starter** to the plant's SCADA system.
8. **Connect a portable generator** to supply power to the relocated MCC section and backwash pump. Perform startup and testing of both on generator power.
9. **Operate the Water Treatment Plant (WTP)** in this temporary configuration for three consecutive weekdays to verify proper functionality of temporary power and controls.
10. **Replace the MCC** and reconnect the MCC section to the equipment. Reconnection of the backwash pump in the new MCC shall be completed first.
11. **Connect Finished Water Pump No. 2** to the new MCC and remove the relocated RVAT MCC section. Disconnect and remove the portable generator.

12. **Finalize installation of Pump No. 3.** Work on Pump No. 3 may begin at any time. Priority should be given to bringing pump No. 3 back online first.
13. **Complete process mechanical work**, including removal, replacement, and installation of valves, piping, and related components. Test and disinfect new piping and valves.
14. **Paint existing and new piping** as specified in the contract documents.
15. **Complete project finish-out**, including startup and testing.

1.26 PHOTOGRAPHIC REPORTS

A. The Contractor shall submit each month during construction not less than ten (10) 8" x 10" digital photographs (color prints and electronic files) to CCUSA, as outlined and stipulated hereinafter. All color prints shall have a 2" x 3" label in the lower right corner with the contract number, job name, Owner's name, Engineer's name, date and a short description.

B. CCUSA, or its representative, shall have the right to designate the origin points of the photographs and the desired scope or perception of the photographs which are intended to give a complete picture of the status of the project. The photographs shall be taken by a person or firm experienced in such work and approved by the Engineer.

C. The cost of the aforementioned will not be a pay item, but shall be included in the lump sum price bid and no additional compensation to the Contractor will be considered.

1.27 NAMEPLATES

A. The Contractor shall provide and install corrosion-resistant metal nameplates, with data engraved or stamped, for permanent attachment on all equipment. The data shall include the manufacturer, product name, model number, serial number, capacity, size, operating and power characteristics, and other essential data, as applicable for the particular equipment. The nameplates shall be permanently fastened to the equipment in a location that is accessible and visible, in a manner suitable for the particular equipment.

B. In addition to the manufacturer's nameplates, all equipment, including such items as unit heaters, fans, pumps, compressors, tanks, etc. shall be permanently identified by name and number corresponding to the as-built drawings with nameplates which shall be engraved and laminated black-on-white finish phenolic nameplates. Data and installation shall be approved by the Engineer. Nameplate letters shall be minimum 2-inch high etched white letters and beveled white trim. Nameplates for motor control center, and control and metering or instrument panels shall be provided with 3/8-inch high letters. Motors shall be identified by the same number as the driven unit. Identifying characters shall be not less than 2-inches high and shall be painted. Decals, Rotex, or Dymo field applied labels will not be acceptable. All nameplate data shall be reproduced in the Operating and Maintenance Manuals.

1.28 OPERATION OF EXISTING VALVES

A. Any existing valves that need to be operated during the course of construction shall be operated by CCUSA personnel only. The Contractor shall notify CCUSA a minimum of 24 hours prior to the operation of the valves.

1.29 MEASUREMENT AND PAYMENT

A. GENERAL

Measurement and payment shall be in accordance with General Requirements of the Contract. Work completed under this Contract will be made at the lump sum and unit prices bid as shown on the Proposal and as described in this section. Except where a specific unit price bid item is provided for in the Proposal, all work shall be included in the lump sum items shown. The absence from the Proposal form of bid items specifically described in the Contract Documents shall be interpreted as meaning that the cost of any such work contemplated by the Contract Documents shall be included in the lump sum prices bid. The Total Bid Amount shall include all lump sum bid items and contingency items.

The lump sum and unit prices shall include the furnishing of all labor, tools, equipment, materials and services and the performance of all work required to complete the Contract as indicated and specified in accordance with all requirements of the Contract Documents and to the satisfaction of the Engineer.

PART 2 – PRODUCTS

(NOT USED)

PART 3 – EXECUTION

(NOT USED)

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SECTION 01300
SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION

This Section includes general requirements and procedures related to the Contractor's responsibilities for preparing and transmitting Submittals to the Engineer to demonstrate that the performance of the Work will be in accordance with the Contract requirements. Submittals include Samples, Manuals, Methods of Construction, and Record Drawings. Other requirements for submittals are specified under applicable sections of the Contract Documents.

1.02 SUBMITTAL REQUIREMENTS

A. Progress Schedule

1. Within thirty (30) days after issuance of the Notice to Proceed, the Contractor shall prepare and submit his proposed construction schedule to the Engineer for review and approval.

2. If so required, the schedule shall be revised until it is approved by the Engineer.

3. Schedule shall be updated monthly, depicting progress to the last day of the month and submitted to the Engineer not later than the fifth day of the month, and prior to the application for progress payment. Failure to provide monthly schedule updates will be grounds for the Engineer or Owner to withhold progress payment approval.

4. Schedule shall be prepared in the form of a horizontal bar chart showing in detail the proposed sequence of the work and identifying construction activities for each structure and for each portion of work.

5. Schedule shall be time scaled, identifying the first day of each week. The Schedule shall be provided with estimated dates for Early Start, Early Finish, Late Start and Late Finish. The work shall be scheduled to complete the Project within the Contract time. The Late Finish date shall equal the Contract Completion Date.

6. Schedule shall show duration (number of days) and float for each activity. Float shall be defined as the measure of leeway in starting or completing a scheduled activity without adversely affecting the project completion date established by the Contract Documents.

7. Updated schedule shall show all changes since the previous submittal.

8. All revisions to the schedule must have the prior approval of the Engineer.

B. Equipment and Material Orders Schedule

1. Contractor shall prepare and submit his schedule of principal items of equipment and materials to be purchased to the Engineer for review and approval.

2. If so required, the schedule shall be revised until it is approved by the Engineer.

3. Schedule shall be updated monthly and submitted to the Engineer not later than the fifth day of every month with the application for progress payment.

4. The updated schedule shall be based on the Progress Schedule developed under the requirements of Paragraph 1.02(A) of this Section.

5. Schedule shall be in tabular form with appropriate spaces to insert the following information for principal items of equipment and materials:

   a. Dates on which Shop Drawings are requested and received from the manufacturer.

   b. Dates on which certification is received from the manufacturer and transmitted to the Engineer.

   c. Dates on which Shop Drawings are submitted to the Engineer and returned by the Engineer for revision.

   d. Dates on which Shop Drawings are revised by manufacturer and resubmitted to the Engineer.

   e. Date on which Shop Drawings are returned by Engineer annotated either "Furnish as Submitted" or "Furnish as Corrected".

   f. Date on which accepted Shop Drawings are transmitted to manufacturer.

   g. Date of manufacturer's scheduled delivery.

   h. Date on which delivery is actually made.

C. Working Drawings

1. Within thirty (10) days after the Notice to Proceed, the Contractor shall prepare and submit his preliminary schedule of Working Drawing submittals to the Engineer for review and approval. If so required, the schedule shall be revised until it is approved by the Engineer.

2. Working Drawings include, but are not limited to, Shop Drawings, layout drawings in plan and elevation, installation drawings, elementary wiring diagrams, interconnecting wiring diagrams, manufacturer's data, etc.

Contractor shall be responsible for securing all of the information, details, dimensions, Drawings, etc., necessary to prepare the Working Drawings required and necessary under this Contract and to fulfill all other requirements of his Contract. Contractor shall secure such information, details, Drawings, etc., from all possible sources including the Drawings, Working Drawings prepared by subcontractors, Engineers, suppliers, etc.

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

   a. All working and installation dimensions.

   b. Arrangement and sectional views.

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

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

4. In the event that the Engineer is required to provide additional engineering services as a result of a substitution of materials or equipment by the Contractor, the additional services will be provided in accordance with the General Conditions, and will be covered in supplementary or revised Drawings which will be issued to the Contractor. All changes indicated that are necessary to accommodate the equipment and appurtenances shall be incorporated into the Working Drawings submitted to the Engineer.

5. Working Drawings specifically prepared for this Project shall be on mylar or other approved reproducible material sheets of the same size as the Drawings. Working Drawings shall conform to recognized drafting standards and be neat, legible and drawn to a large enough scale to show in detail the required information.

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

7. Shop Drawings

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

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

   c. Where manufacturer's publications in the form of catalogs, brochures, illustrations or other data sheets are submitted in lieu of

prepared Shop Drawings, such submittals shall specifically indicate the item for which approval is requested. Identification of items shall be made in ink, and **submittals showing only general information are not acceptable.**

8. Layout and Installation Drawings

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

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

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

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

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

9. Method of Construction

   a. When so specified or directed by the Engineer, submit proposed method of construction for specific portions of the Work for review and approval. This submittal shall include detailed written description of all phases of the construction operation to fully explain to the Engineer the proposed method of construction. If required by the Specifications, submit working drawings to supplement description. Review and approval by the Engineer will be in accordance with approval process herein and shall not relieve the Contractor from his responsibility with regard to fulfillment of the terms of the Contract. All risks associated with the proposed method remain the Contractor's responsibility and the Engineer shall have no

responsibility therefore. After review and approval, if, in the opinion of the Contractor, modifications are necessary, submit such modifications in detail including reasons for the modifications. Modifications shall not be implemented without review and approval by the Engineer.

10. Contractor Responsibilities

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

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

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

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

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

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

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

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

10. Procedure for Review

a. Submittals shall be transmitted in sufficient time to allow the Engineer at least twenty one (21) working days for review and processing.

b. Contractor shall transmit electronic copies via a document management platform (such as Sharepoint) and all technical data or drawing to be reviewed.

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

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

"Approved" (A) - no exceptions are taken.

"Approved as Noted" (AAS) - minor corrections are noted and shall be made. Resubmission not required.

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

"For Information Only " (FIO) — submittal was received and was distributed for record purposes without review.

“Rejected” – The submitted material/equipment has been preliminary reviewed. A completely new submittal is required.

e. Contractor shall continue to resubmit submittals in full if they are returned “Revise and Resubmit” as required by the Engineer until

submittals are acceptable to the Engineer. It is understood by the Contractor that Owner may charge the Contractor the Engineer's charges for review in the event a submittal is not approved by the third submittal for a system or piece of equipment. These charges shall be for all costs associated with engineering review, meetings with the Contractor or manufacturer, etc., commencing with the fourth submittal of a system or type of equipment submitted for a particular Specification Section.

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

11. Engineer's Review

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

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

12. Record Drawings (As-Builts)

a. Contractor shall maintain current record drawings onsite for the Engineer’s review. **Record drawings shall be updated monthly at a minimum.**

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

c. The Contractor shall incorporate all defects and repairs into the Record Drawings.

d. Final Record Drawings furnished shall be corrected to include any departures from the Conformed Drawing set.

D. Operation and Maintenance Manuals

1. Preliminary Operation and Maintenance Manuals, prepared specifically for this Project, shall be furnished for each item of equipment furnished under this Contract. The preliminary manuals (submitted digitally) shall be provided to the Engineer not less than 60 days prior to the start-up of the respective equipment.

2. The preliminary manuals shall be reviewed by the Engineer prior to the Contractor submitting final copies for distribution to the Owner.

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

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

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

6. Following the Engineer's review of the preliminary manuals, the Contractor shall submit one (1) electronic file to the Engineer for final review. The manuals shall reflect the required revisions noted during the Engineer's review of the preliminary documents. Failure of the final manuals to reflect the required revisions noted by the Engineer during a review of the Preliminary documents will result in the manuals being returned to the Contractor. Once the final copies are accepted, three (3) hard copies and two (2) electronic/digital copies on USB thumb drive of the Final Operation and Maintenance Manuals to the Owner. Acceptable final Operation and Maintenance Manuals shall be provided not less than two weeks prior to equipment start-up.

E. Certified Shop Test Reports

1. Each piece of equipment for which pressure, head, capacity, rating, efficiency, performance, function or special requirements are specified or implied shall be tested in the shop of the manufacturer in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents and applicable test codes and standards. Contractor shall keep the Engineer advised of the scheduling of shop tests so that the Engineer may arrange for the witnessing or inspection at the proper time and place.

2. The Contractor shall secure from the manufacturers the actual test data, the interpreted results and a complete description of the testing facilities and

testing setup, all accompanied by a certificate of authenticity sworn to by a responsible official of the manufacturing company and notarized. These reports shall be forwarded to the Engineer for review.

3. In the event any equipment fails to meet the test requirements, the manufacturer shall make all necessary changes, adjustments or replacements and the tests shall be repeated, at no additional cost to the Owner or Engineer, until the equipment test requirements are acceptable to the Engineer.

4. No equipment shall be shipped to the Project until the Engineer notifies the Contractor, in writing, that the shop test reports are acceptable.

F. Samples

1. Contractor shall furnish for review all samples as required by the Contract Documents or requested by the Engineer.

2. Samples shall be of sufficient size or quantity to clearly illustrate the quality, type, range of color, finish or texture and shall be properly labeled to show the nature of the material, trade name of manufacturer and location of the work where the material represented by the sample will be used.

3. Samples shall be checked by the Contractor for conformance to the Contract Documents before being submitted to the Engineer and shall bear the Contractor's stamp of approval certifying that they have been so checked. Transportation charges on samples submitted to the Engineer shall be prepaid by the Contractor.

4. Engineer's review will be for compliance with the Contract Documents and his comments will be transmitted to the Contractor with reasonable promptness.

5. Accepted samples will establish the standards by which the completed work will be judged.

PART 2 - NOT USED

PART 3 - NOT USED

END OF SECTION 01300

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SECTION 01700

PROJECT CLOSEOUT

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies administrative and procedural requirements for project closeout, including but not limited to:

1. Inspection procedures.

2. Project record document submittals.

3. Operating and maintenance manual submittal.

4. Release of liens.

5. Submittal of warranties.

6. Final cleaning.

1.02 REQUIREMENTS OF REGULATORY AGENCIES

Conduct cleaning and disposal operation to comply with codes, ordinances, regulation, and anti-pollution laws.

1.03 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.

1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the work claimed as substantially complete. Include supporting documents for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.

2. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the Work is not complete.

3. Advise the Owner of pending insurance change-over requirements.

4. Submit to the Engineer specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents.

5. Obtain and submit releases enabling the Owner unrestricted use of the work and access to services and utilities; include occupancy permits, operating certificates and similar releases.

6. Submit to the Engineer record drawings, maintenance manuals, and similar final record information.

7. Deliver spare parts, extra stock, and similar items to the Owner via the Engineer.

8. Complete start-up testing of systems, and instruction of the Owner's operating and maintenance personnel. Discontinue or change-over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.

9. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

1.04 FINAL ACCEPTANCE

A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.

1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.

2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.

3. Submit a certified copy of the Engineer's final inspection list of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, and the list has been endorsed and dated by the Engineer.

4. Submit consent of surety to final payment.

B. Reinspection Procedure: The Engineer will reinspect the work upon receipt of notice that the work, including inspection list items from earlier inspections, has been completed, except items whose completion has been delayed because of circumstances acceptable to the Engineer.

1.05 RECORD DRAWINGS

A. The Contractor is required to keep an up-to-date set of Record Drawings (As-Constructed Drawings) for the project. In addition, the Contractor shall identify the location of all new piping installed, existing piping to remain and existing piping to be abandoned as it is installed or uncovered during the construction period. No trenching for piping shall be backfilled until the piping has been located by the Contractor. The Contractor shall also identify the location of all buried or embedded

conduits and duct banks including new work and existing to remain or to be abandoned as it is installed or uncovered during the construction. Up-to-date is defined as containing modifications for work performed within the past 30 days. The record drawing information shall include but not be limited to the following:

1. All dimensional changes. Degree of dimensioning shall equal that of the original drawing except for the yard piping and site electrical drawings. The Record Drawing dimensioning for the yard piping and site electrical (buried or embedded conduits and duct banks) drawings shall include as a minimum both horizontal locational dimensioning from above grade permanent structure and elevation at each location where the process piping and electrical work enters or leaves a structure and at each change in direction. In addition, where the buried process piping and electrical work parallels the wall of a structure, horizontal dimension from the structure and elevation shall be provided at a minimum of two locations.

2. Electrical breaker designations for each circuit such as receptacles, lights, heaters, etc.

3. All internal piping valve and fitting modifications. Degree of detail shall be equal to that of the original drawing.

4. All structural reinforcement modifications.

5. All electrical conduit size and routing wire size and wiring quantity modifications, wiring number and tagging assignments.

6. All site work modifications such as roadways, sidewalks, grading, etc.

B. The Engineer will review the status of the Contractor's record drawings on a monthly basis. If the record drawings do not meet the requirements stated above, 10% of the succeeding progress payments, in addition to the normal contract retaining, will be withheld until such time as the record drawings are brought into compliance.

C. The Contractor shall make the record drawings available to the Engineer whenever requested for reproduction by the Engineer so that he can begin preparation of the final record drawings to be supplied to the Owner.

D. At the end of the project, the Contractor's record drawing set shall be turned over to the Engineer.

1.06 RECORD DOCUMENT SUBMITTALS

A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.

B. Record Drawings: A clean, undamaged set of blue or black line prints of Contract Drawings will be maintained by the Contractor. The Contractor shall mark the set to show the actual installation where the installation varies from the work as originally shown. Mark whichever drawing is most capable of showing conditions fully and

accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Record Drawings. Give particular attention to concealed elements that work be difficult to measure and record at a later date.

1. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the work.

2. Mark new information that is important to the Owner but was not shown on Contract Drawings or Shop Drawings.

3. Note related Change Order numbers where applicable.

4. Organize Record Drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set. Upon completion of the work, submit Record Drawings to the Engineer for the Owner's records.

C. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous record-keeping and submittals in connection with actual performance of the work. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to the Engineer for the Owner's records.

1.07 GUARANTEES, CERTIFICATES, OPERATION AND MAINTENANCE MANUALS

A. During the course of the work and within 6 weeks after approval of Shop Drawings, Contractor shall collect and assemble six (6) copies each of the guarantees, manufacturers' specification sheets and/or working drawings, operation and maintenance instructions, parts list including exploded views, recommended safety procedures, and recommended list of spare parts. The Contractor shall submit all copies, with an itemized listing, to the Engineer.

B. Operation and Maintenance Manuals shall include all mechanical and electrical equipment specified.

C. Operation and Maintenance Manuals shall include all electronically operated features.

D. The Operation and Maintenance Manuals shall be assigned a value of 10% of the equipment cost, and this assigned amount will be retained from progress payments until the manuals are submitted to and approved by the Engineer and the equipment is delivered to the site.

E. Furnish Operation and Maintenance Manuals on 8-1/2" x 11" sheets or booklets, loose bound in 3-ring binders with front and back page lifters, with binder contents indicated on the front and spine of the binder cover. All loose sheets shall be in vinyl page protectors with reinforced binding edge. Furnish drawings included in the manuals on 11" x 17" sheets laminated and folded to 8-1/2" x 11" or folded and placed in vinyl "envelope pockets" incorporated into the binder. All materials in manuals shall be original print quality manufacturer's literature. Photostatic copies

of printed materials are not acceptable. Provide an index of the contents of each manual or a master index for a system consisting of several manuals. Provide printed and laminated, reinforced index tabs for each manual. Indexed sections to include Installation, Start-up, Operation, Troubleshooting, Maintenance, Parts List, Recommended Spare Parts and Miscellaneous Components. Submit no less than six (6) copies.

F. Include a detailed description of function of each principal component, procedures for starting, operation, overhaul and maintenance. Include safety precautions, test procedures and a catalog cross-reference to commercially available parts.

G. Submit a Preventive Maintenance and Lubrication Schedule for the equipment furnished which specifically explains the duties to be fulfilled by the Owner during the guarantee period. List the manufacturer's recommended lubricant plus two equal substitutes for all equipment. Shall be included in the O&M Manuals.

1.08 RELEASE OF LIENS

A. The Contractor shall deliver to the Engineer a blanket release of liens covering all work performed under this Contract, including that of subcontractors, sub-subcontractors, vendors, and other suppliers of materials and labor. Execute the release of liens on documents similar to AIA Document G706, "Contractor's Affidavit of Payment of Debtors and Claims", and AIA Document G706A., "Contractor's Affidavit of Release of Liens".

B. The forms shall be executed by the authorized officer and notarized. All required attachments shall be included as noted on AIA Document G706. If exceptions are listed in either AIA Document G706 or Document G706A, the Contractor shall furnish bond satisfactory to the Owner for each exception.

1.09 PROJECT CLOSEOUT SUBMITTALS

A. Submit two copies of Project Closeout submittals bound in three-ring binders, clearly labeled to the type of submittal. Provide pocket folders for folded information.

B. Submittals shall be submitted within ten days of Substantial Completion and prior to final Application for Payment.

1. Exception: Operation and Maintenance Manuals shall be submitted within six weeks after approval of shop drawings or within ten days of Substantial Completion, whichever is earlier.

C. Warranties and Bonds

1. Obtain warranties and bonds, executed in duplicate by responsible subcontractors, suppliers, and manufacturers.

2. Except for items put into use the Owner's permission, leave date of beginning of time of warranty until the date of Substantial Completion is determined.

3. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual; identify the number and title of the Specification Section in which product is specified.

4. Separate each warranty or bond with index tab sheets keyed to Table of Contents. List subcontractor, supplier, and manufacturer, with name, address and telephone number of responsible principal.

PART 2 - PRODUCTS

2.01 CLEANING MATERIALS

A. Use only those materials which will not create hazards to health or property, and which will not damage finishes and surfaces.

B. Use only materials and methods recommended by manufacturer of material being cleaned.

PART 3 - EXECUTION

3.01 CLOSEOUT PROCEDURES

A. Operating and Maintenance Instructions: Each installer of equipment that requires regular maintenance shall arrange to meet with the Owner's personnel to provide instruction in proper operation and maintenance. If installers are not experienced in procedures, provide instruction by manufacturer's representatives. Include a detailed review of the following items.

1. Operation and maintenance manuals
2. Record documents
3. Spare parts and materials
4. Tools
5. Lubricants
6. Fuels
7. Identification systems
8. Control sequences
9. Hazards
10. Cleaning
11. Warranties and bonds
12. Maintenance agreements and similar continuing commitments.

B. As part of instruction for operating equipment, demonstrate the following procedures:

1. Start-up

2. Shutdown

3. Emergency operations

4. Noise and vibration adjustments

5. Safety procedures

6. Economy and efficiency adjustments

7. Effective energy utilization

C. Training by factory representatives shall be video taped by the Contractor in a VHS format, and the tapes then turned over to the Engineer upon completion of training.

3.02 INITIAL OPERATION

The Contractor shall place the completed Project, equipment and systems into initial operation. The schedule and sequence of the initial operation procedures shall be included in the Project Schedule. Coordinate the initial operation procedures with the Owner's operating personnel.

3.03 FINAL CLEANING

A. All final cleaning shall be performed by the Contractor, unless otherwise specified.

B. Remove temporary protection and labels not required to remain.

C. Clean surfaces free of grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed interior and exterior surfaces, bringing them to a state or readiness for Owner occupancy.

D. Clean transparent glossy materials to a polished condition; remove foreign substances. Polish reflective surfaces to a clear shine.

E. Vacuum clean carpeted and similar soft surfaces as specified.

F. Clean, wash, and polish resilient and hard-surfaced floor as specified.

G. Clean surfaces of equipment; remove excess lubrication.

H. Clean plumbing fixtures and similar equipment to a sanitary condition.

I. Electrical Devices:

1. Clean light fixtures, lamps and lenses.

2. Clean the faces of all electrical devices and cover plates for same, including power receptacles, switches, computer outlets, computer and TV outlets, TV outlets, telephones, communication speakers, fire alarm speakers, fire alarm pull stations, fire alarm flashing lights, smoke detectors, clocks, speaker volume control switches, security system motion detectors, and fire alarm horns.

3. Clean the fronts of all electrical panelboards and the main distribution switchboard.

J. Remove waste, foreign matter and debris from areaways and drainage systems.

K. Remove waste, debris, and surplus materials from site. Clean grounds; remove stains, spills, and foreign substances from paved areas and sweep. Rake clean other exterior surfaces.

L. Clean permanent filters of ventilating equipment and replace disposable filters when units have been operated during construction; in addition, vacuum clean ducts, blowers and coils for every three months' use; replace or clean strainers, dirt legs, etc.

3.04 TERMINAL INSPECTION

A. Two months prior to expiration of the one year guarantee period, the Contractor shall make an inspection of the work in the company of the Engineer and the Owner. The Engineer and the Owner shall be given no less than five days' notice prior to the anticipated date of terminal inspection.

B. Where any portion of the work has proven to be defective and requires replacement, repair or adjustment, the Contractor shall immediately provide materials and labor necessary to remedy such defective work and shall execute such work without delay until completed to the satisfaction of the Engineer and the Owner, even though the date of completion of the corrective work may extend beyond the expiration date of the guarantee period.

C. The Contractor shall not be responsible for correction of work which has been damaged because of neglect or abuse by the Owner nor the replacement of parts necessitated by normal wear in use.

END OF SECTION 01700

SECTION 03600

GROUT

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work of this section includes grouting as indicated on the drawings or specified in other sections. Unless otherwise specified, all grouting shall be done with non-shrinking grout.

1.02 REFERENCES

A. American Concrete Institute:

1. ACI 308, Recommended Practice for Curing Concrete.

B. American Society for Testing and Materials:

1. ASTM C33; Concrete Aggregates.

2. ASTM C109; Test Method for Compressive Strength of Hydraulic Cement Mortars (Using two inch or 50-mm Cube Specimens).

3. ASTM C150; Specification for Portland Cement.

4. ASTM C191; Test Method for Time of Setting of Hydraulic Cement by Vicat Needle.

5. ASTM C596; Test Method for Drying Shrinkage of Mortar Containing Portland Cement.

6. ASTM C827; Test Method for Early Volume Change of Cementitious Mixtures.

1.03 SUBMITTALS

A. Submit a statement of compliance, together with supporting data, from the materials suppliers attesting to the conformance of products and ingredients with these specifications.

B. Submit manufacturer's instructions for mixing, handling, surface preparation, and placing the epoxy type and the non-shrink, non-metallic type grouts.

1.04 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Grout manufacturer shall furnish copies of current independent laboratory test results showing the non-shrink, non-metallic grout as non-shrink from time of placement according to the following:

1. The grout indicates no expansion after final set according to ASTM C827.

2. The grout indicates 4,000-psi strength developed with a trowelable mix within 24 hours according to ASTM C109.

3. The grout indicates placement time limitation based on initial set of not less than 60 minutes according to ASTM C191.

4. Test results, as supplied by the grout manufacturer, shall indicate that in projects of similar scope and size, the effective bearing area was between 95 and 100 percent.

1.05 DELIVERY, STORAGE AND HANDLING

A. Provide protection for the products to prevent moisture damage and contamination of the grout materials.

B. Store the grout in undamaged condition with seals and labels intact as packaged by the manufacturer.

1.06 PROJECT CONDITIONS

A. Protect freshly poured grout against high and low temperatures and unfavorable environmental conditions in accordance with ACI Standards 308.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Portland Cement: ASTM C150, Type II.

B. Water: Potable; containing no impurities, suspended particles, algae, organic substances, acids, alkalis, or dissolved natural salts in quantities that will cause:

1. Corrosion of steel,

2. Volume change that will increase shrinkage cracking,

3. Efflorescence,

4. Excess air entraining.

C. Fine Aggregate:

1. Washed natural sand.

2. Gradation in accordance with ASTM C33 and represented by a smooth granulometric curve within the required limits.

3. Free from injurious amounts of organic impurities as determined by ASTM C40.

2.02 RAPID-CURING EPOXY GROUT

A. High strength, three-component epoxy grout formulated with thermosetting resins and inert fillers.

B. Grout shall be rapid curing, have high adhesion, and be resistant to ordinary chemicals, acids and alkalis.

C.

Physical Properties		Reference Spec.
Compressive Strength	12,000 psi (7-day)	ASTM C579
Tensile Strength	2,000 psi minimum	ASTM C307
Coefficient of Expansion	3 x 10^{-6} in/in/^{o}F	ASTM C531
Shrinkage	None	ASTM C827

2.03 NON-SHRINK, NON-METALLIC CEMENTITIOUS GROUT

A. Pre-mixed ready for use formulation requiring only the addition of water; non-shrink, non-corrosive, non-metallic, non-gas forming, no chlorides. No more water shall be used than is necessary to produce a flowable grout.

B. Certified to maintain initial placement volume or expand after set and meet the following minimum properties when tested in accordance with Corps of Engineers Specification CRD-C621, for Type D non-shrink grout:

Setting Time:	Initial	2 hours (Approx.)
ASTM C191	Final	3 hours (Approx.)
Expansion:		0.4% Maximum
Compressive Strength:	1 day	4,000 psi
CRD-C621	7 days	7,000 psi
	28 days	10,000 psi

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces by brushing, hammering, chipping or other similar means until a sound, clean concrete surface is achieved. Perform additional surface preparation in accordance with non-shrink, non-metallic grout manufacturer's instructions.

B. Lightly roughen the concrete, but not enough to interfere with the proper placement of grout.

C. Remove foreign materials from metal surfaces in contact with grout.

D. Align, level and maintain final positioning of components to be grouted.

E. Take special precautions during periods of extreme weather conditions in accordance with the manufacturer's written instructions.

F. Saturate concrete surfaces with clean water; remove excess water, leave none standing.

3.02 FORMWORK

A. Construct leakproof forms anchored and shored to withstand grout pressures, so that no movement is possible.

B. Provide clearance between the formwork and the area to be grouted to permit proper placement of grout.

C. Forms shall be provided where structural components of baseplates or bedplates will not confine the grout.

D. Pre-treat wood forms with forming oils so that they do not absorb moisture.

E. Remove supports only after grout has hardened.

3.03 MIXING

A. Portland Cement Grout:

1. Prepare grout composed of Portland cement, sand and water; do not use ferrous aggregate or staining ingredients in grout mix.

2. Use proportions of 2 parts sand and 1 part cement, measured by volume.

3. Prepare grout with sufficient water to obtain consistency to permit placing and packing.

4. Mix water and grout in two steps; pre-mix using approximately 2/3 of the water; after partial mixing, add the remaining amount of water to bring mix to the desired placement consistency and continue mixing 2-3 minutes.

5. Mix only that quantity of grout that can be placed within 30 minutes after mixing.

6. After the grout has been mixed, do not add more water for any reason.

B. Epoxy Grout & Non-Shrink Cementitious Grout: Mix and prepare epoxy grout and non-shrink cementitious grout in strict accordance with the manufacturer's instructions.

C. Mix grout components as close to the work area as possible and transport the mixture quickly and in a manner that does not permit segregation of materials.

3.04 PLACING

A. Unless otherwise specified or indicated on the drawings, the thickness of grout under baseplates shall be 1-1/2 inches. Grout shall be placed in strict accordance with the directions of the manufacturer so that all spaces and cavities below the top of baseplates and bedplates are completely filled, without voids.

B. Place grout material quickly and continuously.

C. Do not use pneumatic-pressure or dry-packing methods.

D. Apply grout from one side only to avoid entrapping air. The final installation shall be thoroughly compacted and free of air pockets.

E. Do not vibrate the placed grout mixture, or permit it to be placed if the area is being vibrated by nearby equipment.

F. In all locations where the edge of the grout will be exposed to view, the grout shall be finished smooth after it has reached its initial set. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate, bedplate, member, or piece of equipment.

G. Do not remove leveling shims for at least 48 hours after grout has been placed.

H. Unless otherwise noted in the drawings, anchor bolts and threaded rod anchors shall be epoxy grouted in holes drilled into hardened concrete. Diameters of holes shall be as follows:

Item	Diameter of Hole
Threaded Rod Anchors	1/8 inch larger than the bar or rod outside diameter
Anchor Bolts	Per manufacturer's instructions

I. The embedment depth for epoxy grouted anchor bolts and threaded rod anchors, shall be not less than 15 bolt or rod diameters, unless otherwise indicated on the drawings. Holes shall be prepared for grouting as recommended by the grout manufacturer.

J. Anchor bolts and threaded rod anchors shall be clean, dry, and free of grease and other foreign matter at time of installation. The bolts, rods, and bars shall be set and positioned, and the epoxy grout shall be placed and finished in accordance with the recommendations of the grout manufacturer. Particular care shall be taken to ensure that all space and cavities are filled with epoxy grout, without voids.

K. During assembly of all threaded stainless steel components, anti-seize thread lubricant shall be liberally applied to the threaded portion not embedded in concrete.

3.05 CURING

A. After grout has attained its initial set, keep damp for a minimum of 3 days.

B. Prevent rapid loss of water from the grout during the first 48 hours by the use of an approved membrane-curing compound or with the use of the wet burlap method.

END OF SECTION 03600

SECTION 09900

PAINTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. The work of this section includes furnishing coatings and coating systems for painting and finishing, preparation of surfaces to receive coatings, and application of coatings on interior and exterior surfaces.

B. Work Included - The work of this section includes but is not limited to painting the following surfaces:

1. Miscellaneous metalwork

2. Interior piping, valves and appurtenances

3. Mechanical equipment

C. Work Not Included - The following related items shall not be painted under this Section of the Contract:

1. Anodized aluminum, stainless steel or fiberglass.

2. Any surface or equipment that has received finish coat of paint at factory, if such finish is undamaged and matches the color schedule.

3. Manufacturer's serial number or identification plates on equipment when such plates are pre-finished or polished type. (This does not include cast or embossed names on equipment castings.)

4. Machined or polished surfaces of equipment where such surfaces are susceptible to rolling or sliding friction.

1.02 DEFINITIONS

A. The term "paint" as used herein includes emulsions, enamels, epoxies, paints, stains, varnishes, sealers and other coatings, whether organic or inorganic, indicated as prime, intermediate or finish coats in this specification and other documents made a part thereof.

B. "Submerged" is defined as below the elevation of the top of the wall of a structure containing liquid. In all cases, the decision of the Engineer shall be final in determining classification of surfaces.

1.03 QUALITY ASSURANCE

A. Include on label of each container:

1. Manufacturer's name
2. Type of paint
3. Manufacturer's stock number
4. Color
5. Instructions for reducing, where applicable.

B. Applicable Industry Standards

1. ASTM D16 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.
2. AWWA (American Water Works Association) - C204 - Chlorinated Rubber-Alkyd Paint Systems for the Exterior of Above Ground Steel Water Piping. WWA (American Water Works Association) - D102 - Painting Steel Water Storage Tanks.
3. NACE (National Association of Corrosion Engineers) - Industrial Maintenance Painting.
4. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.

C. Field Quality Control

1. Request review by Engineer of first finished room, space, or item of each color scheme required for color, texture, and workmanship.
2. Use first acceptable room, space, or item as product standard for each color scheme.
3. For spray application, paint surface not smaller than 100 square feet as project standard.

1.04 SUBMITTALS

A. Submit color chart for the paint system to the Engineer for selection of colors.

B. Submit manufacturer's product data listing materials properties, application recommendations, and environmental conditions required for use.

1.05 PRODUCTS DELIVERY, STORAGE AND HANDLING

A. Deliver paint products in sealed containers with manufacturer's labels legible and intact.

B. Store products in ventilated dry areas, protected from contact with soil and from exposure to the elements. Keep products dry at all times. Restrict storage to paint materials and related equipment. Comply with heath and fire regulations.

1.06 JOB CONDITIONS

A. Environmental Requirements

Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating systems may be applied.

Do not apply paint in areas where dust is being generated.

B. Protection

Cover or otherwise protect finished work, surfaces not being painted concurrently or not to be painted.

C. Factory Painted Surfaces

1. The surface preparation and painting of materials and equipment will be to manufacturer's standard unless otherwise specified in applicable portions of these specifications.

2. Assure compatibility of coatings applied at the project site with coatings provided by manufacturers and suppliers.

D. Special consideration and care shall be taken to avoid painting when conditions exist for the pipe to sweat and condensation form before the coating is properly cured. The Contractor shall make appropriate adjustments when scheduling the painting and/or provide the proper environment to paint and cure the piping to avoid this condition. This may require painting and/or curing during periods of time when the plant is not in operation.

PART 2 - PRODUCTS

2.01 REFERENCE STANDARDS

A. Paint and coatings provided under this Contract list Tnemec as the basis of design.. Products of Carboline, Sigma Coatings or other manufacturers of comparable quality and specified type will be acceptable if said paints are submitted for approval to the Engineer with satisfactory data on past performance in wastewater treatment plants, certification of composition & performance criteria, and detailed directions for application and use including recommended coverages.

B. Coatings shall be comparable to the products of:

1. Tnemec Company, Inc.

2. Sherwin-Williams Company

3. Carboline

4. or Equal

C. Apply coatings to surfaces as listed in the Schedule at the end of this Section.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine surfaces scheduled to receive paint and finishes for conditions that will adversely affect execution, permanence or quality of work and which cannot be put into an acceptable condition through preparatory work as included in paragraph 3.03, Surface Preparation.

B. Do not proceed with surface preparations or coating application until environmental conditions are suitable.

3.02 TEMPORARY CONSTRUCTION

A. Furnish, install, and remove upon completion of painting all scaffolding, ladders or other facilities required to complete painting work.

B. Temporary heating and ventilating facilities will be required in damp areas or confined spaces. These facilities and all other methods or equipment required to facilitate painting work or afford protection of workmen or work shall be furnished, installed and removed at the completion of work as part of this contract.

3.03 SURFACE PREPARATION

A. Remove or protect hardware, hardware accessories, plates, lighting fixtures and similar items placed prior to painting; reposition or remove protection upon completion of each space. Disconnect equipment adjacent to walls; where necessary, move to permit painting of wall surfaces and, following completion of painting, replace and reconnect.

B. Metal Surfaces

Metal to be painted that has not been shop primed shall have all rust, scale, dust, loose or foreign substances removed by wire brushing with power tools, chipping or sandblasting. Cleaned metal shall be field primed immediately after cleaning to prevent new rusting.

Clean galvanized metal surfaces shall be cleaned in accordance with SSPC-SP1 Solvent Cleaning to remove oily residue and ASTM D 6386-99 Brush-Off Blast Cleaning. Dry with a clean cloth.

Touch-up paint structural steel, miscellaneous metal, hollow metal doors and frames, and other materials which have been prime coated, as required, where shop coat has been damaged by welding or handling and erection; paint rivets, bolts and welds which are unpainted after assembly and erection.

Prepare steel substrates in accordance with the Steel Structures Painting Council surface preparation number indicated in the application schedule and as outlined below, unless otherwise required by the coating manufacturer's most recent printed application instructions:

1. SSPC-SP1 Solvent Cleaning - Thoroughly wipe with aromatic/ketone solvent using clean rags and clean solvent.

2. SSPC-SP6 Commercial Blast Cleaned Steel (for non-immersion, exterior and interior exposure steel)

3. SSPC-SP13, ICRI, CSP 3-9 profile. Brush blast concrete surfaces using the appropriate blasting medium; sand or grit to obtain the proper surface profile.

4. SSPC-SP10 Near-White Metal Blast Cleaned Steel (Immersion and chemical exposures)

To minimize potential for flash rusting, steel surfaces shall be at least 50^{o}F above the dew point before surface preparation and priming begin.

3.04 APPLICATION

A. General

Apply paint in strict accordance with manufacturer's instructions and in a manner satisfactory to the Engineer.

Apply each coating at rate specified by manufacturer. If material has thickened or must be diluted for application by spray gun, build up coating to the same film thickness achieved with undiluted material. Correct deficiencies in film thickness by application of additional coats of paint.

Drying time shall be construed to mean "under normal conditions". Where conditions are other than normal because of weather or because painting must be done in confined spaces, longer drying times will be required. Do not apply additional coats of paint or place unit in service until paint is thoroughly dry.

Where thinning is necessary, only the products of manufacturer furnishing the paint, and for particular purpose, will be allowed. Thin paint in strict accordance with manufacturer's instructions and only with the full knowledge and approval of the Engineer.

Do not apply final coats until after other trades, whose operations would be detrimental to finish painting, have finished work in the areas to be painted and the areas have been approved by the Engineer for painting.

Slightly vary the color of successive coats. Sand and dust between each coat to remove defects visible from a distance of 5 feet.

Finish coats shall be smooth, free of brush marks, streaks, drips, laps or pile up of

paints, and skipped or missed areas.

Finished metal surface shall be free of skips, voids or pinholes in any coat when tested with a low voltage detector.

Mask edges of paint adjoining other materials or color to obtain sharp, clean division without overlapping.

B. Finishing

Do not apply additional coats until completed coat has been examined by the Engineer.

Change colors at corner of stop where colors differ between adjoining spaces or rooms and where door frames match wall color.

Refinish whole wall where portion of finish has been damaged or is not acceptable.

Adjust stained and natural finishes as necessary to obtain uniform appearance.

3.05 CLEANING

A. Touch-up and restore finish where damaged. Remove spilled, splashed, or splattered paint from all surfaces.

B. Leave storage space clean and in condition required for equivalent spaces in project.

3.06 SCHEDULE

A. The finish schedule and color schedule shall be as indicated on the drawings or as directed by the Engineer. Paint any work not specifically named, but required by the intent of the drawings and specifications to be painted, in accordance with similar items.

B. Omit the first coats specified hereinafter, except for touch-up, if surfaces have been primed at the mill, factory or shop. For touch-up, use primer of the same composition as the mill, factory or shop primer.

C. Apply paints to surfaces in accordance with the Schedule.

D. Interior Finished Water Piping, Valves, and Appurtenances

a. Paint new piping and existing finished water piping associated with Pumps 1, 2, and 3 as well as the discharge header piping.

b. Color selections for piping systems will be made by the Owner. Paint all valves, handwheels and operating handles of all valves, associated meters, pumps and equipment, etc. the same color as the piping system.

c. For ductile or cast iron piping with a bituminous primer, apply the appropriate number of coats of the manufacturer's recommended sealer to prevent bleed through.

E. Finished Water Pump No. 3

a. Paint finished water pump No. 3 and its motor

b. Color selections for piping systems will be made by the Owner. Paint all valves, handwheels and operating handles of all valves, associated meters, pumps and equipment, etc. the same color as the piping system.

F. Equipment and Control Panels

Paint factory finished equipment and control panels where necessary to match colors.

Paint process equipment the same color as their respective piping systems.

G. Physical Hazards

Comply with OSHA Standard 1910.144 for identification and color code marking of all physical standards.

(SEE ATTACHED PAINT/COATING SCHEDULE)

PAINTING/COATING SCHEDULE						
					TNEMEC	
SYSTEM NUMBER	**SURFACE**	**PREPARATION**	**GENERIC**	**COATS**	**NAME**	**DFT**
1	New Interior Non-Submerged Ferrous Metal	SSPC-SP-6/NACE 3	Modified Aromatic Polyurethane Primer	Shop Prime	Series 1 Omnithane*	2.5-3.5 mils
			Modified Aromatic Polyurethane Primer	Field Touchup	Series 1 Omnithane*	2.5-3.5 mils
			Polyamidoamine Epoxy	Intermediate	Series N69-Color Hi-Build Expoxoline II*	4.0-6.0 mils
			Polyamidoamine Epoxy	Finish	Series N69-Color Hi-Build Expoxoline II*	4.0-5.0 mils
2	Existing Interior Non-Submerged Ferrous Metal	Remove loose coating and rust, feather edges, and clean surfaces prior to coating.	Phenalkamide Epoxy	Prime	Series 138 Protuff	4.0-6.0 mils
			Polyamidoamine Epoxy	Finish	Series 138 Protuff	4.0-6.0 mils
3	Factory Paint Equipment & Machinery	Dull Clean & Dry	Touch up paint per Manufacturer's recommendations			

END OF SECTION 09900

SECTION 10400

IDENTIFICATION DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Furnish all labor, materials, equipment and appliances required for the complete execution of the Work as shown on the Drawings and specified herein for interior and exterior signage.

B. Principal items of work include:

1. Plastic engraved door and informational signs as indicated on the Drawings.

2. Process Equipment Identification Signs

1.02 SUBMITTALS

A. Shop Drawings

1. Contractor shall submit shop drawings for review in accordance with Conditions of Contract.

2. Indicate locations, dimensions, anchorage, types and gauges of materials being used, features included, elevations, etc.

B. Manufacturer's Literature: Submit manufacturer's latest publications of descriptive literature and product data.

1.03 QUALITY ASSURANCE

A. Regulations, Standards and Publications:

1. ADA - American Disabilities Act

1.04 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Product Handling:

1. Deliver all materials in good condition. Store in dry place, off ground and keep dry at all times. Handle materials to prevent damage to product or structure.

PART 2 - PRODUCTS

2.01 PROCESS EQUIPMENT, PIPE AND VALVE IDENTIFICATION MARKINGS

A. Equipment Identification

1. Mark each unit of process equipment including all pumps, local control panels, chemical feed tanks, reset timer, flow meters, thermostats, switches, etc. with its functional name (example: “Finished Water Pump No. 1", “Sludge Flowmeter No. 1”) by means of an etched stainless steel plate with permanent adhesive backing.

2. Insure that equipment designations and their corresponding electrical control equipment designations coincide.

B. Piping Identification

1. Identify process piping with its process designation and direction of flow identified with semi-rigid, snap-on acrylic-plastic identification markers at 15-foot intervals, at each change of direction, and adjacent to each point it passes through a wall, floor or ceiling. Comply with ANSI and OSHA pipe marking requirements.

2. Identify pipes less than 1" in diameter with brass tags, 1-1/2" in diameter, with depressed 1/4" high black enamel-filled letters, securely fastened at 5-foot intervals.

C. Valve Identification

1. Identify each valve with an identifying letter designating the system and an identifying number designating the unit served (example: check valve on the finished water pump discharge piping from Finished Water Pump No. 2 shall be designated as “Finished Water Pump No. 2 Check Valve”. Identify solenoid valves with same designation indicated on process and instrumentation diagrams included in the Contract Drawings.

2. Identify valves with phenolic identification tags, 1-1/2" in diameter, with depressed 1/4" high black enamel-filled letters, securely fastened to the valve.

3. Furnish a chart, in duplicate, of all valves. Include valve identification number, normal open/closed position, location, and purpose.

D. Locations and method of attachment of name plates, tags, and markers shall be approved by the Owner’s representative.

E. Equipment identification shall comply with specification section 15100, if applicable.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Identification devices shall be installed level, plumb and true, in correct relation to adjoining work.
2. Secure parts in rigid, substantial manner; attachment concealed wherever practicable.
3. All items shall be complete with bolts, anchors, clips, ready to install.

B. All materials specified herein shall be installed in compliance with the approved manufacturer's printed specifications. Mounting devices, bolts, screws, nuts and the like shall be of high strength aluminum or stainless steel. The final location of each sign shall be as determined by the Engineer.

C. Plastic door numbers and room name plates shall be attached stainless steel oval Phillips head screw at each corner.

1. Submit a schedule of door numbers and name plates to the Engineer for approval.

2. Install door and name plates after final field finish has been applied and thoroughly dried.

3.02 ADJUSTMENT AND CLEANING

A. After completion of project, remove all protective devices, touch up as necessary and clean all exposed surfaces with a mild solution of detergent and warm water. Leave all surfaces in a neat and clean condition.

B. Touch-up minor surface damage which can be job-repaired to satisfactory condition, subject to approval of the Engineer.

END OF SECTION 10400

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SECTION 11101

GENERAL PROCESS MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

The provisions of this entire section of the specifications are intended to govern the quality of design, fabrication, workmanship, operation, etc., of all materials, equipment and appurtenances to be furnished and installed under the various sections of the process mechanical specifications and all other sections that include process mechanical equipment as part of the specified items.

1.02 SUBMITTALS

A. Shop Drawings and Product Data

Shop drawings, including dimensioned drawings, descriptive literature, performance data, electrical characteristics, and in general all information necessary to provide compliance with the specifications, shall be submitted as required in Section 01300.

B. Maintenance Data and Operating Instructions

Submit an Operation and Maintenance Manual for the equipment furnished including a detailed description of the function of each principal component, procedures for operation, instructions for overhaul and maintenance in accordance with Section 01300. Include lubrication schedule, safety precautions, test procedures, electrical schematics, and parts lists.

1.03 GUARANTEE

All materials, equipment, workmanship and performance shall be guaranteed for the period and in accordance with the provisions of Section 01700.

1.04 MANUFACTURER'S OPERATION AND MAINTENANCE MANUALS

The Contractor shall provide manufacturer=s operation and maintenance manuals as required in Section 01300.

1.05 STANDARDS

Where standards, codes or specifications are referred to, the reference is to particular standards, codes or specifications together with all the latest amendments and errata applicable at the time the bids are taken. These are listed below:

I.E.E.E.	Institute of Electrical & Electronics Engineers
A.S.T.M.	American Society for Testing Materials
A.S.M.E.	American Society of Mechanical Engineers
A.N.S.I.	American National Standards Institute
A.W.S.	American Welding Society

A.W.W.A.	American Water Works Association
N.F.P.A.	National Fire Protection Association
N.E.M.A.	National Electrical Manufacturer=s Association
Federal	Federal Government Specifications
O.S.H.A.	Occupational Safety and Health Act
U.L.	Underwriters Laboratories
A.A.B.C.	Associated Air Balance Council
A.D.C.	Air Diffusion Council
A.G.A.	American Gas Association
A.R.I.	Air Conditioning and Refrigeration Institute
C.S.	Commercial Standard
I.B.R.	Institute of Boiler and Radiator Manufacturers
M.S.S.P.	Manufacturers Standards Society of the Valve and Fitting Industry
S.M.A.C.N.A.	Sheet Metal and Air Conditioning Contractors National Association
N.E.C.	National Electrical Code

1.06 GENERAL DESIGN OF EQUIPMENT AND MACHINERY

A. All equipment and machinery furnished under this contract shall be of the latest and most improved design suitable for the service of which it is to be used. All equipment and machinery shall be designed and constructed to operate efficiently, continuously and quietly under the specified requirements with a minimum of labor, power, maintenance, renewals and repairs. The design and construction of all equipment and machinery shall be such as to permit operation with minimum noise, wear and vibration (maximum amplitude of 3.0 mils unless otherwise specified) when properly installed.

B. Ample room for erecting, repairs, inspecting and adjusting all equipment and machinery shall be provided. The design, construction and installation of all equipment and machinery shall conform to and comply with the latest safety codes and regulations.

C. The design and construction of the several units shall be such that they shall present a uniform appearance and the arrangement shall be such that their operation shall be in harmony in every respect. Whenever possible, fittings and fixtures of the same make and model shall be used for the several units and their connections. All equipment of identical type and service shall be the product of the same manufacturer.

D. All equipment selected shall be of such size and general arrangement to suit the space in which it is to be installed.

E. The various parts of the equipment and machinery shall be of plain shape and good lines, especially designed and constructed for strength and durability. Casting shall be designed and constructed to cool uniformly without shrinking strains and shall have good-sized fillets at all re-entrant corners. Sudden change of section shall be avoided.

F. Whenever possible, part of each unit shall be made to gauge and be a duplicate of and interchangeable with the same parts of other machines of the same size and kind.

G. The workmanship shall be of the highest class throughout.

H. All assemblies shall be completely shop fabricated and structural steel parts shall be shop erected. Assemblies and structural steel parts shall be matchmarked before being disassembled for shipment. Parts shall be shipped assembled in as large unit as possible to minimize field reassembly. All parts shall be amply proportioned for all stresses, which may occur during operation, and for any additional stresses, which may occur during fabrication and erection.

I. Unless otherwise specified, welding shall be in accordance with the latest standard specifications for AGas Tight Welding@ of the American Welding Society.

J. Unless otherwise specified, galvanizing shall be hot-dipped in accordance with the latest standard specifications for AZinc Coating@ of the ASTM, Serial Designation A-123.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified, materials shall be in accordance with the following latest Standard Specifications of the ASTM:

Structural Steel	A-36
Welding Steel Pipe	A-53
Iron Castings	A-48
Babbitt	B-23
Bronze Castings	B-30
Bronze (Manganese)	B-138
Bronze (Silicone)	B-98
Steel Bolts	A-307
Hot Dip Zinc Coating	A-123
Stainless Steel Bolts	A-193, Grade B, Type 2

B. All materials shall, if required, be tested and shall fulfill all requirements specified. Physical tests may be made by the Owner. The Contractor at his own expense shall furnish test pieces and samples in the number, shape, size and finish required by the Engineer. All broken material shall become the property of the Owner. The failure of test specimens to fully conform to the requirements of the specifications shall be sufficient cause for rejection of the whole melt or stock from which samples were obtained.

C. Iron castings shall be smooth, clean and free from scale, lumps, blisters and other defects. No plugging, welding or filling will be allowed.

D. The alloy grade number of all babbitt shall be that bearing alloy of a composition recommended by the manufacturer of the equipment or machinery for the service required, subject to the approval of the Engineer.

E. All bronze shall be made of new material and shall be free from objectionable imperfections. If the materials show signs of improper mixing when being machined, the castings will be rejected.

2.02 JOURNALS, BEARINGS AND KEYS

A. Journals and bearing surfaces shall be of sufficient size and properly proportioned for the least wear and to avoid heating under all conditions, and where necessary, provisions shall be made for each removal and for proper adjustments. Journals shall be suitable boxes, which, where necessary, shall be lined with babbitt metal hammered into grooves and bored in place. If bearings are of the ball bearing type, both inner and outer races as well as the balls shall be heat-treated steel to resist wear. The balls shall be of ample size to carry the maximum loads with a large factor of safety to prevent flaking, spalling, or crushing. The balls shall be properly spaced and held in position by rugged continuous spacing or retainer rings.

B. Pins and keys shall be properly proportioned. Keys, nuts and all other parts, which might otherwise work loose shall be secured with approved locking devices.

2.03 LUBRICATION

A. All bearings, except those specifically requiring oil or water lubrication shall be pressure grease lubricated. All lubrication points shall be readily accessible, away from locations dangerous to workmen. Pressure grease lubrication fittings shall be the AAlemite@ type as made by the Stewart Warner Corporation, or equal. The pattern of the fitting shall be selected for accessibility in lubricating and shall meet the approval of the Engineer. Housings of grease-lubricated bearings shall be automatically exhausted to atmosphere to prevent excessive greasing. The Contractor shall furnish three Alemite Hydraulic guns, or equal.

B. The Contractor shall furnish lubrication charts or schedules for each piece of equipment or machinery. The charts or schedules shall designate each point of lubrication, the type of lubricant to be applied and the frequency of lubrication. Charts and schedules shall be submitted to the Engineer in quadruplicate, bound in folios, with each chart or schedule protected by a transparent plastic envelope.

C. The Contractor shall furnish one (1) year’s supply of each type of lubricant. A typewritten list shall be furnished with the lubricants, designating the specific lubricant to be used for each piece of equipment. This is in addition to the required operating and maintenance manuals, which will also contain lubrication requirements.

2.04 MOTORS AND CONTROLS - GENERAL

A. Motors and controls shall conform to the latest requirements of IEEE and NEMA, and where applicable, shall be UL listed. Minimum sizes are specified with the

driven equipment. Motor starting and control equipment is specified either with the motor, which is controlled, or in an electrical specification section. The Contractor is advised to consult all specification sections to determine responsibility for motors and controls.

B. Motors shall be designed, built and tested in accordance with the latest revision of NEMA Standard MG 1.

C. Motors shall be suitable for use under the conditions and with the equipment to which applied, and designed for operation on the electrical systems specified or indicated.

1. Motor capacities shall be such that the horsepower rating and the rated full-load current will not be exceeded while operating under the specified operating conditions. Under no condition shall the motor current exceed that indicated on the nameplate.

2. Motor sizes noted in the individual equipment specifications are minimum requirements only. It is the responsibility of the equipment manufacturers and of the Contractor to furnish motors, electrical circuits and equipment of ample capacity to operate the equipment without overload, without exceeding the rated full-load current, or overheating at full-load capacity under the most severe operating service of this equipment. Motors shall have sufficient torque to accelerate the driven equipment to operating speed.

3. Motors shall be continuous duty type and shall operate quietly at all speeds and loads.

4. Motors shall be designed for operation on 60-hertz power service. Unless otherwise specified or shown, motors less than 2 horsepower shall be single phase, and motors 2 horsepower and larger shall be 3 phase.

5. Motors shall be mounted so that the motor can be removed without removing the entire driven unit.

D. Single phase motors smaller than 1/20 horsepower shall be ball or sleeve bearing, drip-proof, totally enclosed or explosion proof, as specified, 115 volts, permanent split capacitor or shaded pole type. These motors shall not be used for general power purposes and shall only be provided as built-in components of such mechanical equipment as fans, unit heaters, humidifiers and damper controllers.

E. Single phase motors 1/20 horsepower and larger shall be ball bearing, drip-proof, totally enclosed or explosion proof, as specified, with Class A or B insulation, as standard with the motor manufacturer; 115, 115/230, 200 or 230 volts as required; capacitor start-induction run, permanent split capacitor, or repulsion start-induction run type.

F. Except as otherwise specified in the various specification sections, 3 phase motors shall meet the requirements of this paragraph. Motors shall be NEMA design B squirrel cage induction type. Insulation shall be Class F and motor shall be rated at

no greater than 50 degrees C rise for open motors and 65 degrees C rise for closed motors both above an ambient temperature of 45 degrees C. At 40 degrees C ambient temperature explosion proof and totally enclosed motors shall have a 1.00 service factor and drip proof motors shall have a service factor of 1.15 or higher. Motors specified for operation at 480 volts shall be name plated 460 volts.

G. Minimum three phase motor efficiencies at full load for motors having nominal rated speeds of 1200 RPM and higher shall be as follows:

Horsepower	Minimum Efficiency
1	80.0
1-1/2	81.5
2	82.5
3	84.0
4	85.5
5	87.5
7-1/2	87.5
10	87.5
15	88.5
20	90.2
25	91.0
30	91.0
40	91.7
50	92.4
60	93.0
75	93.0
100	93.6
125	93.6
150	94.1
200	94.5
250	95.0

Three phase motors shall be E-plus Energy Efficient Standard Duty Motor of the Electric Motor Division of Goulds, Inc., the MAC II High Efficiency motor of Westinghouse Electric Corporation, the equivalent product of Baldor Company, or equal.

H. Motors seventy-five (75) horsepower and larger shall be as specified with the driven equipment in these specifications.

I. Belt-connected motors shall have adjustable bases and setscrews to maintain proper belt tension. All fan motors shall have adjustable sheaves for speed adjustment.

2.05 FLANGES AND BOLTS

A. Flanges, except as otherwise specified, shall be cast solid, and boltholes shall be drilled and spot-faced on the back. Stud holes shall not be drilled through. Flanges shall be uniform in thickness and shall come fair and, if required, shall be turned or chipped in a neat and workmanlike manner.

B. Jacking screws shall be provided for covers, etc. where required, and also suitable eye bolts for lifting. Bolts and nuts shall be of the best quality of open hearth, free machining steel. Bolts shall have good, sound well-fitting threads; nuts shall be cold pressed. All heads, nuts and threads shall be of the American Standard regular sizes. All ferrous bolts and nuts shall be galvanized by the hot dipped process.

C. Bolts and nuts connecting pumps, valves and meters (as in flange connections) shall be Stainless Steel- Grade 316.

2.06 COUPLINGS

A. Except where otherwise specified for a particular item of equipment, all equipment where flexible couplings are specified or are required for the purpose, a standard self-aligning forged steel coupling with sealed lubrication, as manufactured by Thomas, Koppers, Falk, Sier-Bath, or equal shall be provided between each motor and its driven equipment. One hub of the coupling shall be firmly fixed and keyed to the equipment shaft with the other hub similarly secured to the abutting drive shaft. Couplings shall be placed as close as possible to the driven equipment and the motor bearings to make compactly arranged units. Couplings shall be of all metal construction and shall be moisture proof and dustproof. Arrangement of couplings shall be such that there is sufficient room to place a dial indicator for alignment checking of shafts of the motor driven equipment. Each coupling shall be provided with an easily removable guard meeting all OSHA requirements.

B. All equipment and motors/drives shall be field aligned using a dial indicator in accordance with the procedures established by the latest revision of the Hydraulic Institute Standards. Parallel and angular misalignment shall not exceed the limits recommended by both the equipment and the coupling manufacturer.

2.07 EQUIPMENT BEDPLATES

The various items of motor driven equipment, such as pumps, shall be mounted on structural steel bedplates. The bedplates shall be adequate size to accommodate the equipment and its motor, to form an integral rigid mounting platform. Steel or brass shims shall be used to level equipment bedplates mounted in contact with concrete pads or floors. Jacking bolts or jacking (leveling) nuts on mounting studs shall not be used in lieu of shims. Bedplates shall be grouted to the concrete base and shall be filed with grout in all instances where the manufacturer has made provision for introducing grouting mixture into bedplate cavities. It shall be the contractor=s complete responsibility to determine the proper method, to provide all materials and components required, and to coordinate the work, to set, couple, align and install all equipment in a satisfactory manner.

PART 3 - EXECUTION

3.01 MANNER OF INSTALLATION

A. The general arrangement of pipe and equipment shall be as shown on the drawings. Detailed drawings of proposed departures due to actual field conditions or other causes shall be submitted to the Engineer for approval. The Contractor shall carefully examine the drawings and shall be responsible for the proper fitting of

materials and equipment as indicated, without substantial alteration. Because of the small scale of the drawings, it is not possible to indicate the exact location of piping, all offsets, fittings and accessories, which may be required. The Contractor shall carefully investigate the space requirements for proper clearances and the structural and finish conditions affecting his work and shall arrange such work accordingly, furnishing such offsets, fittings, valves and accessories as may be required to meet such conditions.

B. Each trade shall determine the location, size, etc. of all chases and openings required for the proper installation of its work, and shall see that such are provided. Where it is necessary to run pipes or ductwork through walls or fittings, the trade performing the work shall notify the Contractor so that proper provisions can be made for same. Each trade shall furnish and set all inserts, sleeves, hanger supports, etc. required for its work and shall be responsible for their proper and permanent location.

C. All piping and ductwork exposed to view shall be run generally parallel with the lines of the building and as close to walls and column as may be practical and consistent with proper grade and the maintenance of proper clearances for access to all parts requiring servicing.

D. The Contractor, in the prosecution of the work, shall do no cutting of woodwork, masonry, concrete or other materials after same have been installed, without the written permission of the Engineer. No waterproofing shall be cut for any purpose except on written approval of the Engineer.

3.02 TESTING

A. After erection, the Contractor shall adjust and balance all equipment and systems, and shall demonstrate that all equipment is operating in a satisfactory manner. All rotating equipment shall be lubricated according to recommendations of the manufacturer and all adjustments shall be made to suit anticipated station operating conditions. Each piece of machinery shall be tested to show that it operates quietly, without vibration, overheating, or sign of distress at full-specified capacity. Adjustments shall be made as necessary. All defective parts on machinery shall be replaced.

B. The Engineer shall be notified in advance of all tests and all tests shall be conducted to his entire satisfaction.

3.03 MISCELLANEOUS

A. Finished parts shall be well protected in the shop, during transportation and before and after erection to prevent injury of any kind. Injured parts which in the opinion of the Engineer are damaged or which cannot be refitted, shall be promptly replaced by the Contractor without expense to the Owner. All exposed finished parts of machinery shall be greased or oiled before shipment.

B. The Contractor shall furnish all tools of special nature, which are required for making adjustments (by the Owner after the work has been turned over to him) to equipment, but will not be required to furnish standard tools.

C. All exposed belts, gears, and drives shall be protected with guards. Guards may be of the equipment manufacturer=s standard design, but must meet all the OSHA Standards.

3.04 PAINTING AND LABELING

A. All fabricated or assembled surfaces normally painted shall be thoroughly dry and free from all rust, grease, dirt or scale. The Contractor is reminded to correlate the selection of shop prime coats to be compatible with subsequent field applied coats of paint. The Contractor shall touch up paint any item damaged during shipping or installation.

B. Each piece of equipment (including mechanical operators, and electrical switches for the equipment) shall be identified by hand painting or stenciled, two-inch letters and numbers, to indicate the service or function. Unless specified otherwise in the mechanical and electrical sections of these specifications, each motor and motor controller shall be similarly numbered (or lettered) to correspond to the number (or letter) of the driven unit.

3.05 ADJUSTMENTS TO RELATED WORK

The final work shall include any adjustment that may be required by the approved equipment furnished, with modifications made to concrete shapes and to dimensions shown on the contract drawings as may be required to suit the details of the approved equipment furnished, all at no additional cost to the Owner.

END OF SECTION 11101

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SECTION 15060

PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish and install all materials, equipment and appurtenances necessary for the complete and satisfactory installation of all piping systems, as shown on the drawings and as required for a complete installation as specified herein.

B. This Section applies to all interior, exterior, buried, and exposed (non-buried) piping systems.

C. The Contractor shall provide all labor, materials, equipment and services necessary to install the piping systems as specified herein and as shown on the Contract Drawings.

1.02 GENERAL REQUIREMENTS

A. Sizes shown are nominal diameter, unless indicated otherwise.

B. Drawings do not show all fittings, offsets, unions, hangers, supports, and other appurtenances. Provide as required and show on shop drawings.

C. Verify exact dimensions of valves, fittings, and equipment to assure Work will fit together properly and conform to the general arrangement shown on the Drawings.

D. Determine the following prior to fabricating piping systems:

1. Determine dimensions required to correctly locate pipe.

2. Determine dimensions required to fit pipe to equipment and valves.

3. Proper location and orientation of pipe sleeves and wall castings.

4. Determine dimensions required to avoid obstructions and conflicts with other Work.

E. Use the actual dimensions of equipment to which connections will be made, and the indicated dimensions on the drawings, as a guide in selecting laying lengths of pipes and fittings.

F. When connecting to existing piping:

1. Do not reuse existing gaskets, bolts, pipes, or fittings.

2. Field verify the exact point of connection to the existing pipe.

G. For small piping systems (<4”), the drawings do not necessarily show all fittings, offsets, unions, hangers, supports, etc. All such items shall be furnished and installed, however, as required for complete and satisfactory installation of the equipment shown.

H. Piping for plumbing and HVAC systems is specified in other sections of the specifications.

I. The Contractor shall verify all dimensions of valves, special castings and fittings, pipe equipment, etc., so that all of the pipe work performed will fit together properly and will conform to the arrangement as shown on the drawings. In selecting laying lengths of fittings, the Contractor shall be guided by the dimensions of equipment to which connections are made and by the indicated dimensions on the drawings. All pipe and specials shall be accurate to the dimensions shown. Hubs, spigots, and flanges shall be at right angles to the axis of the opening, and openings shall be at the exact angle specified.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 09900 – Painting

D. Section 11100 – General Process Mechanical Requirements

E. Section 15080 - Valves and Piping Specialties

F. Section 15094 – Pipe Supports

G. Section 15190 - Testing Piping Systems

1.04 QUALITY ASSURANCE

A. Reference Standards

1. American Welding Society (AWS).
   a. AWS 2.4, Standard symbols for welding, brazing and nondestructive examination
   b. AWS B2.1, Welding Procedure and Performance Qualifications
   c. AWS D1.1, Structural Welding Code - Steel
   d. AWS D10-9, Qualification of welding procedures and welders for piping and tubing
   e. AWS QC1, Standard for AWS Certification of Welding Inspectors

2. American Society of Mechanical Engineers (ASME).
   a. Boiler and Pressure Vessel Codes (BPVC)
   b. ASME B31.3, Chemical Plant and Petroleum Refinery Piping
   c. ASME B31.2, Fuel Gas Piping
   d. ASME B31.8, Gas Transmission and Distribution Piping Systems

3. American National Standards Institute (ANSI).

a. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
b. ANSI B16.3, Malleable Iron Threaded Fittings Class 150 and 300
c. ANSI B16.5, Pipe Flanges and Flanged Fittings
d. ANSI B16.9, Factory-Made Wrought Steel Buttwelding Fittings
e. ANSI B31, Code for Pressure Piping
f. ANSI B31.2, Fuel Gas Piping
g. ANSI B31.3, Chemical Plant and Petroleum Refinery Piping
h. ANSI B31.8, Gas Transmission and Distribution Piping Systems

4. American Water Works Association (AWWA).
   a. AWWA C104, Cement-mortar lining for ductile-iron pipe and fittings for water
   b. AWWA C110, Ductile-iron and gray-iron fittings, 3 in. Through 38 in. For water and other liquids
   c. AWWA C111, Rubber-gasket joints for ductile-iron pressure pipe and fittings
   d. AWWA C115, Flanged ductile-iron pipe with threaded flanges
   e. AWWA C150, Thickness design of Ductile-iron pipe
   f. AWWA C151, Ductile-iron pipe, centrifugally cast, for water and other liquids
   g. AWWA C606, Grooved and shouldered joints

5. Steel Structures Painting Council (SSPC)
   a. SSPC-SP-1, Solvent Cleaning
   b. SSPC-SP-3, Power Tool Cleaning

6. American Society for Testing and Materials (ASTM)
   a. ASTM A 48, Specification for Iron Castings
   b. ASTM A 53, Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated, Welded and Seamless
   c. ASTM A 74, Specification for Cast Iron Soil Pipe and Fittings
   d. ASTM A 105, Specification for Carbon Steel Forging for Pipe Components
   e. ASTM A 106, Specification for Seamless Carbon Steel Pipe for High-Temperature Service
   f. ASTM A 126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings
   g. ASTM A 182, Specification for Forged Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
   h. ASTM A 183, Specification for Carbon Steel Track Bolts and Nuts
   i. ASTM A 193, Specification for Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service
   j. ASTM A 194, Specification for Alloy Steel Nuts for Bolts for High Pressure and High-Temperature Service
   k. ASTM A 197, Specification for Cupola Malleable Iron
   l. ASTM A 234, Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

m. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
o. ASTM A 536, Specification for Ductile Iron Castings
p. ASTM A 563, Specification for Carbon and Alloy Steel Nuts
q. ASTM B 32, Specification for Solder Metal
r. ASTM D 1784, Specification for Rigid PVC Compounds and CPVC Components
s. ASTM D 1785, Specification for PVC Plastic Pipe, Schedules 40, 80, and 120
t. ASTM D 2997, Specification for Certrifugally Cast "Fiberglass" Pipe
u. ASTM D 3517, Specification for "Fiberglass" Pressure Pipe
v. ASTM D 3567, Practice for Determining Dimensions of "Fiberglass" Pipe and Fittings
w. ASTM F 437, Specification for Threaded CPVC Plastic Pipe Fittings, Schedule 80
x. ASTM F 439, Specification for Socket Type CPVC Plastic Pipe Fittings, Schedule 80
y. ASTM F 441, Specification for CPVC Plastic Pipe, Schedules 40 and 80
z. ASTM F 493, Specification for Solvent Cements for CPVC Plastic Pipe and Fittings
aa. ASTM A403, Specification for Wrought Austenitic Stainless Steel Piping Fittings.

B. Materials contaminated with gasoline, lubricating oil, liquid or gaseous fuels, aromatic compounds, paint solvent, paint thinner, or acid solder will be rejected.

1.

D. All contractor personnel that will prepare solvent cemented joints for PVC shall be qualified for such bonding practices according to the bonding qualification procedure described in ASME B 31.3, Chapter VII for bonding of plastic piping.

1.05 SUBMITTALS

A. The following items shall be submitted with the Shop drawings in accordance with, or in addition to, the submittal requirements specified in Section 01300 - Submittals.

1. Manufacturer's product data, specifications, and installation instructions.

2. Detailed shop drawings for system material and equipment. Show complete information concerning fabrication, installation, anchoring, fasteners and other details.

3. Fabrication drawings for shop fabricated piping.

4. Layout drawings for each piping system, indicating the following as a minimum:

a. Piping material, class, grade and joint type.
b. Anchors, supports, hangers, saddles, straps, and other accessories.
c. Fittings, couplings, joints, and joint harnesses.
d. Centerline elevations.
e. Location, size, and type of anchor bolts.
f. Wall and floor penetrations, including sleeves, castings, sealant, escutcheons, and other accessories.
g. Bill of materials.
h. Orientation of valves and valve operators.
i. Critical clearances.
j. Thrust restraints - Details to include materials, sizes, assembly ratings, and pipe attachment methods.
k. Expansion compensation.
l. Insulation.
m. Pipe coatings.
n. Pipe identification.
o. Valve tags and tag numbers.
p. Miscellaneous details required for complete installation and understanding.

5. Thrust restraint system details, as applicable.

6. Approval of the shop drawings will not relieve the Contractor of any responsibility for accuracy of dimensions and detail.

B. Submit manufacturer's instructions for installation of adapters and assembly of mechanical and push-on joints, including the manufacturer's maximum recommended deflection per joint.

C. Quality Control Submittals:

2. Piping system test reports, including the following:
a. Pipe pressure tests.
b. Valve tests.
c. Dielectric joint tests.

5. Certificates:
a. Manufacturer's certification of compliance for each pipe material.

D. Contract Close-out Submittals:

1. Project Record Documents.
2. Operating and Maintenance Manuals, including warranty information.

1.06 PRODUCT DELIVERY HANDLING AND STORAGE

A. During loading, transporting, unloading, and storage on site, exercise care to prevent damage to piping materials.

B. Do not drop pipe or fittings.

C. Store materials on site in enclosures or under protective coverings.

D. Assure that materials are kept clean and dry; do not store materials directly on the ground.

1.07 REGULATORY REQUIREMENTS

A. Materials and coatings used in the construction of any pipe or pipe fitting in contact with process water, chemicals, or potable water shall be NSF 61 Certified and approved for use in potable water installations.

PART 2 - PRODUCTS

2.01 GENERAL NOTES – FITTINGS

A. All fittings shall be of the type indicated on the drawings unless otherwise specified. Ductile iron piping shall be provided with ductile iron fittings; carbon steel piping shall be provided with carbon steel fittings; C/PVC pipe shall be provided with C/PVC fittings, copper tubing shall be provided with bronze, wrought copper or brass fittings.

B. Nipples shall be extra heavy of same material as piping system in which they are installed. Close nipples are not acceptable.

D. Wherever the sizes of pipes are reduced, the fittings shall be “reducers” made to suit these changes without the use of bushings.

E. All flanges shall come fairly face to face, the pipe in perfect line, the pipes shall not be sprung to make a joint. Gaskets for flanged joints shall be as specified under “Joints”. All joints shall be neatly made and with great care.

F. Screwed type systems shall contain ample unions in piping at equipment to allow easy removal of the equipment.

2.02 DUCTILE IRON PIPE AND FITTINGS

A. General

1. All ductile iron pipe shall be manufactured per AWWA C150.

2. All ductile iron joints shall adhere to AWWA C111.

3. Pipe and fittings shall be cement-mortar lined inside per AWWA C104, with curing to be effected by an application of a bituminous seal coating which shall cover and seal the cement mortar. The thickness of the

cement lining shall be “Double Thickness”, which is double the standard thickness.

4. Ductile iron pressure pipe shall be made of ductile iron of good quality and of such character as shall make the metal casings strong, tough and of even grain and soft enough to satisfactorily permit drilling, tapping and cutting. All piping shall be smooth, free from scale, lumps, blisters, and sand holes and defects of every nature which make it unfit for the use intended. All piping shall be straight and shall be true circles in section with its inner and outer surfaces concentric. No plugging, filling, burning-in or welding shall be allowed. All piping shall be subject to inspection and approval by the Engineer upon delivery, and no broken, cracked, misshaped or otherwise damaged or unsatisfactory piping will be accepted.

5. Each piece of pressure ductile iron pipe shall have the weight and class designation conspicuously painted on it as near as possible to flange or bell end of the pipe and these designations shall be clearly legible.

6. Where required or shown, the Contractor shall provide ductile iron specials. Specials shall in general consist of spool pieces, less than standard lengths of flanged, spigot end, or bell end pipe, or combination of ends, and nonstandard fittings. The specials shall conform in material, thickness and finish to the pipe in which they are installed. Taped reinforced bosses shall be provided as an integral part of fittings, when shown or specified.

B. Exposed Pipe

1. Unless otherwise stated on the Drawings, all pipe shall be manufactured and supplied in accordance with AWWA C115.

2. All ductile iron pipe shall be Class 54 or greater.

3. Pipe and fittings shall not be asphaltic coated. Pipe and fittings shall be supplied with the manufacturer’s shop prime coat of paint which shall be compatible with the final field coat of paint. Pipe and fittings shall receive final field painting per Section 09900 - Painting.

4. Fittings

   a. All ductile iron fittings and specials shall be manufactured in accordance with AWWA C110 generally.

5. Joints

   a. All joints shall be flanged. Flanges may be cast integrally with the ductile iron pipe or screwed on type. Pipe compound of the manufacturer’s recommendation shall be used at each threaded joint on flanges.

b. Interior flanged joints shall use nuts, bolts, and other associated hardware which is 316 stainless steel.

c. Exterior flanged joints shall use nuts, bolts, and other associated hardware which is either 316 stainless steel.

2.03 BLACK AND GALVANIZED STEEL PIPE (GENERAL USE)

A. Pipe: ASTM A53, Seamless. Schedule 40, unless otherwise indicated on the contract drawings.

B. Fittings

1. Threaded: Malleable Iron, ANSI B16.3, 150# Class

2. Flanged: Cast Iron, ANSI B16.1, 125# Class

3. Socket Welded: Forged Steel, ANSI B16.11.

C. Unions: Threaded, Forged Carbon Steel, MSS SP-83.

2.04 POLYVINYL CHLORIDE (PVC) PROCESS PIPE (12" NOMINAL PIPE SIZE AND SMALLER)

A. Material shall be ASTM D2241, PVC 1120 (12454-B) or PVC 1220 (12454-C) or PVC 2120 (14333-D).

B. PVC pipe and fittings shall be manufactured from virgin rigid PVC vinyl compounds and shall be Type 1 Grade 1 conforming to ASTM D 1784 and D 1785. Fittings shall conform to the following standard specifications:

Socket Type (Schedule 40); ASTM D 2466
Socket Type (Schedule 80); ASTM D 2467
Threaded Type (Schedule 80); ASTM D 2464

C. Fittings shall generally be socket cement weld type, but may be flanged or threaded type only as needed to connect to valves, adapters, equipment, and appurtenances.

D. Flanged fittings shall be of the same material as the specified pipe and material conforming to ANSI B16.5. Gasket materials shall be suitable for the chemical application.

E. Non-chemical Applications: solvent cement for socket type joints shall conform to ASTM D 2564 for PVC pipe and fittings.

F. Chemical Service joints require special materials. All socket type, solvent cement joints for all chemical service piping and fittings shall utilize primer and cement which is specially formulated for chemical resistance and which is suitable for

bleach (sodium hypochlorite) application, even if the particular application is not bleach. Only cements and primers which have documented performance testing with bleach, caustic soda, and strong acids from an independent third party laboratory testing at at least 100 psi for 2,500 hours shall be considered for approval. Use IPS Weld-On CPVC 724 cement and IPS Weld-On P-70 primer for all chemical applications, pressurized and non-pressurized, or approved equal.

2.05 JOINTS

A. General

1. All joints at equipment shall conform to the equipment requirements. No direct welded connections shall be made to valves or other equipment. Right and left couplings, long screws, or caulking of pipe threads or gasket joints will not be permitted. Mitered joints for elbows and matching straight runs of pipe for tees or elbows will not be permitted.

2. Soldered or brazed joints shall be made with solder and a noncorrosive paste flux. The solder mixture shall be of 95-5 (tin-antimony) content. The use of acid core solder shall not be permitted. The application of excess heat shall be avoided to prevent undue softening or burning of the fittings or tubing when making connections. All soldering operations shall be performed in strict accordance with best accepted practices. Tubing shall be square cut and reamed to remove all burrs. The inside of the fittings and the outside of the tubing at each end shall be well cleaned immediately prior to soldering to remove all traces of oxidation, regardless of how clean the surfaces of the pipe and fittings may appear.

3. Threads shall be standard, clean-cut and tapered. All pipe shall be teamed free from burrs and kept free from scale and dirt. Unless otherwise specified, non-chemical application threaded joints shall be made up with “Permatex” type 2, black, nonhardening pipe joint compound applied to the male thread only. The use of red lead or white lead will not be permitted. The complete threaded joint shall not have more than two threads exposed when made tight. Threads shall comply with ANSI B2.1.

4. Except where special couplings are indicated, piping requiring screwed connections shall be connected with screwed, malleable iron, ground joint, brass seat, 150 psi unions; for piping requiring flanged connections, flanged malleable iron unions shall be used. The finish of all unions shall match piping in which they are installed. Unions shall be provided at equipment and where required otherwise to facilitate removal of piping or equipment.

6. Flanges shall be of the same material as the piping on which installed. Heads, nuts and threads shall be U.S. Standard sizes. Bolts shall be of such length as to project ¼ inch beyond the nut when the flanged joint with gasket is assembled. Unless otherwise specified in the individual sections, all metallic hardware shall be as follows:

a. Flanged Interior Pipe, general non-chemical: Hot Dipped Galvanized Carbon Steel
b. Flanged Exterior Pipe, general non-chemical: 316 Stainless Steel.
c. Alum, caustic soda, and sodium hypochlorite: Polyethylene-coated Titanium.
d. Fluoride and Polyphosphate: Polyethylene-coated Hastelloy C.

7. For chemical applications, joint gaskets shall be:

a. Alum and Caustic Soda: EPDM.
b. Sodium Hypochlorite, Fluoride, and Polyphosphate: Viton.

B. UNIONS

1. For ductile iron, carbon steel, and grey cast iron pipes assembled with threaded joints and malleable iron fittings, unions shall conform to ANSI B16.39.

2. For copper piping, unions shall have ground joints and conform to ANSI B16.18.

3. For PVC and CPVC piping, unions shall be socket weld type.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install all materials and piping in full accordance with the manufacturer's recommendations for installation. No field bending or distortion of the pipe is permitted.

B. Buried Pipe:

1. Install ductile iron pipe per AWWA C600.

3.05 INTERIOR PROCESS PIPING INSTALLATION

A. Pipe Layout in Building

1. Coordinate work to prevent interference between architectural, structural, electrical and mechanical features; the Contract Drawings are generally diagrammatic due to their small scale.

2. Provide such offsets, fittings and other items as may be required to suit conditions.

3. Do not place joints or fittings over switchboards, panels, motors or other electrical equipment.

4. The completed installation shall present a neat, orderly appearance; do not block openings or passageways; run piping parallel to the walls of buildings or structures.

6. Orient handwheels, levers, valve operators and other valve actuators for convenience of operation; set gate valves with the stem above the horizontal.

7. Cut pipe to measurements established at the site and install without springing or forcing; make changes in direction with fittings.

B. Equipment Connections

1. Make connections to pumps and other equipment in a manner to eliminate strains on piping and equipment.

2. Install unions or flanges adjacent to equipment and wherever their use will facilitate removal of equipment.

E. Flanged Joints

1. Tighten flange bolts so that the gasket is uniformly compressed and sealed; do not distort flanges; do not exceed manufacturer's recommended maximum torque.

2. Leave flange bolts with ends projected 1/8" to 1/4" beyond the face of the nut after tightening.

G. Threaded Joints: ANSI B2.1, NPT

1. Cut threads full and clean with sharp dies; ream ends of pipe after threading and before assembly to remove burrs; leave not more than three pipe threads exposed at each connection; for non-chemical application, use joint compound or thread tape on the male thread only.

H. Solder Joints

1. Ream or file pipe to remove burrs; clean and polish contact surfaces of joints.

2. Apply flush to both male and female end; insert end of tube into fittings full depth of socket.

3. Bring joint to soldering temperature, in as short a time as possible, forming continuous solder bead around entire circumference of joint.

I. Solvent Cemented Joints (PVC): Make joints in pipe and fittings in accordance with the procedures and techniques in ASTM D2855.

3.06 CONNECTION AT DISSIMILAR METALS

A. Wherever pipes of dissimilar metal join, there shall be provided an insulating union, coupling or flange connector for corrosion control. Connectors shall include an approved type dielectric separator. Connectors shall be the product of Dresser Corporation, or equal. Stainless steel nuts, bolts, and washers shall be used at all places at which such dielectric separators are used.

3.07 PIPE SUPPORTS

A. Pipe supports and bracing shall be provided as indicated in Section 15094 Pipe Supports.

3.08 TESTING

A. The following piping systems shall be water pressure tested per AWWA C600 Section 5.2, and at the following test pressures:

Piping System	Test Press. (psi)
Finished Water Piping	150

3.09 DISINFECTION

A. Disinfect all pipes and accessories in contact with filtered or potable water per AWWA C651.

END OF SECTION 15060

SECTION 15080

VALVES AND PIPING SPECIALTIES

PART I – GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish and install all materials, equipment and appurtenances necessary for the complete and satisfactory installation of all piping systems except as noted, as shown on the drawings and as required for a complete installation as specified herein.

B. This Section applies to potable water service, nonpotable water service, buried installment, exposed (non-buried) installment, interior, and exterior installments.

C. Related work specified elsewhere:

1. Section 09900 - Painting

2. Section 15060 - Pipe and Pipe Fittings

3. Section 15094 – Pipe Supports

4. Section 15190 – Testing Piping Systems

1.02 QUALITY ASSURANCE

A. Products shall be new, the latest standard product of reputable manufacturers, and shall have replacement parts available.

B. Potable water materials shall bear the seal of approval of the National Sanitation Foundation (NSF).

C. Materials contaminated with gasoline, lubricating oil, liquid or gaseous fuels will be rejected.

D. The manufacturer of each valve shall have a minimum of 5 years of experience in manufacturing the type of valve supplied.

E. Certification of Welders

1. All shop and field welding under this contract for stainless steel piping and other piping systems shall be done by experienced welders who are skilled and have experience in the method and materials used. All welders shall be qualified as specified in the ASME Code for Unfired Pressure Vessels, Paragraph U-70.

2. For field welding, the Contractor shall submit to the Engineer for his review and approval a certified statement, from an approved testing agency for

each welder he proposes to use for welded piping. Each certified statement shall indicate that the welder has, within six months from proposed employment on this project, been successfully qualified under the requirements of Section IX of the ASME Boiler Construction Code. All certificates and qualifications shall be at the Contractor's expense. The Engineer will return the certified statements to the Contractor for retention on job in the Contractor's field office. Any work installed by an individual who has not been approved by the Engineer shall be removed by the Contractor and shall be replaced with work installed by qualified and approved welders at the Contractor's expense.

1.03 SUBMITTALS

A. Submit in accordance with Section 01300.

B. Shop Drawings and Product Data

1. Submit manufacturer's catalog data, literature, illustrations and specifications.

2. Submit shop drawings of valves and valve operators including dimensions, net assembled weight of each size valve furnished, construction details, and materials of components.

3. Submit manufacturer's installation instructions.

4. Submit manufacturer's maintenance instructions and complete parts lists.

5. For all chemical valves and pipe specialties, submit documentation from the manufacturer, either by general brochure/literature or by special letter, explicitly stating that the products are suitable for the particular chemical and chemical concentration for which it is installed.

C. Certificates

Submit a Certificate of Compliance, together with supporting data, from the materials supplier(s) attesting that valves, accessories, and specialties meet or exceed specification requirements.

D. Submit post-installation field tests to Engineer.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver valves and accessories to the job site in the manufacturer's boxes or crates. Mark each valve as to size, type and installation location.

B. Seal valve ends to prevent entry of foreign matter into valve body.

C. Store valves and accessories in areas protected from weather, moisture and possible damage.

D. Do not store materials directly on the ground.

E. Handle valves and accessories to prevent damage to interior and exterior surfaces.

1.05 JOB CONDITIONS

A. Investigate conditions affecting this work and coordinate with other contractors to prevent interference between architectural, structural, mechanical and electrical features.

B. The contract drawings for small diameter pipe are generally diagrammatic and it is not possible to indicate all fittings, valves, and other items required for a complete operating system. Provide all such valves, fittings and specialties to complete the systems as intended.

C. Provide necessary valve wheels, keys, wrenches, levers and stem extensions. Locate to assure accessibility and operability throughout the operating range without interference. Install valve stem supports, guides and operators. Provide valve accessories of the same manufacturer as the valve, unless specified elsewhere.

D. Provide chain operators for valves 4" size and larger that are located 6'-0" or more above finished floor level.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide valves and piping specialties of the size and type indicated on the contract drawings.

B. Cast iron valve material shall meet or exceed the requirements of ASTM A126, Class B.

C. Valve flanges shall conform to ANSI B16.10, (125# and 250# class) as applicable.

D. Mechanical joint valve ends shall conform to ANSI/AWWA C111/A21.11.

E. Screwed valve ends shall conform to ANSI B2.1; American Standard Taper pipe threads.

F. Valves shall be of a design that requires no more than 50 lbs. pull on the handwheel or standard valve wrench to provide positive shutoff against rated working pressure.

G. All valves and pipe specialties which come in contact with treatment chemicals, potable water, or raw water shall be NSF 61 approved.

2.02 CHECK VALVES

A. Slanting Disc Check Valve with Top Mounted Oil Dashpot shall be as manufactured by DeZurik Corporation, Valmatic or equal

1. The valve body shall be Ductile Iron ASTM A536 Grade 65-45-12 for sizes 6-54" (150-1400mm) and Cast Iron ASTM A126 Grade B for sizes 60-72" (1500-1800mm). Bodies shall be a two piece-design, and on valves 6" & larger, each body half must have an access cover for internal inspection. Each 6" & larger body half shall have a removable cover to accept attachment of a Top Mounted Oil Dashpot (TMD). Disc stabilizers shall be cast into the valve body.

2. Valve body halves shall be O-ring sealed and bolted together to capture the seat ring at a 55 degree angle. The area through the seat section shall be 40% larger than the inlet and outlet of the valve.

3. Valve disc shall have a "hydrofoil" design to create lift and provide low head loss. Discs shall be Ductile Iron ASTM A536 Grade 65-45- 12 on sizes 12" (300mm) and larger. A stainless steel indicator shall be provided to show the disc position.

4. Valve body seat and disc ring shall be Bronze ASTM B271 Alloy C92200 or 316 Stainless Steel per ASTM A296 and manufactured to be field replaceable without any special tools.

5. Valve pivot pins shall be 303 stainless steel per ASTM A562. Pivot pin bushings shall be 304 stainless steel per ASTM A296.

6. Valve shall be pressure rated to at least 150 psi.

7. Top Mounted Dashpot shall be provided for controlled opening and non-slam closing to minimize surge and water hammer. The dashpot must be a self-contained oil system, separate and independent from the pipeline media. Opening and closing speeds shall be independently adjustable by a color-coded micrometer type control valves. An internal adjustable cushion chamber in the head of the cylinder shall be provided for slower speed during the last few degrees of disc closing. The Oil Reservoirs shall be 316 stainless steel per ASTM A240. Hydraulic hoses are to be S.A.E. certified.

2.03 BUTTERFLY VALVES

A. Metal Bodied for Water Service

1. Butterfly valves shall be of the rubber-seated, tight-closing type conforming to the latest revision of AWWA C504.

2. Butterfly valves shall be Class 150B, unless otherwise indicated on the Drawings, and of the short body design with mechanical joint or flanged ends, as shown on the Drawings.

3. The exterior of the valve shall be shop coated with primer compatible with final field coat.

4. The interior shall be epoxy coated.

5. All butterfly valves shall be the product of one manufacturer. Butterfly valves shall be as manufactured by DeZurik, Valmatic, Pratt, or equal.

2.04 AIR RELEASE VALVE

A. The valves shall be installed at the high points in the system or at points selected by the Engineer. The valves shall be single body combination air release / air vacuum valves designed to automatically discharge large volumes of air during pipeline filling, admit air during pipeline draining to prevent vacuum conditions, and release accumulated air from the system while the pipeline is under pressure. All air release and air/vacuum functions shall be accomplished within a single valve body through a double-orifice design.

B. Valves shall be manufactured and tested in accordance with American Water Works Association (AWWA) Standard C512. The large air/vacuum orifice shall be sized to allow large volumes of air to enter the pipeline during drainage to break the vacuum. Manufacturer shall have a quality management system certified to ISO 9001 by an accredited certifying body.

C. Combination valves shall be of the single body, double-orifice type. The large air/vacuum orifice shall allow large volumes of air to escape when filling the pipeline and shall close as liquid enters the valve. When the valve is closed and the system is pressurized, the small air release orifice shall automatically and independently release accumulated air pockets from the pipeline.

D. The valve body inlet shall be internally baffled to protect the float mechanism from direct forces of rushing air and water and to prevent premature valve shut-off. Valves shall be automatic, float-operated, and designed to operate under full system pressure.

F. The valve shall be provided with a replaceable resilient valve seat securely fastened to the valve cover without distortion and capable of providing drip-tight shutoff at the rated pressure. Valve floats shall be heavy-duty stainless steel and shall be center guided through bushings to ensure positive alignment and shutoff. Non-metallic floats or linkage mechanisms are not acceptable.

G. Valve discharge shall be fitted with a PVC gooseneck matching the discharge connection size. Valve assemblies shall be equipped with threaded stainless steel inlet piping and a stainless steel ball valve for isolation. Where indicated on the Drawings, inlet piping shall also be equipped with a pressure gauge connection and pressure gauge.

H. Valve shall be designed for at least 150 psig operating pressure.

I. Valves shall be provided with a minimum two-year warranty.

J. Acceptable manufacturers shall be APCO model AVC as manufactured by DeZURIK, Inc., Val-Matic Valve Co., or equal.

2.05 SPECIALTIES

A. Pressure and Compound Gages

1. Pressure gauges, when required by the Owner, unless otherwise specified shall be bourdon-tube type with measuring element of phosphor-bronze. Gauges shall be 4-½ inch diameter, glycerin filled, white dial with black numbers, and ½-inch NPT connection on the underside. All gauges shall have an accuracy of plus or minus one percent of full-scale range. Gauges shall include a stainless steel diaphragm seal (glycerin filled) with bleed pet cock on lower half (media/liquid side), and 316 S.S. quick connect fitting to match the quick connect stems.

2. Note: The gauge assembly should not be installed directly into the pump, but into a straight length of pipe. The nipple must not be installed in a tapped hole in the piping. Use either a welded-on "Thread-o-Let" connection (3000 psi rating standard) or a service saddle. The service saddle should have either a bronze or coated iron saddle with a double stainless strap.

3. Pump discharge pressure gauges shall have a dual scale reading in psi and feet of water with full scale not greater than 2 times or less than 1.25 times the pump design TDH.

4. On potable water and air systems each gage shall be provided with the manufacturer's shutoff cock. On process systems each gage shall be provided with a shutoff cock, diaphragm seal and flushing connection as shown on the drawings. Diaphragm seal shall be Ashcroft Type 101 with Teflon coated stainless steel diaphragm and shall be filled with silicone. Diaphragm seals shall be filled, connected to gate and calibrated as a complete unit, at the factory.

B. Pressure Gauge Taps and Shutoffs

1. Pressure gauge taps shall be provided on the discharge line of each pump.

2. Fittings

   a. Quick Connect Stems: Shall be Type 316 stainless steel, full flow type, ½-inch female NPT stem with protector cap, Swagelok "QF" series or equal. Quick connect stems shall be fully compatible with the quick connect body furnished with the pressure gauges. Both stem and body shall be of the same manufacturer.

   b. Ball Valves: Shall be Type 316 stainless steel body, stem and ball with Teflon seat and packing, spring return handle to the fully closed position, Marpac, PBM, Flow- Tek or equal.

   c. Service Saddles: Shall be bronze or nylon-coated iron with double

stainless steel straps for use on pump discharge installations, Smith Blair or equal. Furnish bronze bushings as required for ½-inch NPT connections.

d. Nipple: Shall be Schedule 80, seamless, Type 316 stainless steel conforming to ASTM A312-89 with threaded ends.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install valves and accessories in accordance with the manufacturer's instructions.

B. Inspect joint surfaces for structural soundness and thoroughly clean before installation.

C. Pressure test all valves, while installed, along with the general piping system pressure tests.

D. Test overflow relief valves to ensure that the cracking pressure is set properly. Do this by filling the vertically situated overflow pipe (before attaching it to tank) and determining what level of water is required to start opening the valve.

E. Butterfly Valves

Each valve shall be performance and leak tested as specified in AWWA C504, revised as follows: In addition to the testing requirements of AWWA C504, each butterfly valve shall be thoroughly cleaned and opened and closed at least three (3) times prior to testing. Certified copies of the test results shall be submitted to the Engineer for approval prior to shipment of the valve.

3.02 ADJUSTMENT

Check and adjust valves and accessories for smooth operation.

END OF SECTION 15080

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SECTION 15094

PIPE SUPPORTS

PART 1 - GENERAL

1.01 DESCRIPTION

This section includes requirements for providing pipe hangers, brackets, supports, and spacing of expansion joints in piping systems as indicated in accordance with the Contract Documents. Pipe supports shall be furnished complete with all necessary inserts, bolts, nuts, rods, washers, and other accessories.

1.02 JOB CONDITIONS

A. In certain locations, pipe supports and anchors are shown on the drawings, but no attempt has been made to indicate every pipe support and anchor. It shall be the Contractor's responsibility to provide complete system of pipe supports and to anchor all piping in accordance with this section.

B. Concrete and fabricated steel supports shall be as indicated on the drawings, as specified in other sections, or, in the absence of such requirements, as permitted by the Engineer.

C. All piping shall be rigidly supported and anchored so that there is no movement or visible sagging between supports.

D. Pipe supports and expansion joints are not required in buried piping, but concrete blocking or other suitable anchorage shall be provided as indicated on the drawings or specified in other sections.

1.03 SUBMITTALS

A. Shop drawings in conjunction with Specification Sections for piping, valves and pumps, showing the location of all pipe supports for pipes two-inches and larger. Shop drawings shall show fabrication and installation details, and shall include calculations, for all hangers and supports.

B. Catalog data for all pipe support components to be used.

C. Manufacturer's installation instructions.

PART 2 - PRODUCTS

2.01 GENERAL

A. Pipe supports shall comply with ANSI/MSS SP-58 and MSS SP-69 and Federal Specification WW-H-1713. Load carrying and coating tests will not be required.

B. Pipe supports specified are identified by manufacturer's name and catalog number.

C. Pipe supports shall be manufactured for the size and type of pipe to which they are applied. Straphangers will not be acceptable. Threaded rods shall have threading to permit the maximum adjustment available in the support item.

D. All hangers and supports shall be capable of adjustment after installation. Types of hangers and supports shall be kept to a minimum.

E. Pipe supports shall be furnished complete with all necessary inserts, bolts, nuts, rods, washers, and other accessories.

F. Contact between dissimilar metals, including contact between stainless steel and carbon steel, shall be prevented. Supports for brass or copper pipe or tubing shall be copper plated. Those portions of pipe supports which contact other dissimilar metals shall be rubber or vinyl coated.

G. Stainless steel supports fabricated by welding shall be AISI Type 304L or 316L material.

H. All hardware, anchors, bolts, etc used for fastening or anchoring supports at the floor shall be 316 stainless steel.

2.02 DESCRIPTION

A. Pipe support types and application shall comply with the following.

	Description or Size	MSS SP-69	Manufacturer and Model
A.	Hangers		
	2-½-inch and smaller pipe,		
	adjustable J	5	B-Line Fig. B3690, Grinnell Fig. 104, or equal.
	clevis	1	Grinnell Fig. 65, B-Line Fig. B3104, or equal.
	3-inch through 10-inch pipe		
	clevis	1	Grinnell Fig. 260, B-Line Fig. B3104, or equal.
	12 inch and larger pipe		
	clevis	1	Grinnell Fig. 260, B-Line Fig. B3102, or equal

	Description or Size	MSS SP-69	Manufacturer and Model
B.	Standard weight and extra strong steel pipe and stainless steel pipe (all sizes)		
	uninsulated, steel pipe clamp	4	Elcen “1”, Fee & Mason “236", ITT Grinnell “212", or equal
C.	Concrete Rod Attachment Plate, 6-inch and smaller pipe	19	Grinnell Fig. 52, or equal.
D.	Turnbuckles, Steel	13	Elcen 81, Fee & Mason 2382, Grinnell Fig. 230, or equal
E.	Hangar Rods, Carbon Steel, threaded both ends, ½-inch minimum size	--	Elcen 72, Fee & Mason 267, Grinnell Fig. 140, or equal.
F.	Wall Supports and Frames, steel 12 inch and smaller pipe		
	brackets	33,34	Grinnell Fig. 195 & 199; B-Line Fig. B3066 & B3067, or equal.
	prefabricated channels, galvanized	--	12 gauge, 1-5/8" x 1-5/8" with suitable brackets and pipe clamps.
	offset pipe clamp, 1-1/2-inch and smaller pipe, galvanized	--	1-1/4" x 3/16" steel, with 3/8" bolts.
	offset pipe clamp, 2-inch to 3-1/2-inch pipe, galvanized	--	1-1/4" x 3/16" steel, with 3/8" bolts.
G.	Pipe Riser Clamps		
	cold piping system	–	Pipe Shields, Inc., “E1000", or equal
	copper tubing	–	CT-121 or CT-121C

	Description or Size	MSS SP-69	Manufacturer and Model
	other piping systems	–	Grinnell “261", or equal
H.	Floor Supports, steel or cast iron, 6-inch and smaller pipe	38 (with base)	Grinnell Fig. 259; B-Line Fig. B-3095, or equal.
	8 inch through 30 inch pipe	38	B-Line “B3093", Grinnell “264", or equal

PART 3 - EXECUTION

3.01 LOCATION AND SPACING

Piping shall be supported approximately 1-1/2 inches out from the face of walls and at least 3 inches below ceilings or beams. The maximum spacing for pipe supports and expansion joints shall be:

Type of Pipe	Pipe Support Maximum Spacing, Feet	Maximum Run without Expansion Joint, Loop or Bend, Feet (See Note 1)	Expansion Joint Maximum Spacing, Feet (See Note 2)	Type of Expansion Joint
Ductile Iron	15	80	80	Mechanical Couplings
Steel:				
1-1/4-inch and smaller	7	30	100	Note 3
1-1/2 to 4- inch	10	30	100	Note 3
Copper:				
1-inch and smaller	5	--	--	None required
Over 1-inch	7	50	100	Note 3
PVC:				
1/8- and 1/4-inch	Continuous Support	20	60	None required
½- to 2-inch	4	20	60	None required

Over 2-inch	6	20	60	None required
Cast Iron Soil Pipe:	10	–	–	None required

Notes: 1. Unless otherwise permitted, an expansion joint shall be provided in each straight run of pipe having an overall length between loops or bends exceeding the maximum run specified herein.
2. Unless otherwise permitted, the spacing between expansion joints in any straight pipe run shall not exceed the maximum spacing specified herein.
3. Expansion joint fittings as specified in the miscellaneous piping section.
4. At least two properly padded supports for each pipe section.
5. At least one support for each pipe section.

3.02 INSTALLATION

A. Concrete inserts or L-shaped anchor bolts shall be used to support piping from new cast-in-place concrete. Expansion anchors shall be used to fasten supports to masonry.

B. Design loads for inserts, brackets, clamps, and other support items shall not exceed the manufacturer's recommended loads.

C. Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead ending. Anchors shall be located as required to force expansion and contraction movement to occur at expansion joints, loops or elbows, and as required to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows used as expansion joints.

D. Provide dielectric isolation. Do not allow copper and other metals to make contact with each other.

E. All piping and pipe supports located in sewage wetwells shall be stainless steel.

F. All piping shall be supported and anchored so that there is no movement or visible sagging between supports.

G. Hanger rods shall be straight and vertical. Chain, wire, strap, or perforated bar hangers shall not be used. Hangers shall not be suspended from other piping.

H. Vertical Piping:

1. Secure at sufficiently close intervals to keep pipe in alignment and to support weight of pipe and its contents.

2. Support vertical iron and steel pipe on maximum 5'-0" centers with steel pipe riser clamps.

3. Support vertical copper tubing at no more than 10'-0" spacing, using plastic coated steel pipe riser clamps or pipe clamp hangers at end of runs and at intermediate points as installation dictates.

4. Support vertical plastic pipe at 4'-0" centers, using plastic coated pipe riser clamps or pipe clamp hangers at end of runs and at intermediate points as installation dictates.

5. Vertical piping shall be supported at each floor and between floors by stays or braces to prevent rattling and vibration.

I. Horizontal Piping:

1. Support at sufficiently close intervals to prevent sagging, thrust, and vibration.

2. Install hangers or supports at ends of runs or branches and at each change of direction or alignment.

3. Install steel clevis-type pipe hangers for horizontal iron and steel pipe on maximum 10'-0" centers.

4. Install steel clevis-type pipe hangers for copper tubing on 6'-0" centers for 1-1/4" size and smaller, and on 10'-0" centers for copper tubing larger than 1-1/4" size.

5. Install plastic coated ring-type pipe hangers for horizontal plastic pipe on maximum 4'-0" centers, close to every joint, at ends of each branch, and at each change in direction of elevation; hangers shall not compress, distort, cut or abrade plastic piping and shall permit free movement of the pipe.

J. The Contractor is responsible for properly bracing piping against lateral movement or sway. The Engineer shall review with the Contractor and approve method of bracing of piping at each location prior to Contractor proceeding with the installation of the bracing. Bracing shall be installed at all locations where sway is anticipated and as directed by the Engineer.

K. Rubber hose and flexible tubing shall be provided with continuous angle or channel support.

END OF SECTION 15094

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SECTION 15190

TESTING PIPING SYSTEMS

PART I - GENERAL

1.01 DESCRIPTION

A. The work of this section includes, but is not limited to

1. Pressure Pipe Hydrostatic Testing
2. Disinfection of Potable Water Piping

B. Related Work Specified Elsewhere

1. Section 15060 - Pipe and Pipe Fittings
2. Section 15080 - Valves and Piping Specialties

1.02 GENERAL REQUIREMENTS

A. The Engineer shall be notified in advance of all tests and all tests shall be conducted to his entire satisfaction. All tests shall be made prior to insulating piping.

B. Repairs to the various systems shall be made with new materials. No caulking of threaded joints, cracks or holes will be acceptable. Where it becomes necessary to replace pieces of pipe, the replacement shall be the same material and thickness as the defective piece. Tests shall be repeated after defects disclosed thereby have been made good or the work replaced.

C. All piping shall be adequately braced and supported during the tests so that no movement, displacement or damage shall result from the application of the test pressure. Relief devices in the various systems shall be capped or plugged during the tests.

D. All equipment used in testing shall be subject to the approval of the Engineer, and shall be such as to properly develop, maintain and measure test procedures.

1.03 QUALITY ASSURANCE

A. Reference Standards

1. American Society for Testing and Materials (ASTM) C828 Low-Pressure Air Test of Vitrified Clay Pipelines
2. American National Standards Institute (ANSI); American Water Works Association (AWWA)

a. ANSI/AWWA C600 Section 4 - Hydrostatic Testing

b. ANSI/AWWA C651 Disinfecting Water Mains

B. Test Acceptance

1. No test will be accepted until leakage rate is below specified maximum limits.

2. The Contractor shall determine and correct the cause of test failures and retest until successful test results are achieved.

1.04 SUBMITTALS

A. Submit in accordance with Section 01300.

B. Submit the following prior to start of testing:

1. Test Procedures

2. List of Test Equipment

3. Testing Sequence Schedule

4. Certification of test pressure gauge calibration and accuracy.

5. Certification of composition of chlorination products.

PART 2 - PRODUCTS

2.01 DISINFECTION PRODUCTS

A. Liquid Chlorine: AWWA B301.

B. Calcium Hypochlorite and Sodium Hypochlorite: AWWA B300.

2.02 AIR TESTING EQUIPMENT

A. Air Compressor

B. Air Supply Lines

C. Test Connections

D. Pressure Regulator

E. Pressure Relief Valve

F. Pressure Gauge Calibrated to 0.1 lb/sq. inch.

2.03 HYDROSTATIC TEST EQUIPMENT

A. Hydro Pump

B. Pressure Hose

C. Test Connections

D. Pressure Relief Valve

E. Pressure Gauge Calibrated to 0.1 lb/sq. inch.

PART 3 - EXECUTION

3.01 PREPARATION

A. Provide concrete reaction support blocking, cured a minimum of 7 days, or a minimum of 3 days if high early strength concrete is used, for the pipeline to be tested.

B. Flush pipeline to remove debris; collect and dispose of flushing water and debris in a manner conforming to Regulatory Agency requirements.

3.02 HYDROSTATIC TESTING PRESSURE PIPING SYSTEMS

A. Applicable to process piping systems within the water treatment plant.

B. Fill entire systems with water and vent air from the system at least 24 hours before the actual test pressure is applied.

C. Apply the required test pressure when the water and average ambient temperatures are approximately equal and constant.

D. Test piping at pressures listed on Yard Piping Plan; avoid excessive pressure on safety devices and mechanical seals.

E. Maintain test pressure for a minimum of 2 hours without drop after the force pump has been disconnected.

F. Visually inspect joints, fittings, and valves while pipe is under test pressure.

G. Correct all visible leaks and retest as often as necessary until satisfactory results are achieved.

3.03 DISINFECTION OF POTABLE WATER PIPING

A. Conduct disinfection of potable water system after completion of satisfactory

pressure and leakage testing.

B. Disinfect in accordance with recommended practice established by AWWA C651.

C. Preliminary Flushing

1. Flush the line at a rate of flow of 2.5 feet per second for a period of 15 minutes; refer to table at end of this Section for the rates of flow to produce a velocity of 2.5 fps.

2. Provide and install one hydraulically propelled polyurethane Apig@ in each line 4 inches or greater in diameter prior to flushing and flush the Apig@ through the line; pig shall have the ability to negotiate fabricated mitered bends and short radius elbows and pass through tees, crosses and multi-dimensional sizes of pipe and valves.

3. Dispose of flushing water in compliance with Federal, State and Local laws.

D. Chlorine Form

1. The chlorine form to be applied to the system shall be either liquid chlorine, calcium hypochlorite or sodium hypochlorite.

2.

2. The Engineer's written approval of the chlorine form to be used is required.

E. Chlorine Application

1. Introduce the chlorine to the system by use of the continuous feed method.

2. Feed water and chlorine to the line at a constant rate so that chlorine concentration in the pipe is a minimum of 50 mg/L available chlorine.

3. Continue chlorine applications until the entire system is filled with the chlorine solution.

4. During the 24-hour treatment, operate all valves, stops, and hydrants in the section treated.

5. At the completion of the 24-hour treatment, the water shall contain a minimum of 25 mg/L chlorine throughout the line.

6. Repeat the disinfection process until the specified minimum available chlorine is present at the end of the treatment sequence.

F. Final Flushing

1. Flush the heavily chlorinated water from the system under treatment until the chlorine concentration in the water leaving the system is less than 1 mg/L.

2. Comply with federal, state and local laws when discharging the flushed disinfecting chlorine solution.

G. Bacteriological Testing

1. After final flushing is completed and before the water main is placed in service, test the line for bacteriologic quality.

2. Collect a minimum of 2 samples in sterile bottles treated with sodium thiosulfate.

3. Provide bacteriological test reports to the Owner and the Engineer; failure to meet State Health Standard requirements will be cause for the Contractor to rechlorinate and retest the system, at no additional cost to the Owner.

TABLE

Required Flow to Flush Pipelines *(a)

Pipe Diameter (Inches)	Flow Required to Produce 25 fps Velocity in gpm	Size of Tap on Main (inches) *(b)	Hydrant Outlets	
			Number	Size (Inches)
4	100	15/16	1	2-1/2
6	220	1-3/8	1	2-1/2
8	390	1-7/8	1	2-1/2
10	610	2-5/16	1	2-1/2
12	880	2-13/16	1	2-1/2

*(a) With a 40 psi pressure in main, hydrant flowing to atmosphere, a 2-1/2" hydrant outlet will discharge approximately 1,000 gpm.

*(b) Size of tap on main with no length of discharge piping.

END OF SECTION 15190

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SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: the general electrical requirements.

1.02 REFERENCES

A. The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic definition only.

B. In case of conflict between the referenced standard and the requirements of the specification, the specifications shall prevail.

C. Materials and installation shall comply with codes, laws and ordinances of Federal, State, local governing bodies having jurisdiction.

D. In every installation where regulations of electric utility and telephone companies apply, conformance with their regulations shall be mandatory and any costs incurred shall be included in the Contract.

E. In case of differences between building codes, State and Federal laws, local ordinances, utility company regulations, and the Contract Documents, the most stringent shall govern.

F. National Fire Protection Association (NFPA):
   1. NFPA 70 National Electrical Code (NEC)
   2. NFPA 70E Standard for Electrical Safety Requirements for Employee Workplaces.

1.03 COORDINATION AND PRE-INSTALLATION MEETINGS

A. General
   1. Attend the monthly coordination/progress meetings

1.04 SUBMITTALS

A. General
   1. Submittals shall be made in accordance with the requirements of this Specification Section, Specification Section 01300, and the requirements of individual sections within Specification Sections of Division 16.

B. Product Data
   1. Submit Product Data, including catalog cuts, for all products provided.
      a. Clearly indicate the usage of each product on each submittal.
      b. Include electrical rating of products.

C. Operation and Maintenance (O&M) manuals
   1. Preventive Maintenance (PM) Instructions
      a. The instructions shall include all applicable visual examinations, periodic maintenance procedures, hardware testing, and diagnostic hardware/software routines. Instructions on how to load and use any test and diagnostic programs and any special or standard test equipment shall be an integral part of these procedures.

1.05 CLOSEOUT SUBMITTALS

A. General
   1. Maintain a set of redlined Contract drawings.

1.06 QUALITY ASSURANCE

A. General
   1. Conform all work to regulatory requirements of all state, local, and national governing codes and requirements.
   2. Conform all work to NFPA 70, National Electrical Code.

B. Drawings
   1. The Contractor shall carefully examine the Contract Documents, visit the site, and become familiar with the local conditions relating to the Work. Failure to do so will not relieve the Contractor from the obligations of the Contract.
   2. Conduits are shown diagrammatically and shall be routed to suit the field conditions and NEC requirements.
   3. Fittings, junction boxes, pull boxes, supports and hardware are not shown on the drawings, nevertheless provide all appurtenances required for the raceway system.
   4. All equipment dimensions and elevations on the Drawings are approximate, Contractor shall use shop drawings for proper sizes of layouts, foundations and pads for final installation.
   5. Any minor changes in the locations of equipment, conduits, outlets, devices, etc., from those locations as shown on the Contract Drawings shall be at no cost to the Owner. Minor change in location shall be defined as within 10 feet of the location shown on the Contract Drawings for all interior work and within 25 feet for all exterior work.
   6. Where headroom or space conditions appear inadequate, the Contractor shall notify the Owner before proceeding with installation.

C. Installer
   1. Employ an installation firm with a minimum of three years documented experience in type and scope to that required by this Contract to install the Work of this Division.
   2. Employ skilled licensed electricians to supervise the Work of this Division.
   3. Submit information verifying the installer’s qualifications.

D. Regulatory Requirements
   1. Perform all electrical work in conformance with the requirements of NFPA 70, and local code requirements for the municipality in which the work is being performed.

2. Secure and pay for all required permits, governmental fees, taxes and licenses necessary for the proper execution and completion of the electrical work.
3. Submit to governmental agencies and utility companies any shop drawings for equipment, which are required by these agencies, for their approval.

E. Certifications
1. Submit evidence with all Product Data that the products represented meet testing agency quality verification requirements, including agency listing and labeling requirements.
   a. Such evidence may consist of either a printed mark on the data or a separate listing card.
   b. Submit a written statement from those product manufacturers that do not provide evidence of the quality of their products that indicates why an item does not have quality assurance verification.
   c. Such statements provided in lieu of quality assurance verification are subject to the acceptance of the Owner and the Engineer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and equipment in a clean condition.

B. Provide packaging that plugs, caps, or otherwise seals openings both during shipping and temporary storage.

C. Provide equipment needed for unloading operations and have such equipment on the work site to perform unloading work when the material and equipment is delivered.

D. If possible, clearly identify pick-points or lift-points on electrical equipment crating and packaging.

E. In the absence pick-points or lift-points on equipment crating and packaging, identify pick-points or lift-points on the equipment itself.

F. Handle materials and equipment in accordance with manufacturer's written instructions.

G. When unloading materials and equipment, provide special lifting harnesses or apparatus as required by manufacturers.

H. Store electrical materials and equipment, whether on-site or off-site, in accordance with the following:
1. Follow the manufacturer's written instructions for storing the items.
2. Store electrical equipment and products under cover.
3. Except for electrical conduit, store electrical equipment and products in heated warehouses or enclosed buildings with auxiliary heat and that provide protection from the weather on all sides.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Environmental Conditions

1. Unless otherwise specified, all equipment provided under this contract shall, as a minimum, be suitable for operation in the ambient conditions specified below.
   a. Heated Buildings
      1) Temperature 60 to 85 °F
      2) Humidity 40 to 70 percent
   b. Field Locations
      1) Temperature 0 to 110 °F
      2) Humidity 10 to 95 percent

1.09 WARRANTY

A. Provide 1 year warranty from date of substantial completion.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Commonality
   1. Products which serve similar functions shall be from the same manufacturer and part number. If this commonality requirement cannot be met, indicate the reason for not meeting it during the submittal process.

B. Maintainability
   1. Modular Design
      a. Products shall be of modular design allowing easy replacement of components in the field. All components shall be replaceable without dismantling other components or equipment to reach a failed component.
   2. Test Equipment Connections
      a. Test equipment connections shall be accessible and well-marked. Test connections referenced in service manuals shall be labeled on the equipment with the same name or number.

PART 3 EXECUTION

3.01 INSTALLATION OF WORK

A. The Contractor shall furnish other trades with advance information on locations and sizes of frames, boxes, sleeves and openings needed for the Work. The Contractor shall also furnish information and shop drawings necessary to permit trades affected to install their work properly and without delay.

B. With the approval of the Owner and without additional cost to the Owner, the Contractor shall make minor modifications in the Work as required by structural interferences, by interferences with work of other trades or for proper execution of the Work.

C. Work installed before coordinating with other trades so as to cause interferences with the work of such other trades shall be changed as directed by the Owner to correct such condition without additional cost to the Owner.

D. Minor changes in the locations of outlets, fixtures and equipment shall be made prior to rough-in at the direction of the Owner and at no additional cost to the Owner.

E. The Contractor shall cooperate with other trades and coordinate the Work to eliminate conflicts with other work.

F. The equipment shall be installed with ample space allowed for removal, repair or changes to equipment. Ready accessibility to removable parts of equipment and to wiring shall be provided without moving other equipment which is to be installed or which is in place.

G. The Contractor shall compare the Drawings and Specification SECTIONS, checking all measurements to determine the intent of the Contract Documents. Any discrepancies shall be brought to the Owner's attention for interpretation.

H. The Contractor shall protect the materials and work of other trades from damage during installation of the Work provided under this Contract.

I. Underground ducts and manholes.
   1. Both new and existing underground ducts shall be tested with a mandrel to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of the duct. If obstructions are detected, remove obstruction and retest.
   2. Where necessary, pump out manholes and remove any debris before installing wire or cable.

3.02 TRANSMISSION OF VIBRATION

A. Electrical equipment, conduit, and fittings shall not be mounted to or supported by elements subject to vibration.

B. Where flexible conduit lengths are utilized as a means of isolating equipment and conduit systems vibration, care shall be exercised to assure continuity of ground throughout.

C. Conduit lengths shall be kept to a minimum.

3.03 PROTECTION

A. The Contractor shall protect conduit and wireway openings against the entrance of foreign matter by means of plugs or caps.

B. The Contractor shall cover fixtures, materials, equipment and devices furnished or installed under this Contract or otherwise protect against damage, before, during, and after installation.

C. Fixtures, materials, equipment, or devices damaged prior to final acceptance of the Work shall be restored to their original condition or replaced.

D. Equipment shall be inherently safe and moving parts shall be covered with guards.

END OF SECTION

SECTION 16070

ELECTRICAL HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of material for furnishing, installing, cleaning and protecting hanger and support systems for electrical wiring, conduit boxes, and equipment.

1.02 REFERENCES

A. American Society for Testing and Materials, (ASTM):
1. ASTM A36 Specification for structural steel.
2. ASTM A53 Specification for pipe, steel, and hot-dipped, zinc-coated, welded and seamless.
3. ASTM A153 Specification for zinc coating (hot-dip) on iron and steel hardware.
4. ASTM A283 Specification for Mild Steel Plates.
5. ASTM A325 Specification for carbon steel externally threaded standard fasteners.
6. ASTM A500 Specification for cold-formed welded and seamless carbon steel structural steel tubing in rounds and shapes.
7. ASTM A525 Specification for plain-end and seamless pipe.
8. ASTM A563 Specification for carbon and alloy steel nuts.
9. ASTM A570 Specification for steel, sheet and strip, carbon, hot-rolled, structural quality.
10. ASTM A575 Specification for steel bars, carbon, merchant quality, hot wrought.
11. ASTM A576 Specification for steel bars, carbon, structural quality, hot wrought.
12. ASTM A633 Specification for normalized, high-strength, low-alloy structural steel plates.
13. ASTM A635 Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled
14. ASTM E84 Specification for fire resistance of building materials.

1.03 SUBMITTALS

A. Product Data:
1. Submit Product Data and catalog cuts.
2. Include load capacity and clearly indicate the usage of each product.
3. Submit manufacturer's catalog data for fastening components and indicate installation methods

B. Shop Drawings:
1. Submit detailed shop drawing and fabrication details for all custom fabricated items and support framing systems.

C. Structural Calculations
1. Submit structural calculations for u-channel support frames.

1.04 QUALITY ASSURANCE

A. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products.

B. Select manufacturer of support framing that has been manufacturing support framing for a minimum of 5 years. Use manufacturers who carefully control operations to ensure that the engineering, quality, safety and reliability of product are achieved.

C. Provide manufacturers certification that the galvanizing and the products meet the ASTM standards specified.

D. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

A. Provide steel shapes in sizes as indicated and as follows:
1. Steel Sections: ASTM A36/A, A36M
2. Steel Tubing: ASTM A500, Grade B
3. Plates: ASTM A283
4. Sheets: ASTM A570
5. Pipe: ASTM A53, Grade B Schedule 40, hot-dipped, zinc-coated

2.02 U-CHANNEL SUPPORT FRAMING SYSTEMS

A. Acceptable Manufacturers:
1. Provide products of a single manufacturer for metal framing systems and fittings for metal framing systems. Acceptable manufacturers are:
a. Unistrut.
b. Kindorf.
c. B-Line.

B. For aboveground noncorrosive interior locations:
1. Provide U-channel supports, 1-5/8-inch nominal, fabricated from 12 gauge ASTM A570, grade 33 structural and electrolytically zinc-coated to conform to ASTM B633, Type II, SC1. Provide combination members where required that are spot-welded on 3-inch centers. Provide depths of 1-3/8-inch or larger, however, when supports are mounted directly to walls provide depths of 13/16-inch or larger.
2. Conforming to ASTM A575, A576, A635, or A36 with electro-galvanized finish conforming to ASTM B633, Type III, SC1.

C. Provide 316 stainless steel U-channel supports, fittings, threaded rod and hardware for exterior or corrosive interior locations.

2.03 CONDUIT SUPPORTS

A. Provide one-hole style fastener of malleable iron for exterior use and of stamped steel for interior use. Provide both types in galvanized finish. Provide pipe straps similar to those as manufactured by Thomas & Betts.

B. Provide PVC coated (40-mil application) support devices including threaded rod, channel supports and conduit straps/fasteners in areas of the building(s) where PVC coated RMC conduits are to be installed.

2.04 CABLE SUPPORTS

A. Panelboards/Enclosures: Furnish and install cable supports in feeder risers as required by the underwriters. Provide supports of hot dipped galvanized malleable iron with a threaded collar and furnished with a hard fiber, impregnated hardwood or a canvas bakelite tapered wedging cable plug. Provide voltage rated supports as manufactured by the O. Z. Electrical Manufacturing Co., Inc., Type "M" or approved equal.

2.05 ANCHORS AND FASTENERS

A. Drive (Deep-Pitch) Screws: Self-tapping type, 316 stainless steel, Fed. Spec. FF-S-107C(2).

B. Drilled-In Anchors and Fasteners: Fed. Spec. FF-S-107C (2).
   1. Applications in Masonry (and Precast Concrete Hollow-Core Structural Elements):
      a. Anchors: Provide anchors designed to accept both machine bolts and threaded rods. Provide anchors consisting of an expansion shield and expander nut contained inside the shield. Provide expander nut fabricated and designed to climb the bolt or rod thread and simultaneously expand the shield as soon as the threaded item, while being tightened, reaches and bears against the shield bottom.
      b. Shield Body: Provide shield body consisting of four legs, the inside of each tapered toward shield bottom (or not end). The end of one leg shall be elongated and turned across shield bottom. Outer surface of shield body shall be ribbed for grip-action.
      c. Expander Nut: Provide square design with sides tapered inward from bottom to top.
      d. Material: Provide die cast Zamac No. 3 zinc alloy of 43,000 psi minimum tensile strength.
      e. Fasteners: Provide 316 stainless steel machine bolts conforming to S.A.E. Grade 2 for use with above anchors: nuts and washers to conform to ASTM A 563.
      f. Acceptable Manufacturers:
         1) U.S.E. Diamond, Inc.; FORWAY System.
   2. Applications in Cast-in-Place Concrete (and Solid Precast Concrete Structural Elements):
      a. Stainless Steel Anchor/Fastener: Provide one-piece stud (bolt) with integral expansion wedges, nut and washer, and meeting physical requirements of

Fed. Spec. FF-S-325, Group II, Type 4, Class 1. Stud of AISI Type 303 or 304 stainless and nut and washer of AISI Type 316 stainless.

b. Acceptable Manufacturers:
   1) U.S.E. Diamond, Inc.; SUP-R-STUD.
   2) Hilti Fastening Systems; KWIK-BOLT.
   3) Molly Fastener Group; PARABOLT.
   4) Phillips; RED HEAD Wedge-Anchor.

C. Note: Hammer drive-type explosive charge drive-type anchors and fastener systems are not acceptable. Lead shields, plastic-inserts, fiber-inserts, and drilled-in plastic sleeve/nail drive systems are also not acceptable.

2.06 WALL SEAL

A. Provide hydrostatic seal to seal opening between conduit and a through structure opening. Manufacturers for watertight sealing fittings are to be OZ/Gedney Type WSK, or Link-Seal.

2.07 FIRE SEALS

A. Provide approved fire seals where conduit penetrates fire rated walls, floors, partitions and ceilings to ensure that the fire rating is maintained. Provide fire seal system, which is UL listed for application.
   1. Provide fire seal compound or mechanical seal for fire rating 2 hours or less.
   2. Acceptable Manufacturers:
      a. Compound - Dow Corning, 3M
      b. Mechanical Seal - Link-Seal
      c. Through-Wall Barrier - Crouse-Hinds TW Series

2.08 PRODUCTS

A. Provide bolts, nuts, and washers smaller than 1/4-inch trade size 316 stainless steel.

B. Welding materials: AWS D1.1; type required for materials being welded.

2.09 TOUCH-UP PRIMER FOR GALVANIZED SURFACES:

A. SSPC-Paint 20, Type I, inorganic zinc

PART 3 EXECUTION

3.01 EXAMINATION

A. Carefully investigate the structural and finish condition, as well as other construction work which, may affect the work of this Section. Arrange Electrical Work accordingly and furnish such fittings and apparatus as required to accommodate such conditions and to preserve access to other equipment, rooms, areas, etc.

B. Prior to performance of work described above, make detailed drawings of proposed departures from original design due to field conditions or other cause, and submit for Engineer's approval.

3.02 PREPARATION

A. Field Measurement: The Drawings are generally indicative of the work, but due to their small scale, it is not possible to indicate some offsets, fittings, and apparatus required nor the minor structural obstructions that may be encountered.

B. Obtain roughing-in dimensions of electrically operated equipment being installed in other construction work. Set conduit and boxes only after receiving approved dimensions and checking such equipment locations.

C. Layout electrical work to suit actual field measurements and according to accepted Trade standard practice. Provide electrical installations conforming to NEC 300 for wiring methods general requirements, and to other applicable Articles of the NEC governing methods of wiring.

3.03 INSTALLATION

A. Anchor And Fastener Installations:
   1. Threaded Bolts: Draw threaded bolt connections up tight using 316 stainless steel lock washers to prevent bolt or nut loosening.
   2. Drilled-In Expansion Anchor Installation:
      a. General: Install expansion anchors in strict accordance with manufacturer's instructions and in accordance with the following.
      b. Drilling Holes: Drill holes to the required diameter and depth in accordance with anchor manufacturer's instructions for size of anchors being installed.

B. Minimum Embedment: Embed expansion anchors to manufacturer's instructions .Areas designated as wet, as NEMA 3, 3R, 4X, 12, and 13 Areas.
   1. Secure equipment and conduit to (not fewer than 2) vertically wall-mounted, non-metallic or stainless-steel channels (7/8" min).

3.04 FABRICATION

A. Fit and shop assemble items in largest practical Sections for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by intermittent welds and plastic filler.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline.

E. Ease exposed edges to small uniform radius. Cut all backboard corners to 1-inch radius.

F. Exposed mechanical fastenings: Provide flush countersunk screws or bolts; unobtrusively located, consistent with design of component except where specifically noted otherwise.

G. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication except where specifically noted otherwise.

H. Drill or punch holes accurately as required for attachment of work and for bolted connections. Burned holes are not acceptable. Holes shall be no more than 3/32-inch larger than fasteners.

I. Perform welding of assemblies in accordance with AWS D1.1. Dress welds smooth and free of sharp edges and corners.

J. Fabrication Tolerances:
   1. Squareness: 1/8 inch (3 mm), maximum difference in diagonal measurements.
   2. Maximum offset between faces: 1/16 inch (1.5 mm).
   3. Maximum misalignment of adjacent members: 1/16 inch (1.5 mm).
   4. Maximum bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
   5. Maximum deviation from plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

K. Fabricated Items:
   1. Bollards: galvanized steel pipe, concrete filled, crowned cap, as detailed; prime paint finish.

3.05 FINISHES-STEEL

A. Galvanizing of items specified above as galvanized: Galvanize after fabrication to ASTM A 123. Provide minimum 1.25 oz/sq ft (380 g/sq m) galvanized coating.

3.06 FIELD QUALITY CONTROL

A. Inspect the items for the following and correct any discrepancies:
   1. Adequacy of coating, damage to coatings. Touch up damaged coating surfaces; use specified primer for primed steel surfaces, use zinc-rich primer for galvanized steel surfaces.
   2. Adherence to fabrication tolerances:
      a. Squareness: 1/8 inch (3 mm), maximum difference in diagonal measurements.
      b. Maximum offset between faces: 1/16 inch (1.5 mm).
      c. Maximum misalignment of adjacent members: 1/16 inch (1.5 mm).
      d. Maximum bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
      e. Maximum deviation from plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

3.07 PROTECTION

A. Protect the items during work of other trades.

END OF SECTION

SECTION 16095

MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of material for demolition and salvaging existing electrical systems, wiring, raceways, supports, equipment and minor repair of underlying structure.

1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC)

1.03 SUBMITTALS

A. Submit demolition plan.

1.04 QUALITY ASSURANCE

A. Demolition information shown or otherwise indicated on the Drawings is based on visual field examination and existing record documents. The Contractor shall field verify the demolition work before starting demolition.

B. Protection: Exercise care during demolition work to confine demolition operations to the areas as indicated on the Drawings. The physical means and methods used for protection are at the Contractor's option. However, the Contractor will be completely responsible for replacement and restitution work, of whatever nature, at no expense to the Owner.
   1. Additionally, if public safety is endangered during the progress of the demolition work, provide adequate protective measures to protect public pedestrian and vehicular traffic on streets and walkways.
   2. Conform signs, signals and barricades to requirements of Federal, State and local laws, rules, regulations, precautions, orders and decrees.

1.05 SEQUENCING AND SCHEDULING

A. Schedule all work with the Owner. Do not start work in an area until a schedule has been prepared, submitted and approved.

B. Coordinate the work schedule with the Owner, and other Contractors. Coordinate the work to not interfere or conflict with the performance of work by the Owner.

C. Coordinate all power outages with Owner.

D. Perform demolition in a manner not to delay or interfere with other work of this project or of the Owner in operation of the facilities.

PART 2 PRODUCTS

2.01 MATERIALS

A. Basic Electrical Materials: Those products such as conduit, raceway, wire and cable, support devices, fasteners, and control devices as required for work of this Section are specified in other Sections of Division 16.

B. Patching Materials: Patching materials shall match, as nearly as practical, the existing material for each surface being patched.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify that measurements and existing circuiting arrangements are as shown on Drawings.

B. Equipment, machinery and apparatus, motorized or otherwise, used to perform the demolition work may be used as chosen at the Contractor's discretion, but which will perform the work within the limits of the Contract requirements.

C. Verify that abandoned wiring and electrical equipment serve only the abandoned facility.

3.02 DEMOLITION

A. General:

1. Remove, relocate and extend existing installations to accommodate new construction as indicated and/or as required.
2. Remove exposed abandoned conduit systems, including abandoned conduit systems above accessible ceiling systems.
3. Remove wiring in abandoned conduit systems to source of power supply.
4. Maintain access to existing electrical installations, which remain active. Modify installations and provide access panels or plates as appropriate.
5. Extend existing installations using materials and methods compatible with existing electrical installations, and as specified in other Sections of Division 16.
6. Wiring Devices:
   a. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduits serving the outlet is abandoned and removed. Provide blank covers for abandoned outlets, which are not removed.
   b. Disconnect and remove electrical devices and equipment serving equipment that has been removed.
7. Equipment:

a. Disconnect and remove electrical equipment where so indicated on the Drawings.
b. Disconnect and remove abandoned equipment as indicated on the drawings or as otherwise required due to the removal of associated equipment.

8. In exposed through-structure conduit locations, or where concealed conduits become exposed by penetrating a structural floor, wall or ceiling, the abandoned conduits must be cut below the finished structural surface in order to perform surface patching.

B. Conduit openings or other demolition openings left in existing equipment enclosures, junction boxes, and or pull boxes, which will remain after construction, shall be covered. These conduit openings shall be covered with "snap in" or "screw in" type knockout closures used for this purpose. These knockout closures shall be the same as the NEMA rating of the enclosure, pull box, or junction box.

C. System De-activation: Prior to demolition and removal work, de-activate existing electrical systems as indicated and/or as required.

D. Use means and methods for permanent disconnection, which render the remaining electrical systems and apparatus in conformity with NFPA 70.

E. Provide temporary wiring and connections to maintain existing systems in service during construction.
1. Conform temporary wiring to the requirements of NEC Article 400, Flexible Cords and Cables.
2. Reinstate as soon as possible any existing circuits disrupted during construction not intended to be removed as part of this contract.

F. Remove all wiring from disconnected circuits, feeders, and equipment unless otherwise specified or indicated. Remove all exposed raceways and related supports. Cut all exposed raceways below floor and plug.

G. Coordinate electrical power outages with Owner.

H. Use equipment and methods that do not damage items to remain or salvaged and areas adjacent to demolition operations. Use methods that do not interfere with Owner's operations and which do not cause excessive dust. Remove debris as it accumulates.

I. Cutting: Perform cutting work of existing structure materials by such methods as will prevent extensive damage beyond the immediate area of cutting.

J. Debris Removal: Dispose of demolition debris off site in a lawful manner. Containerize or otherwise store debris as work is in progress.

K. Patching: After demolition and removal work is performed patch the existing structure as required to match surrounding finish and appearance including the appropriate surface decoration.

3.03 ABANDONED ELECTRICAL EQUIPMENT AND APPARATUS:

A. Existing electrical equipment and apparatus in or on the structures not claimed as salvage by the Owner shall become the property of the Contractor and may not be disposed of on the site but removed and disposed of in a lawful manner off-site.

3.04 SALVAGE:

A. The Owner shall have the right to claim as salvage any items and materials removed. Should such right of salvage be exercised by the Owner, move and neatly store removed items on the site in a location agreeable to the Owner.

3.05 HAZARDOUS MATERIALS

A. In the case where there is lead based paint on existing equipment requiring removal, the Contractor shall do so to comply with all local, state, and federal regulations required for such removal.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Electrical identification requirements for
      a. Equipment
      b. Conduits
      c. Wire
      d. Etc.
   2. Conduit coating requirements.

1.02 SUBMITTALS

A. Product Data:
   1. Submit product data

B. Shop Drawings:
   1. Submit list of identification tags.

PART 2 PRODUCTS

2.01 EQUIPMENT IDENTIFICATION

A. The Contractor shall provide white with black core laminated phenolic nameplates with 3/8 lettering etched through the outer covering.

2.02 WIRE IDENTIFICATION

A. Cable/wire markers shall be provided for both ends of all conductors.

B. Wire and cable markers shall be self-adhesive, self-laminating mechanically printed with a clear protective laminating over wrap or mechanically printed heat shrink tubing. Cable and wire markers shall be approved by the Engineer and shall be attached to all cables where entering or leaving the conduit run. The cable designation and circuit use from the cable schedule shall appear on the tag.

C. Manufacturers are to be Brady, Panduit, 3-M Company, or Thomas and Betts.

2.03 CONDUIT IDENTIFICATION

A. All conduit runs shall be identified by means of a non-corrosive metal tag with stamped identification and attached at all conduit terminations, including junction boxes. Tags shall be attached with stainless steel wire.

B. Conduit tags shall be made of brass or stainless steel, 1/32 inch thick and 3/4 inch wide, embossed with the designations in 5/16 inch high letters and numbers.

PART 3 EXECUTION

3.01 EQUIPMENT IDENTIFICATION

A. Major equipment shall be identified with nameplates.

B. Fasten with stainless steel screws to equipment after finish painting is completed. Fasteners shall not change the NEMA Type rating of an enclosure. Embossed self-adhering plastic tape labels will not be accepted.

3.02 LIGHTING AND POWER PANELS

A. Provide a revised typewritten directory of circuits in lighting and power panels where new circuits are added to new or existing panels.

3.03 WIRE IDENTIFICATION

A. Label each wire with wire markers at terminals and at all accessible points in equipment, panelboards, control panels, manholes, handholes, junction boxes, and pull boxes.

B. Each cable run shall be assigned a circuit number and shall be recorded on a cable schedule showing from, to, purpose, number of conductors and length.

C. All conductors shall be tagged in cabinets at the time wires are pulled in and tested. The wire and cable markers shall not be removed for any reason.

3.04 CONDUIT IDENTIFICATION

A. Conduit identification tags shall be fastened to the conductors near the conduit termination where conduits enter motor control centers, switchboard, switchgear, terminal cabinets, outlet boxes, junction boxes, pull boxes, and other items. The tag shall be attached with stainless steel wire.

B. Exterior installed conduits, except branch lighting circuit conduits, shall be tagged at the ends and in intermediate boxes, chambers, manholes, handholes, and other enclosures.

3.05 CONDUIT COATING

A. PVC coated conduit shall not be coated but shall be distinctly marked with color-coded bands around the conduit and labeled.

B. Examine surfaces to be coated and report any conditions that would adversely affect the appearance or performance of the coating systems, and which cannot be put into an acceptable condition by preparatory work specified herein.

C. Apply coatings only when the prevailing environmental conditions are in accordance with the manufacturer’s printed instructions.

D. Surface Preparation

1. Surfaces to be coated shall be clean and dry. Before applying coatings, oil, grease, dirt, rust, loose mill scale, old, weathered coatings, and other foreign substances shall be removed
2. Any solvent wash, solvent wipe, or cleaner used, including but not limited to those used for surface preparation in accordance with referenced Steel Structures Painting Council (SSPC) specifications, shall be of the emulsifying type which emits no more than 2.8 lb/gal (340 gms/l) VOCs, contains no phosphates, is biodegradable, removes no zinc, and is compatible with the specified primer. Clean cloths and clean fluids shall be used for solvent cleaning.
3. Cleaning shall be scheduled so that dust and spray from the cleaning process will not fall on wet, newly coated surfaces.
4. Hardware, hardware accessories, nameplates, data tags, machined surfaces, sprinkler heads, electrical fixtures, and similar uncoated items which are in contact with surfaces to be coated shall be removed and reinstalled or masked prior to surface preparation and coating operations. Following completion of coating, removed items shall be reinstalled.
5. The Contractor is responsible for dust control and for protection of mechanical, electrical, and all other equipment adjacent to and surrounding the work area. compatible with the specified primer. Clean cloths and clean fluids shall be used for solvent cleaning.

END OF SECTION

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SECTION 16080

ELECTRICAL TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of performance testing the electrical systems and equipment.

B. Related Sections
   1. Section 16050 – Basic Electrical Materials And Methods.

1.02 REFERENCES

A. Applicable Documents and Testing Requirements of:
   1. America National Standards Institute (ANSI): as applicable, including:
      a. ANSI C2, National Electrical Safety Code.
      b. ANSI Z244.1 American National Standards for Personnel Protection.
   2. National Electrical Manufacturer's Association (NEMA): as applicable, including:
      a. NEMA ICS 2.3 - Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers.
      b. NEMA ICS 7.1 - Safety Standards for Construction and Guide for selection, Installation, and Operation of Adjustable Speed Drive Systems.
      c. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
      d. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
   3. American Society for Testing and Materials (ASTM), as applicable.
   4. Institute of Electrical and Electronics Engineers (IEEE), as applicable, including:
      a. IEEE C.57.13, IEEE Standard Requirements for Instrument Transformers.
      b. IEEE 81, Section 9.03; Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System
   5. National Fire Protection Association (NFPA), as applicable, including:
      a. NFPA 70 - National Electrical Code (NEC).
      b. NFPA 70E - Electrical Safety Requirements for Employee Workplaces.
      c. NFPA 72 - National Fire Alarm Code (NFAC).
   6. International Electrical Testing Association (IETA) as applicable, including:
      a. Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.
   7. Insulated Cable Engineer's Association (ICEA), as applicable.
   8. Local Utility Codes and Ordinances.
   9. Occupational Safety and Health Administration (OSHA), as applicable, including:
      a. Title 29, Parts 1907, 1910 and 1936.
   10. National Electrical Testing Association:
      a. ATS-1 Acceptance Testing.

1.03 SUBMITTALS

A. Submit documentation as required by this Section of the Contract to the Design Engineer.

B. Submission to include the following:
   1. Field inspection report as required for each item of material and/or equipment outlined herein.
   2. Manufacturer's directions for use of ground megger with proposed method indicated.

C. Test Reports:
   1. Each test report prepared by the respective testing firm(s) comply, where applicable, to all stipulations specified in Section 26 05 00 for Operation, Maintenance and Installation Manuals with reference to preparation, paper requirements, indexing and binders. Include in each test report the following:
      a. Summary of project.
      b. Description of equipment tested.
      c. Description of test.
      d. Test results.
      e. Conclusions and recommendations.
      f. Appendix, including appropriate test forms.
      g. Identification of test equipment used.
      h. Signature of responsible test organization authority.
      i. Furnish five copies of each completed report to the Design Electrical Engineer no later than 30 days after completion of each test. Assemble and certify the testing firm each final test report, which must be submitted to the Design Engineer for review, comments and subsequent approval.

1.04 QUALITY ASSURANCE

A. Testing Personnel
   1. Technicians performing these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make a judgment on the serviceability of the specific equipment.
   2. Technicians shall be certified in accordance with ANSI/NETA ETT-2000, *Standard for Certification of Electrical Testing Personnel*. Each on-site crew leader shall hold a current certification, Level III or higher, in electrical testing.

B. Test Instrument Calibration:
   1. The testing firm is to have a calibration program, which ensures that all applicable test instrumentation are maintained within rated accuracy.
   2. The accuracy is to be directly traceable to the National Bureau of Standards.
   3. Instruments are to be calibrated in accordance with the following frequency schedule.
      a. Field Instruments: Analog - 6 months maximum
         Digital - 12 months maximum
      b. Laboratory Instruments: 12 months
      c. Leased specialty equipment: 12 months

4. Make dated calibration labels visible on all test equipment.
5. Keep records up-to-date, which show date and results of instruments calibrated or tested.
6. Maintain an up-to-date instrument calibration instruction and procedure for each test instrument.
7. Calibrating standard is to be of higher accuracy than that of the instrument tested.

1.05 SEQUENCING AND SCHEDULING

A. Schedule all testing with work of other Divisions to ensure an orderly sequence of startup and completion of work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Perform, supervise, and furnish all test equipment needed to perform tests and provide safety measures, procedures and equipment required for each test.

B. All testing shall be witnessed by Owner and Engineer.

C. Notify all involved parties including the Engineer prior to tests, advising them of the test to be performed and the scheduled date and time.

D. Prepare written test procedures and forms used in the test reports and submit for approval prior to commencement of testing.

E. Include in each test report the following information:
1. Job title.
2. Date of test.
3. Equipment, system or cable identification.
4. Type of test.
5. Description of test instrument and date of latest calibration.
6. Section of specification defining test along with description of test and evaluations as reported by the testing company.
7. Test results (correct all readings at 20 degrees C).
8. Signature of person supervising test.
9. Signature of Contractor.
10. Space for Engineer's signature.

F. Perform all tests with apparatus de-energized except where otherwise specifically required.

G. Before testing and energizing a system, all necessary precautions shall be taken to ensure the safety of personnel and equipment. All conductors and all electrical equipment shall be properly insulated and enclosed. All enclosures for conductors and equipment shall be properly grounded. Insulation resistance measurements shall have been made and approved on all conductors and energized parts of electrical equipment.

H. All tests shall be recorded on the following forms:

Form Number	Description
16080-1	MULTIPLE CONDUCTOR CABLE MEGGER TEST, 300 VOLTS & LESS.

3.02 INSPECTION AND TEST PROCEDURES

A. Wire and Cable, Low-Voltage, 600-Volt Maximum:
   1. Visual and Mechanical Inspection
      a. Perform visual and mechanical inspections in accordance with NETA, ATS paragraph 7.3.2.1
   2. Electrical Tests
      a. Perform visual and mechanical inspections in accordance with NETA, ATS paragraph 7.3.2.2

B. Grounding Systems
   1. Visual and Mechanical Inspection
      a. Perform visual and mechanical inspections in accordance with NETA, ATS paragraph 7.13.2.1
   2. Electrical Tests
      a. Perform visual and mechanical inspections in accordance with NETA, ATS paragraph 7.13.2.2

3.03 SITE TESTING

A. General
   1. The intent of site testing is to uncover and correct field wiring errors, identify defective/damaged equipment and correct communications issues prior to the Site Demonstration Test (SDT).
   2. Equipment shall be wired to field devices and tested from the field device to the equipment.
   3. Site testing shall be witnessed by Owner and the Engineer.
   4. Revised shop drawings from the factory testing are required before site testing is conducted.
   5. Notify Owner and Engineer 2 weeks prior to testing.

B. Test Documentation
   1. Maintain a copy of all the test documents and provide space for Owner and Engineer to sign off on witnessed testing.

3.04 SITE DEMONSTRATION TESTING (SDT)

A. Provide on-site electricians to support testing as specified in Section 17000.

3.05 CONDUCTOR RESISTANCE TESTING
   1. Testing shall be performed before connecting the cables to the terminals at either end. Continuity of each conductor shall be checked at this time.

B. Each conductor shall be checked with a 500-volt megger to ground, with all other conductors in the cable and shield, grounded. The minimum acceptable megger resistance shall be 50 megohms for each conductor to ground.

3.06 GROUND RESISTANCE TESTING

A. Arrange and pay for the services of a qualified independent electrical testing organization to perform testing as describe.

B. Subject the completed grounding system to a megger test at each location where a maximum ground resistance level is specified, at service disconnect enclosure ground terminal, and at ground test wells. Measure ground resistance without the soil being moistened by any means other than natural precipitation or natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method in accordance with Section 9.03 of IEEE 81, "Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System."

C. Provide ground/resistance maximum values as follows:
   1. Equipment rated 500 kVA and less: 10 Ohms
   2. Equipment rated 500 kVA to 1000 kVA: 5 Ohms
   3. Equipment rated over 1000 kVA: 3 Ohms

D. Where ground resistances exceed specified values, and if directed, modify the grounding system to reduce resistance values. Where measures are directed that exceed those indicated the provisions of the Contract, covering changes will apply.

E. Prepare test reports, certified by the testing organization, of the ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.07 CORRECTION OF DEFICIENCIES

A. Report all unacceptable values immediately. Correct all deficiencies found in work of this contract and separately report deficiencies in work of items of other contracts.
   1. Retest items requiring correction. Correct or have corrected any remaining deficiencies and retest until work is acceptable.

3.08 FORMS

FORM 16080 - 1

MULTIPLE CONDUCTOR CABLE MEGGER TEST, 300 VOLTS & LESS
WIRING - SIGNAL & COMMUNICATION CABLE
DATE_____
PROJECT NAME_____
CABLE NUMBER_____ LOCATION_____
FROM MANHOLE_____ TO MANHOLE_____
CABLE SIZE_____ CABLE LENGTH_____
NUMBER OF CONDUCTORS_____ INSULATION TYPE_____
MANUFACTURER_____ LINE VOLTAGE_____
TEMPERATURE_____ HUMIDITY_____
MEGGER TYPE_____ SERIAL NUMBER_____
TEST VOLTAGE_____ MULTIPLIER_____
REMARKS_____

CONDUCTOR NO.	MEGOHMS		CONTINUITY		CONDUCTOR NO.	MEGOHMS		CONTINUITY	
	C/C	C/S	PASS	FAIL		C/C	C/S	PASS	FAIL

TEST PERFORMED BY:_____ _____
Signature Date

TEST WITNESSED BY: _____ _____
Signature Date

END OF SECTION

SECTION 16110

ELECTRICAL RACEWAY SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes electrical raceway system products.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch).
   2. ANSI C80.1, Rigid Steel Conduit - Zinc-Coated (GCR).
   3. ANSI C80.3, Electrical Metallic Tubing - Zinc Coated (EMT).
   4. ANSI C80.6, Intermediate Metal Conduit - Zinc Coated (IMC).

B. American Society for Testing and Materials (ASTM):
   1. ASTM A 568/A 568M, Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold Rolled, General Requirements for.
   2. ASTM D1784, Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

C. National Electric Manufacturer's Association (NEMA):
   1. NEMA RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   2. NEMA TC 2, Electrical Polyvinyl Chloride (PVC) Conduit.

D. National Fire Protection Association (NFPA):
   1. NFPA 70, National Electrical Code (NEC).
   2. NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities, 2012

E. Underwriters Laboratory, Inc. (UL):
   1. ANSI/UL 6, Standard for Rigid Metal Conduit.
   2. ANSI/UL 360, Standard for Liquid-Tight Flexible Steel Conduit.
   3. ANSI/UL 498, Standard for Safety for Attachment Plugs and Receptacles.
   4. ANSI/UL 514A, Metallic Outlet Boxes.
   5. ANSI/UL 797, Electric Metallic Tubing - Steel.
   6. ANSI/UL 886, Standard for Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
   7. ANSI/UL 1242, Standard for Electrical Intermediate Conduit - Steel

F. Institute of Electrical and Electronics Engineers (IEEE):
   1. IEEE C2, National Electrical Safety Code.

1.03 DEFINITIONS

A. Definitions for all items are as stated in NFPA 70, IEEE C2, and in other reference documents unless otherwise stated, specified, or noted.

1.04 SUBMITTALS

A. Product Data
   1. Submit Product Data and catalog cuts. Clearly indicate the usage of each product on the submittal

B. Shop Drawings:
   1. Provide detailed shop drawing and fabrication details for all custom fabricated materials such as pull boxes, panels, etc
   2. Prior to beginning installation, submit complete detailed conduit installation drawings.
      a. Installation drawings shall identify the size, type, routing, wiring to be installed and percent fill for each conduit installed.

1.05 QUALITY ASSURANCE

A. Certifications:
   1. Provide products that are listed and labeled by Underwriters Laboratory (UL), approved by Factory Mutual (FM), or certified as meeting the standards of UL by the Electrical Testing Laboratory (ECL) unless products meeting the requirements of these nationally recognized testing laboratories are not readily available or unless standards do not exist for the products.
      a. Provide products that are listed and labeled, or approved as stated above, for the items intended locations and applications.

B. All conduits shall be sized in accordance with the National Electrical Code for the number and type of conductors to be installed.

PART 2 PRODUCTS

2.01 CONDUIT AND FITTINGS

A. Electric metal conduit (EMC) is **not** acceptable.

B. Galvanized Rigid Steel Conduit
   1. Galvanized rigid steel (RGS) conduit and fittings shall be installed in all areas of this Project except as required to be PVC Coated RGS Conduit.
   2. RGS conduit shall be heavy wall type, hot dipped galvanized with zinc coated threads, and Underwriters' Laboratory labeled.
   3. RGS conduit and couplings shall be threaded, rigid steel, hot dipped galvanized after fabrication and shall be in accordance with UL 6.

C. RGS Conduit manufacturers:
   1. Allied Tube and Conduit Corp.
   2. Wheatland Tube Company
   3. Steel Duct Conduit Products

D. Intermediate metal conduit (IMC) is **not** acceptable.

E. PVC Coated RGS Conduit

1. PVC coated rigid steel conduit and fittings shall be installed in all wet wells, chemical areas, outside, and damp locations. PVC coated RGS conduit shall extend 8 inches into areas not requiring PVC coated RGS conduit.
2. PVC coated rigid steel conduit, including elbows and couplings shall be made with RGS conduit, conforming to the RGS specifications above, to which is bonded a Polyvinylchloride (PVC) coating for the protection of the conduit.
3. The minimum thickness of the exterior PVC coating shall be 40 mils.
4. A urethane chemically cured coating shall be applied to the interior of the conduit. This internal coating shall be applied at a nominal 2 mil thickness.
5. PVC coated conduit shall conform to NEMA Standard RN1-1986.
6. PVC coated RGS conduit shall be used for installation throughout chemical environment where chemicals are stored or mixed with liquids, chemical vapors are present.
7. All PVC coated conduits shall be new. Any minor damage to new or existing PVC coated conduit shall have modifications/repair work performed per manufacturer's products and instructions.
8. Major damage to PVC coated RGS conduit will require replacement of the conduit by the contractor at no additional cost to the Owner.

F. PVC coated RGS conduit manufacturers:
   1. Robroy Industries
   2. Perma Cote Industries
   3. Arnco Corp.
   4. Aeroquip Corp.

G. The minimum size conduit shall be 3/4 inch, unless otherwise indicated on the Drawings.

H. All conduit fittings shall be of the types specified, shall be in accordance with UL 514 for normal application, and UL 886 for hazardous applications or for use with plastic coated flexible metal conduit. Conduit fittings will match the type of conduit installed.

I. Conduit fitting manufacturers:
   1. American Fittings
   2. Appleton Electric
   3. Killark Electric
   4. OZ/Gedney
   5. Robroy Industries
   6. Perma Cote Industries
   7. Arnco Corp.
   8. Aeroquip Corp.

2.02 FLEXIBLE CONDUIT AND FITTINGS

A. Conduits installed in dry locations requiring movable connection for adjustment or vibration isolation shall be provided with an 18-inch minimum length of flexible liquid-tight galvanized steel conduit.

B. Flexible conduit installed in wet locations, interior and exterior locations, and at motors shall be liquid-tight type.

C. Flexible liquid-tight conduit shall be galvanized steel with a moisture and oil-proof plastic coated jacket of the UL listed type.

D. Connectors shall be galvanized steel with insulated throat, squeeze-type, with annular gripping rib. Particular attention shall be given to maintaining ground bond and firm support through flexible connections. Liquid-tight connections shall have insulated throats.

E. Flexible liquid-tight conduit shall be 3/4 inch diameter minimum. Smaller 1/2 inch diameter may be provided when specifically approved by Owner prior for connections to such devices as limit switches, for which the use of 3/4 inches flexible conduit may not be practical.

F. Flexible metal conduit shall be in accordance with UL.

G. Plastic-coated, flexible metal conduit shall be in accordance with UL 360, type UA with plastic outer jacket and integral ground conductor.

H. Manufacturers:
   1. Anamet
   2. Electriflex
   3. International Metal Hose Company

I. Flexible liquid-tight connector manufacturers are to be Anamet, International Metal Hose Company, Robroy Industries, Perma Cote Industries, Arnco Corp., or Aeroquip Corp.

2.03 BUSHINGS

A. Conduit bushings shall be Threadless, Malleable Iron, Zinc Electroplated with 150 degrees C insulating ring. Insulating material shall be self-extinguishing, shall be locked in place, and shall be non-removable.

B. Manufacturers:
   1. Appleton Catalog Series BU
   2. OZ/Gedney Catalog Series IBC

2.04 CONDUIT SEALS AND EXPLOSIONPROOF FITTINGS

A. Conduit seals and explosion proof fittings shall be of the same type RGS or PVC coated RGS as the conduit.

B. Each conduit seal shall be filled with compound, as recommended by the manufacturer.

C. Explosion proof seal, drain, and breather conduit fittings shall be installed as required by Code.

D. Fittings and sealing compound shall be designed for application in the Class, Division and Group.

E. Combination seal and drain fittings may be used in lieu of 2 separate fittings.

F. Manufacturers:
   1. Appleton Electric type ESUF or ESUM
   2. Crouse-Hinds type EYS or EZS
   3. OZ/Gedney type EY
   4. Killark Electric

2.05 PULL BOXES AND JUNCTION BOXES

A. Pull boxes and junction boxes in damp non-hazardous environments such as the exterior of building, interior wet areas shall be JIC NEMA Type 4X, 14-gauge minimum, stainless steel. All outdoor enclosures to be 316 stainless steel.

B. Pull boxes and junction boxes located in non-hazardous and dry environment shall be NEMA Type 12 gasketed, 14 gauge, continuously welded seam, galvanized box and cover. Each cover shall be secured with round, recessed, pan head, or flat head stainless steel screws.

C. Pull boxes and junction boxes in damp non-hazardous chemical environment (indoor and outdoor) where chemicals are stored or mixed with liquids and chemical vapors are present, shall be JIC NEMA Type 4X, 316 stainless steel boxes.

D. Pull boxes and junction boxes located in hazardous environment shall be of explosion proof type designed for application in the Class, Division, and Group. Class, Division and Group shall be as defined in NFPA 820, Chapter 4 Collection System Table 4.2.

E. Pull boxes and junction boxes of the proper size and shape shall be provided.

F. Where required by building construction, special pull boxes or junction boxes shall be provided in sizes and shapes determined from field measurements as required making a neat and workmanlike installation.

G. Where required, the Contractor shall provide pull boxes and junction boxes with metal barriers, baffles or separators for grouping of dissimilar conductors for voltage and insulation, or system separation in compliance with the National Electrical Code.

H. Pull boxes and junction boxes shall be supported independently of the conduit system.

I. Manufacturers:
   1. Appleton Electric
   2. Austin
   3. Curlee Manufacturing Co.
   4. Crouse-Hinds
   5. Hoffman
   6. Keystone
   7. OZ/Gedney

2.06 OUTLET BOXES

A. All outlet boxes shall be malleable iron or PVC coated and shall match the conduit type.

B. Outlet boxes in interior areas, installed concealed, shall be galvanized, pressed steel, knockout type, punched, or partially punched.

C. Each outlet box shall be suitable for the structural conditions with the size determined by the number of conduits entering, and the devices or fixture attached and as required by the manufacturer. All outlet boxes shall be in accordance with UL 514 for normal application and UL 886 for applications in hazardous locations.

D. Manufacturers:
   1. Appleton Electric
   2. Killark Electric
   3. Raco
   4. Steel Owner
   5. Robroy Industries
   6. Perma Cote Industries
   7. Arnco Corp.
   8. Aeroquip Corp.

2.07 EXPANSION JOINTS

A. The Contractor shall furnish and install expansion fittings and bonding jumpers for metallic conduit system where conduit crosses each building expansion joint, at each straight uninterrupted run of surface mounted conduit, and each vertical riser in excess of 100 feet, and where conduit transfers between structurally independent pipes, poles or supports. The distance between fittings as installed shall not exceed 200 linear feet.

B. Expansion fittings shall provide for 8 inch movement and shall include bonding jumpers.

C. Manufacturers:
   1. Appleton Electric Type XJ with XJB jumpers
   2. Crouse-Hinds, O.Z./Gedney
   3. Robroy Industries
   4. Perma Cote Industries
   5. Arnco Corp.
   6. Aeroquip Corp.

PART 3 EXECUTION

3.01 CONDUIT INSTALLATION

A. General.
   1. The conduit system shall be installed complete with all accessories, fittings, and boxes, in an approved and workmanlike manner to provide proper raceways for electrical conductors.

2. All conduit runs shown on the Drawings are shown diagrammatically for the purpose of outlining the general method of routing the conduits. It shall be the Contractor's responsibility to avoid interferences.
3. All conduit shall be new unless otherwise indicated on the Drawings. Conduit systems shall be installed complete with all accessories, fittings, boxes, cabinets, etc., and shall be run concealed or exposed as shown.
4. Exposed conduit runs shall be installed true, plumb, parallel with or at right angles to adjacent structural members, and shall present an orderly, neat, and workmanlike appearance.
5. Field bends shall be carefully made to prevent conduit damage or reduction in internal areas. Field bends shall be made with proper tools for the size and type of conduit being used. The bending radius shall be not less than six times the nominal diameter of the conduit or shall not be less than minimum cable bending radius, whichever is greater. Carefully matched bends on parallel runs shall be done to present a neat appearance. The number of crossovers shall be kept to a minimum.
6. Each conduit cut on the job shall be carefully reamed after threading, to remove burrs. All field cut threads shall be tapered. Running threads will **not** be permitted. All field cut threads on steel conduit shall be given a coat of zinc dust in oil, or other approved compound.
7. All threaded joints shall be watertight and ensure a low resistance ground path in the conduit system.
8. All conduits shall be carefully cleaned before and after installation and all inside surfaces shall be free of imperfections likely to injure the cable. After installation of complete runs, all conduits shall be snaked with an approved tube cleaner equipped with an approved cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Any conduits through which the mandrel will not pass shall be removed and replaced. After snaking, the ends of the dead-ended conduits shall be protected with standard malleable metal caps to prevent the entrance of water or other foreign matter.
9. Lines of nylon or polypropylene, propelled by carbon dioxide or compressed air, shall be used to snake or pull wire and cable into conduits. Flat steel tapes or sparks tapes may be used where RGS conduit runs are shorter than 50 feet. Steel cables will **not** be acceptable.
10. Where conduits are connected to boxes or equipment enclosures, drilled holes or full size knockout openings shall provide electrical continuity for grounding and shall be assured by the use of bonding type locknuts. Where connections are at concentric knockouts, jumper type grounding bushings and wire jumpers shall be installed.
11. At pull and junction boxes that have any box dimension in excess of 18 inches and having a total of more than four conduit terminations, jumper-type grounding bushings shall be installed on conduit ends and jumper wires shall be installed to bond all conduits and to bond conduits to boxes.
12. Conduit bends which are crushed or deformed in any way shall **not** be installed.
13. Conduit systems shall be installed, with fittings, double locknuts and bushings, and made up tight to insure ground continuity throughout the system.
14. Conduit connections to NEMA Type 3R, NEMA Type 4, and NEMA Type 4X enclosures shall terminate in a threaded hub, that matches the conduit type, with an insulated throat to provide a positive seal, an electrical ground and a water tight connection.

15. All conduit shall be installed at least six inches away from all high temperature sources such as piping, ducts, and equipment surfaces, except at connections to equipment.
16. Hub manufacturers:
    a. Meyers
    b. OZ/Gedney Type CH-T
    c. Killark
    d. Robroy Industries
    e. Perma Cote Industries
    f. Arnco Corp.
    g. Aeroquip Corp.

B. As far as practicable, conduit shall be pitched slightly to drain to the outlet boxes, or otherwise installed to avoid trapping of condensate. Where necessary to secure drainage, a breather-drain fitting shall be installed in the boxes or tapped conduit at low points.

C. Breather drain fitting manufactures:
    1. Crouse-Hinds Co.
    2. Appleton Electric Co.
    3. Killark

D. Conduits shall **not** be run through columns or beams unless so specifically detailed on the installation drawings.

E. Conduits Installed In Concrete Floor Slab or Under the Floor Slab
    1. Where installed in concrete slab, the conduit shall be placed in the center of slab and no closer than 3 diameters from adjacent conduits. The maximum outside diameter of conduits in slab shall be no greater than one third of slab thickness. The conduit shall be installed in the middle one third of the slab.
    2. Joints for conduit installed in concrete slabs shall be made watertight. Taped joints will **not** be acceptable for this purpose.
    3. Conduit openings shall be temporarily plugged with metal caps to exclude water, concrete, plaster, and other foreign material.
    4. Conduits run below any floor slab shall be entirely encased in steel reinforced concrete with a minimum thickness of five inches from outside of concrete and with a minimum thickness of three inches between the outer surfaces of adjacent conduits. In no case shall conduit be laid in fill below slab.
    5. Conduits embedded in concrete shall be blocked and braced in place by use of adequate conduit separators to prevent displacement during the placing of concrete. The Contractor shall be held responsible for proper position of conduits and shall rearrange any conduit that may be displaced while concrete is placed.
    6. Conduits run in floor slabs or underground shall be a minimum of one inch in size, and as shown on the Drawings.

F. The number of 90 degree bends shall be limited to 3 or a total of 270 degrees including all off-sets, sweeps, kicks, etc. This shall be between panelboards, switchboards, pull boxes, outlet boxes, fittings, or between outlet to fitting including bends located immediately adjacent to outlet or fittings. The maximum run without pull boxes shall **not** exceed 200 feet.

G. Conduits crossing building expansion joints shall be provided with expansion fittings and flexible grounding bonds bypassing the fittings to insure ground continuity.

H. All wiring systems shall be "pullable" the use of "BX" Type "AC" cable and Type "MC" cable will **not** be acceptable.

I. The Contractor shall be aware that the conduits are sized for cables routed in exposed rigid steel conduits, as shown on the Drawings. The same cables may be partly routed in duct banks. The duct banks shall be sized as shown on the Drawings.

J. Conduits entering switchgear, switchboards, motor control center conduit compartments, free standing panels, and free standing control cubicles shall be fitted with jumper type insulated grounding bushings, bonded together and to the structure of the enclosure by a continuous bonding wire.

K. Conduits and concrete type boxes, masonry boxes, and other flush mounted boxes shall be installed concealed in masonry walls, plaster walls, dry wall and concrete walls.

L. All concealed conduits shall be placed in walls, floors, ceilings, or underground duct banks at the proper time, in accordance with the progress of the structural work.

M. Concrete encased conduit runs extending through structural expansion joints shall have fittings permitting longitudinal and lateral movement of the conduit ends without damaging the contained wires. The fittings shall be watertight and include a grounding bond.

N. Conduit runs that enter the building from outdoors are subject to moisture accumulation due to condensation. A pull box shall be provided in the conduit run near the point of temperature change, to prevent trapping of moisture within the conduit system. A 1/4 inch hole shall be drilled in the bottom of the pull box. After the wires and cables are installed, the end of the conduit continuing into the warmer area shall be packed with a non-setting sealing compound.

O. All communication, conduits shall have a minimum separation of 12 inches from any AC power and control conduits.

P. Trenches shall be kept free from water. Conduits placed for duct banks shall **not** be laid when conditions of the trench are unsuitable for such work, or the weather will prevent quality work.

Q. When work is not in progress, open ends of conduit and fittings shall be securely closed so that no water, earth or other substance will enter. The Contractor shall use threaded caps, plugs, and rubber duct plugs made with wing-nuts or bolts to squeeze the rubber between the steel plates to seal against the inside of the conduit.

3.02 CONDUIT CONNECTIONS TO EQUIPMENT

A. The conduit system shall be terminated at the conduit connection points of electric motors, devices, and equipment. Terminations of conduits at such locations shall permit direct wire connections to the motors, electrical devices, or other equipment.

B. Conduit connections shall be made with rigid conduit if the equipment is fixed and not subject to adjustment, mechanical movement, or vibration. Rigid conduit connections shall have union fittings, to permit removal of equipment without cutting or breaking the conduit.

C. Conduit connections shall be made with approved flexible metallic conduit if the equipment is subject to adjustment, mechanical movement, or vibration. Flexible conduit connections shall be watertight.

3.03 OUTLET BOX INSTALLATION

A. Outlet boxes shall generally be 4 inches square or octagonal except as follows:
   1. In masonry walls, where conduit is installed concealed, each outlet box shall be square cut masonry boxes.
   2. In concrete walls and floor slabs, where conduit is installed concealed, boxes shall be suitable and constructed for installation in concrete.
   3. In exposed work, surface outlet boxes shall be used for switches and receptacles. The NEMA Type shall be as described in this Specification SECTION.
   4. Outlet boxes for use with rigid conduit shall be of the threaded hub, malleable iron cast metal type, with malleable iron cast covers and gaskets.
   5. In finished plaster walls, drywall, etc., raised device covers on outlet boxes shall be provided.
   6. Where 1 1/4 inch conduit is required, the box size shall be a minimum of 4 11/16 inches square.

B. Proper covers on boxes mounted flush shall be provided.

C. All ceiling outlets shall have adequate supports and shall be equipped with adequate devices to carry and mount the light fixtures provided fixtures do not weigh more than five pounds.

D. An outlet box shall be provided at each location requiring one.
   1. Outlet box locations as shown on the Drawings shall be considered as approximate only.
   2. Exact locations shall be determined from the Drawings or from field instructions. The Contractor shall coordinate box locations with the work of other trades.
   3. Each outlet box shall be installed true and plumb, so that the covers or plates shall be level, and at uniform elevations for the type of outlets contained.
   4. A plaster ring shall be installed for each outlet to provide horizontal mounting of each outlet.
   5. Each outlet box shall be supported independently from the conduit system.
   6. Boxes for toggle switches and pilot lights at doorways shall be located at the strike side of the door.

E. There shall be no more openings made in any box than are required for the conduits entering same. Depths of boxes shall be such as to allow for easy wire pulling and proper installation of wiring devices. Where extra openings occur, proper closures shall be installed.

F. Switches and receptacles shall be ganged in a common box only as indicated on the Drawings.

G. Device Boxes
   1. Recessed ceiling fixtures shall have 4 inch square sheet steel box with cover and suitable hanger bar. The box shall be secured to the ceiling suspension members not more than one foot from the fixture opening.
   2. Surface mounted ceiling fixtures, for plaster of dry wall ceilings, shall have 4 inch sheet steel octagon box with round opening plaster ring and suitable hanger bar with 3/8 inch fixture stud. Box shall be secured to ceiling suspension members.
   3. Fixtures which weigh more than five pounds shall be supported independently of the outlet box.
   4. Surface mounted wall bracket fixtures (concealed conduit) shall have 4 inch square sheet steel box with plaster rings as required for the fixture.
   5. Ceiling outlets and wall bracket outlets (exposed conduit) in dry locations shall have 4 inch steel octagon box with 3/8 inch fixture stud.
   6. Outlet boxes on exposed conduit run in wet or damp locations shall have 4 inch cast box with threaded hubs and gasketed covers.
   7. Wall switch and receptacle boxes installed in tiled or plastered wall shall have 4 inch square sheet steel boxes or multigang boxes with proper tile or plaster ring as required. Two gang may be provided by means of 4 inch square box with two gang tile or plaster ring.
   8. Wall switch and receptacle boxes in dry locations in brick walls, unfinished walls, etc., shall have single or multigang 4 inch square sheet steel boxes.

H. Plaster rings shall have threaded ears and shall be of suitable depth for the application.

I. The Contractor shall provide boxes with metal barriers, baffles or separators for grouping of dissimilar conductors or system separation.

3.04 PULL BOX AND JUNCTION BOX INSTALLATION

A. Pull boxes and junction boxes shall be installed where shown and where necessary to insure that finished cable shall not be damaged.

B. Pull boxes and junction boxes shall be supported independently from the conduit system.

C. The Contractor shall add pull boxes where needed even though not shown on the drawings.

3.05 HAZARDOUS AREAS

A. Hazardous areas shall be as defined in NFPA 820, Chapter 4 Collection System Table 4.2., NEC-Area Electrical Classification

B. The installation shall conform to the requirements of NFPA 70 for the Class, Division, and Group.

C. Explosion proof fittings shall be provided for all conduits within hazardous areas. There shall be no union, coupling, box, or fitting in the conduit between the sealing fitting and the point at which the conduit leaves the hazardous area.

3.06 ELECTRICAL HARDWARE INSTALLATION

A. Locations
1. Anchor bolts, sleeves, inserts, hangers and supports required for the Work shall be furnished and installed by the Contractor.
2. Any expense resulting from improper location or installation shall be paid for by the Contractor at no additional cost to the Owner.

B. Conduit Supports
1. Exposed conduits shall be supported in an approved manner. Conduits shall not be fastened to or come in contact with any mechanical system pipes, ducts, or equipment of other trades, except as approved by the Engineer. In all exposed conduit work, approved channel, racks, one-hole straps, or a combination thereof shall be used as supports.
2. Where conduits are supported with one-hole straps, spacers shall be used to provide 1/4 inch minimum clearance between the conduits and supporting surfaces.
3. All hangers, racks, and straps shall be hot-dipped galvanized steel for RGS type conduits, unless otherwise noted.
4. All hangers, racks, rods, straps and mounting hardware shall be PVC coated hot dipped galvanized steel for PVC coated RGS type conduits.
5. Nuts, bolts and washers are to be stainless steel for PVC coated RGS type conduits.
6. Perforated strap hangers are **not** acceptable.
7. Hanger rods for trapeze type hangers shall be made from high tensile strength carbon steel not less than 1/2-inch diameter. The rods shall have free-running, burr-free Unified National Coarse threads, with an electro-galvanized finish. Conduit support spacing shall not exceed 5 feet, or as approved by the Engineer due to specific job site conditions. The bottom of the rods to not extend less than ½" or more than ¾" below the bottom nut.
8. Conduits shall be securely fastened to each support with U-bolts, straps, or clamps. Manufacturers for conduit supports are to be B-Line, OZ/Gedney, or Unistrut Corp. Support spacing shall be held to concrete walls and ceilings by fasteners or electro-galvanized steel inserts.
9. Powder driven fasteners are **not** acceptable.
10. Conduit support manufacturers are to be B-Line, Power Strut, or Unistrut Corp.
11. Vertical conduits shall be supported by heavy wrought iron clamps or collars anchored in construction at each floor.

C. Hangers
1. Provide adequate supports for all equipment, either suspended from the construction above, or by means of struts to the construction below.

2. Provide straps, clamps, threaded rods, turnbuckles and anchors and all miscellaneous specialties for the attachment of hangers and supports to the structure.
3. Conduit hangers for single conduit threaded rod supports shall be a maximum of 7 feet long. Threaded rod supports shall be sized in accordance with the hanger manufacturer's requirements. The minimum size threaded rod support shall be 1/2 inch.

D. Sleeves
1. Provide sleeves where conduits pass through walls, floors, partitions as required by the Drawings, and/or as directed by the Engineer.
2. Sleeves shall be 18 gauge galvanized sheet metal or plastic, as approved by code, of sufficient length to finish flush with finished surfaces at both ends of sleeves.
3. Sleeves shall be not less than 1 inch larger than outside diameter of conduit.
4. Floor sleeves shall be galvanized steel or plastic pipe, as approved by Code, shall be of sufficient length to finish flush with the top and bottom of the floor, and shall be watertight.
5. Sleeves through floors, walls, and ceilings shall have the net openings packed with glass fiber insulation. Each sleeve shall be fire sealed to match the fire rating of the structure they penetrate. Both ends of the sleeves shall be caulked with waterproof mastic to prevent noise, dirt, air, and water transmission.
6. Where conduits pass through floors on grade or exterior walls, the Contractor shall caulk sleeves with non-hardening sealant at both ends to insure waterproofing around the conduit.
7. Sleeves shall be set true to line level plumb and position and shall be so maintained during construction. Where sleeve is provided in poured concrete, the Contractor shall inspect same during and after concrete is poured to insure proper position and to correct any deviation.
8. Where conduit and equipment is to be suspended from poured concrete construction, the Contractor shall provide approved concrete inserts in the form work. Expansion shells may be used on precast concrete members but not closer than 2 inches from the edge.
9. Where conduit passes through walls or floors which are below grade, the Contractor shall provide watertight sealing fittings.
10. Watertight sealing fitting Manufacturers:
    a. OZ/Gedney Type CSMI

E. After completion of the electrical installations, the entire system shall be thoroughly cleaned to remove all foreign materials from the conduits, boxes and enclosures, equipment, lighting fixtures, light standards, panels, cords, etc.

F. The word “cleaned” shall mean the thorough removal of, but not limited to, dust, dirt, oil, grease, cement, plaster, welding spatters and paint spatters.

G. All cleaning agents and methods shall be in accordance with the electrical equipment manufacturers' recommendations and subject to approval of the Engineer.

3.07 ALTERATION

A. Various signal, communications, and other services shall remain in service to provide continuous operation for the Owner's functions. No interruptions of any services will be allowed without written approval from the Engineer.

B. The Contractor shall remove or reroute, branch circuits, and other wiring as required by the alterations or as shown on the Drawings.

C. All electrical conduit penetrations through the existing walls and slabs shall be sealed watertight. All conduit penetrations through the existing walls and slabs shall be core drilled.

D. Prior to core drilling openings, the Contractor shall locate all existing reinforcing bars by non-destructive means or by chipping concrete to face of bars in area where new holes will be cored. The Contractor shall **not** cut existing reinforcing bars when coring holes for new conduits. Damage to the existing surface, from drilling or chipping, will be repaired to match existing surface.

E. All conduit penetrations, size and locations, through existing walls and slabs are shown on the Drawings. Where not shown, submit proposed locations to the Engineer. All new openings for electrical conduits, whether shown or not shown, but required by the other trades to execute their work, shall be submitted to the Engineer for review and approval prior to cutting any openings in the existing slabs and walls. Any changes or modification required by the Contractor or the Engineer shall be at no additional cost to the Owner.

F. The Contractor shall **not** core through any existing beams or columns.

G. Conduit and fittings used to extend an existing raceway shall match the existing raceway.

END OF SECTION

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SECTION 16120

WIRE AND CABLE – 600 VOLTS AND BELOW

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. 600 Volt and below wire and cable
   2. Tape
   3. Wire pulling lubricant

B. Related Sections:
   1. Section 16050 – Basic Electrical Materials And Methods.

1.02 REFERENCES

A. American Society for Testing Materials (ASTM):
   1. ASTM B8 – Specification for concentric-lay-stranded copper conductors, hard, medium hard, or soft.

B. Institute of Electrical and Electronic Engineers (IEEE):
   1. IEEE 383 – Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.

C. National Electrical Manufacturer's Association (NEMA):
   1. WC 7 – Cross Linked Thermosetting Polyethylene Wire and Cable.
   2. WC 26 – Packaging of Wire and cable

D. National Fire Protection Association (NFPA):
   1. NFPA 70 – National Electrical Code (NEC).

E. Underwriter's Laboratories, Inc. (UL):
   1. UL 44 – Rubber-Insulated Wires and Cables.
   2. UL 1581 – Electrical Wires, Cables, and Flexible Cords.

1.03 SUBMITTALS

A. Make all submittals in accordance with Section 16050.

B. Testing Agency/Quality Verification: Provide with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the Owner and the Engineer.

C. Product Data and Catalog Cuts: Provide product data for all products provided; indicate clearly the usage of each product.
   1. All wires and cables.
   2. All lugs.

3. All connectors.
4. Tools used to crimp connectors.
5. Tapes.
6. Pulling lubricant.

D. Tension Calculations:
1. Submit Tension Cable Pulling calculations for all underground power runs. Calculations shall include both pull load and tensions, along with safety factors, for all cables.
2. Design conduit runs so as not to exceed tension limits of manufacturer. Provide additional pulling points as required to limit the tension.

E. Project Record Documents: Record actual installed elevation and locations of grounding cables and rods both concealed and exposed work on the record drawings as specified in Section 16050.

F. Project Closeout: Submit record drawings and include all product data with Installation and Maintenance Manuals submitted with project closeout in accordance with Section 16050.

1.04 QUALITY ASSURANCE

A. Unless products meeting the requirements of nationally recognized testing laboratories are not readily available for a category of products, provide products that are listed and labeled by Underwriters Laboratory (UL), approved by Factory Mutual (FM), or certified as meeting the standards of Underwriters Laboratory by the Electrical Testing Laboratory (ETL).

1.05 DELIVERY, STORAGE AND HANDLING

A. Protect items from damage during delivery, storage and handling in accordance with Section 16050 and as detailed below.

B. Package all wire and cable to conform to NEMA WC-26.

C. Store all products indoors on blocking or pallets.

PART 2 PRODUCTS

2.01 GENERAL

A. Wire and cable shall be soft copper, properly refined, and shall have minimum conductivity of 98 percent. Aluminum conductors are not acceptable.
1. Conductors for power and lighting shall have 600 volt type insulation, shall be not less than Number 12 AWG, shall conform to the latest NEC and shall bear Underwriters' Laboratory label.
2. Wire for signal and control systems shall be stranded Number 14 AWG, unless otherwise indicated on the Drawings or in other Specification SECTIONS.

B. Wire and cable shall have factory color-coded insulation and shall be installed and connected as follows:

1. Color coding shall be in accordance with the latest NEC.
2. Green shall be used for grounding only.

C. The insulation shall be applied tightly to the conductor and shall be free stripping.

D. Branch circuit wiring shall be minimum Number 12 AWG.

E. All wire shall be stranded copper.

F. Type THHN thermo-plastic insulated, 90-degree C dry rated shall be used for interior locations only.

G. Type THWN thermo-plastic insulated, 75-degree C wet rated shall be used for interior and exterior locations.

H. Type XHHW, 600 volt rated insulation, shall be used for exterior wet locations.

I. If any of the cable types are modified by the Drawings, the Drawings shall be followed.

J. Ground cable shall be soft drawn, annealed, stranded copper with green insulation in required sizes and quantities for all equipment grounding and grounding grid systems.

K. Wire types for the specialty systems such as communications shall be in accordance with the requirements in those Specification Sections. The cable insulation shall be 600 volt rated.

L. The 600 Volt insulated wires and cables shall be factory tested prior to shipment in accordance with ICEA standards for the insulation specified.

M. Samples and reports on the results of shop tests for all wire and cables, descriptive literature for splices and terminations shall be submitted to the Engineer.

N. Manufacturers of 600 volt rated cable are to be American Insulated Wire Corp., Dearborn Wire and Cable, Okonite, or Pirelli.

O. Shielded Twisted Pair (TSP) Instrumentation Cable 2/C Cable:
   1. Provide cable which meets the following:
      a. Cable fabricated using stranded (19 x 29 AWG) tin-coated copper conductors with polyethylene insulation, color coded conductor insulation and overall PVC jacket.
      b. Cable 100 percent shielded, utilizing aluminum-polyester foil, incorporating a #18 AWG stranded tinned copper drain wire.
      c. Cable NEC Class CL2 and passing the CSA Vertical Flame Test FT 1.
      d. Cable UL (recognized) Style 20253 having a 600 volt insulation and 90 degree C temperature rating, two-conductor, twisted pair, #16 AWG.
   2. Acceptable Manufacturers:
      a. Belden Corporation #8719.

2.02 CONNECTORS

A. Compression connectors shall be long barrel, tin plated copper, closed end compression type. All connectors shall be tin-plated copper. The barrel for each cable lug shall be sized for the exact cable size specified. Copper-Aluminum connectors are not acceptable.

B. Mechanical or set screw types are not acceptable. The cables shall be terminated with the die type compression tools.

C. Conductors Number 2 AWG and larger shall terminate in two hole solderless lugs.

D. Conductors Number 8 AWG through Number 3 AWG inclusive shall terminate in one hole lugs.

E. Manufacturers shall be Burndy, Panduit, or Thomas & Betts Co.

2.03 TAPE

A. Splices shall not be allowed unless approved by the Owner/Engineer. Splices, if approved, shall be made with UL approved, self-fusing jacketing tape, resistant to weather, oils, water and chemicals. The color shall be as required.

B. Manufacturers are to be 3M - Scotch 33 plus, Plymouth, or Permacel.

2.04 WIRE-PULLING LUBRICANT

A. Where necessary to use a lubricant for pulling wires, the compound shall be listed by Underwriters' Laboratories.

B. Cleaning agents or lubricants that have a deleterious effect on conductor covering shall not be used.

C. Manufacturers are to be Polywater J - High Performance Cable Lubricant, Ideal Industries, Inc., High Performance Cable Lubricant, or Anixter.

PART 3 EXECUTION

3.01 WIRING INSTALLATION

A. All cable and wire shall be installed in underground duct banks or conduit which shall be run concealed, if possible, in the walls, ceiling partitions of the building and embedded. Exposed conduits shall be installed parallel or at right angles to building walls.

B. All duct lines and conduit lines shall be swabbed to remove any debris or accumulated moisture before cables or wires are pulled in.

C. No splices will be permitted without prior written approval by Engineer. If required by Code for pull lengths, the Contractor shall submit each location for approval and shall

include the junction or terminal box points. Cable and wire runs shall be looped through pull boxes without cutting and splicing.

D. All hardware, such as cable stanchions, racks, insulators, brackets, structural supports, wall inserts, cable and junction boxes, bolts, connectors, clamps, fittings, and all other accessories for the installation of wires and cables in buildings, handholes, and outdoors shall be furnished and installed complete to provide a satisfactory operating installation.

E. Branch Circuit Wiring
   1. Where branch circuit wiring for lighting, receptacles and other single phase applications are not shown on the Drawings, the wire and cable shall be sized for a voltage drop in accordance with the National Electrical Code.
   2. The maximum voltage drop for each circuit shall be 3 percent for indoor and outdoor power and lighting circuits.
   3. The Contractor shall use multi-wire circuits utilizing separate neutrals and shall follow the color coding established. The Contractor shall size the wire in accordance with the following:
      a. Under no circumstances shall any switch break a neutral conductor.
      b. Where farthest outlet or light is less than 75 feet from the panel, Number 12 AWG wire shall be used between all outlets and for home runs.
      c. Where the farthest outlet or light is more than 75 feet from the panel, the Contractor shall submit voltage drop calculations to the Engineer, prior to sizing the wire. These calculations shall show the wire size to be installed by the Contractor.
      d. The minimum wire size shall be Number 10 AWG between the panel and the first outlet when it is more than 75 feet from the panel. The minimum wire size shall be Number 12 AWG for all other outlets or lights.

F. Conduit and wiring systems in plenum ceilings shall be installed in accordance with Code requirements.

G. Home runs for branch circuits shall not be grouped to require conduit larger than 1 inch.
   1. A home run shall be that part of a circuit between the panel and the first outlet to which a current consuming service is connected.
   2. Circuit numbers as indicated on the Drawings are intended as a guide for the proper connection to multi-wire circuits at the panels.

H. It shall be the Contractor’s responsibility to see that the circuiting work fulfills the following conditions:
   1. Loads on panel bus shall be as evenly balanced on all phases as possible as shown on the Drawings or approved by the Engineer.
   2. No neutral conductor shall be common to more than one circuit conductor connected to the same phase of the supply system.

I. Proper termination of conduits and wires at, control panels or other equipment items shall be provided.

J. In the event that conduit and wire sizes increase beyond equipment manufacturer's normal provisions for conduit and wire terminations, due to voltage drop or other

considerations in branch circuit designs, provide necessary auxiliary termination facilities, with adequate boxes, lugs, terminals, knock-outs, etc., as may be required.

K. Equipment having safety devices such as limit switches, overload relays, high-low water cut-outs, high-low pressure switches, solenoids, pilot devices, flow switches, freeze protection thermostats, etc., shall be so wired that they will always be in the control circuits of selector switches regardless of switch position.

3.02 CABLE INSTALLATION IN HANDHOLES

A. In general, splices shall not be acceptable unless approved by the Owner/Engineer.

B. Cable slack sufficient for one splice for each cable shall be left in each handhole.

C. Sufficient cable shall be left in each handhole to allow the splices to be raised 3 feet above the top of the handhole cover.

D. The cables shall be carefully formed around the interior of handholes, avoiding sharp bends or kinks.

E. All splices and cables shall be secured to cable racks using non-metallic products specifically designed and manufactured for this purpose.

F. Splices shall be a minimum of two feet from the mouth of the duct opening into the manhole or handhole, and splices in different cables shall be staggered.

G. The entire exposed length of all cables shall be arc-proofed by applying a 1/4 inch minimum thickness of arc-proofing tape. Manufactures are to be 3M No. 7700, Plymouth, or Permacel. Arc-proof tape shall be installed in accordance with manufacturer’s instructions.

3.03 CABLE INSTALLATION IN UNDERGROUND DUCTBANK AND CONDUIT

A. Cable lubricants approved by Underwriters’ Laboratories, Inc. shall be used.

B. Cables shall be installed by methods which insure against harmful stretching of the conductor, injury to the insulation, or damage to the outer protective covering and shall not exceed the cable manufacturer’s recommendations.

C. Splices or joints shall not be drawn inside ducts.

D. Where more than one cable will be installed in a duct, all shall be pulled in at the same time.

E. The ends of all cables shall be sealed with waterproof tape or with heat shrink sealing caps before pulling into ducts, and shall be left so sealed until ready for termination.

3.04 CABLE INSTALLATION IN CONDUIT

A. Cable lubricants approved by Underwriters' Laboratories, Inc., shall be used.

B. Cables shall be installed by methods which insure against harmful stretching of the conductor, injury to the insulation, or damage to the outer protective covering and shall not exceed the cable manufacturer's recommendations.

C. Splices shall not be drawn inside ducts or conduits.

D. Where more than one cable will be installed in a duct or conduit, all shall be pulled in at the same time.

E. The ends of all cables shall be sealed with water proof tape or with heat shrink sealing caps before pulling into conduits or ducts, and shall be left so sealed until ready for termination.

3.05 SPLICES AND TERMINATIONS - 600 VOLT CABLE

A. No splicing will be permitted unless prior approval in writing by Engineer.

B. Terminations shall be made with compression type connectors and lugs. The lug manufacturer's recommended tools shall be used. Mechanical type fittings will not be acceptable. Lugs shall be one or two hole, color keyed. Lug bolting shall include flat washer, Belleville washer, and a locknut.

C. Each cable splice shall be covered with either a cold shrink connector insulator or heat shrink connector insulator. The insulator material shall be rated for 1000 volts and shall be rated for direct burial installation.

D. All splices and pigtail connections for indoor lighting and receptacle wiring for cable sizes Number 10 AWG and smaller may be made up with pre-insulated spring connectors. Manufacturers are to be 3M Company “Scotchlock,” Ideal Industries, Inc., or Buchanan.

E. Outdoor lighting wiring for sizes Number 10 AWG and smaller may be made up with silicone filled pre-insulated spring connectors. Manufacturers are to be King Technology, Inc., Ideal Industries, Inc., or Buchanan.

F. Splices for cable sizes Number 8 AWG and larger shall be butt splice type consisting of long barrel copper only type compression connector. Each connector shall have internal cable stops and color coded for proper die size and number of crimps. Manufacturers are to be Anderson Catalog Type VHS, Burndy Catalog Type YS, or Panduit Catalog Type SCL.

G. Where a cable is cut preparatory to splicing, the Work shall proceed without delay. When an unavoidable delay is encountered in completing a splice, the opened cable shall be protected to prevent the entrance of moisture and foreign matter.

H. The Contractor shall splice control cables with the splice kits and materials in accordance with manufacturer's instructions. A power cable splice kit or resin splice kit shall not be used to make a control cable splice, under any conditions.

I. Shielded Cable Grounding

1. Shielded control cables shall have the shields grounded at one end. The shield shall be insulated from the conductors, equal to that of the original cable insulation, at each splice.
2. Coaxial cable shields shall be insulated from ground throughout the length of the cable run. The shields shall be grounded at, and only at, the coaxial connector terminating in the equipment on each end of the cable run.

3.06 WIRING METHODS

A. All remote mounted devices such as control stations, limit switches, or pressure switches in a common circuit shall have their wires brought back to the terminals on one panel.

B. Where the control cables are not shown on the Drawings, the Contractor shall provide control cables with the number of conductors in each control cable to be such that at least one spare conductor shall be available for up to five conductors in use, two spare conductors shall be available for 6 to 10 conductors in use, and 20 percent shall be available for more than 10 conductors in use. The spare conductors are only required between major electrical equipment. The spares are to be labeled and terminated at both ends on spare terminals.

END OF SECTION

SECTION 16440

MOTOR CONTROL CENTERS (PREPURCHASE)

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The general requirements for motor control centers including vertical sections, main breaker or main lugs, power monitor, surge protective device, circuit breakers, RVSS, relays, selector switches, push buttons, pilot lights, control transformers and special controls as shown on the Drawings and specified herein.

B. Products Installed But Not Furnished Under This Section
   1. The Owner has prepurchase a Square D MCC along with field services for the project. Coordinate manufacture's field services after installation and wiring of the MCC with the Manufacturer and Owner.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM D178 - Specification for Rubber Insulating Mat.

B. National Electric Manufacturer's Association (NEMA):
   1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case.
   2. NEMA ICS 1 - Industrial Control and Systems - General Requirements.
   3. NEMA ICS 2 - Industrial Control and Systems - Controller, Contractors, and Overload Relays.
   4. NEMA ICS 2.3 - Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Center.
   5. NEMA ICS 3 - Industrial Control and Systems - Factory Built Assemblies.
   6. NEMA ICS 4 - Industrial Control and Systems - Terminal Blocks.
   7. NEMA ICS 5 - Industrial Control and Systems - Control Circuit and Pilot Devices.
   8. NEMA ICS 6 - Industrial Control and Systems - Enclosures.
   9. NEMA ST 1 - Specialty Transformers.
   10. NEMA ST 20 - Dry Type Transformers for General Application.
   11. NEMA FU 1 - Low Voltage Cartridge Fuses.
   12. NEMA Standard 250 - Enclosures for Electrical Equipment.

C. Underwriter's Laboratories, Inc. (UL):
   1. UL 845 - Motor Control Centers.

D. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC).

1.03 SUBMITTALS

A. Product Data
   1. Submit Product Data, including catalog cuts, for all products provided.
      a. Clearly indicate the usage of each product on each submittal. Include electrical rating of products.

B. Shop Drawings:
   1. Shop drawings shall be complete in all respects and shall indicate all dimensions, installation methods, size, weight, capacity, ratings, integral controls and types of materials, elevations, and sections. Shop drawings shall include manufacturer's literature and complete information on the following:
      a. Freestanding Vertical Sections
      b. Main Circuit Breakers
      c. Power Monitors
      d. Surge Protective Devices
      e. Thermal-Magnetic Type Circuit Breakers
      f. Motor Circuit Protector Type Circuit Breakers
      g. Magnetic Across-the-Line Motor Starters
      h. Solid State Reduced Voltage Starters
      i. Control Transformers
      j. Relays
      k. Selector Switches
      l. Push Buttons
      m. Pilot Lights
      n. Special Controls
      o. Engineered Control Diagrams and Connection Diagrams
      p. Nameplate Schedules
   2. Wiring Diagrams: Submit wiring diagrams for electrical apparatus showing numbered wiring terminals where applicable. In addition, submission to contain detailed single line diagrams and assembly wiring diagrams. Submit control diagrams indicating control devices mounted in motor control centers, interconnecting wiring, and remote control devices, if any. In addition, submission to contain detailed single-line diagrams.
   3. Manuals: Submit Installation and Maintenance Manuals (I & M) for each motor control center.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and equipment in a clean condition.

B. Provide packaging that plugs, caps, or otherwise seals openings both during shipping and temporary storage.

C. Provide details on the equipment needed for unloading operations.

D. If possible, clearly identify pick-points or lift-points on electrical equipment crating and packaging.

E. In the absence pick-points or lift-points on equipment crating and packaging, identify pick-points or lift-points on the equipment itself.

1.05 WARRANTY

A. Warranty equipment for 30 months after shipment (date of invoice). Warranty against defects of design, workmanship, material and operation of equipment.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. The motor control centers shall be Square D Model 6, Allen-Bradley Centerline 2100 or an equivalent.

2.02 MATERIALS

A. Motor Control Center Structure and Configuration:
   1. The Motor Control Centers shall be NEMA Type 1, gasketed. Wiring shall be NEMA Class 1, Type B. Each motor control center shall have a main breaker, or main lugs, as indicated on the Drawings to feed the horizontal bus. Provide lugs of adequate size to terminate incoming cables. Each motor control center shall be furnished with a ground bus, and a neutral termination pad or a neutral bus, as indicated on the Drawings.
   2. The motor control center shall be rated at 480 volts, 3 phase, 4 wire, 60 Hz and shall be braced to withstand a short circuit current of 65,000 rms symmetrical amperes.
   3. Motor starter units shall be combination type with a molded case circuit breaker. Control voltage for units shall be 120 volts.
   4. The motor control center shall consist of vertical sections bolted together to form a rigid, freestanding assembly.
   5. Vertical sections shall be formed of 13 gauge hot rolled steel with uniform blemish-free surfaces. Top and bottom structural parts shall be 10 gauge. End closing plates shall be 12 gauge, and unit parts and doors shall be 14 gauge. Base channels shall be provided constructed of rugged steel to easily withstand the stress of transit and moving the control center into position. Bolt holes in the base channels shall be provided in all sections for the purpose of bolting the control center to the floor. Steel removable lifting angles shall be provided on the top of the sections for convenience in handling the control center.
   6. Each section, to comply with standards of NEMA, shall be approximately 90" high excluding lifting angles and base channels. It shall be 20" deep by 20" to 35" wide, as indicated on the Drawings.
   7. End sections shall have end-closing plates, which can be removed for the addition of future sections. The top plate shall be of a removable one-piece construction for added convenience in cutting conduit holes. Removable blank plates flanged on all 4 sides and having captive screws shall cover all unused unit spaces.

B. Main Circuit Breaker:
   1. Main circuit breaker shall be thermal magnetic molded case type, individually mounted and identified. Main circuit breaker shall have quick-make, quick-break mechanism and shall visually indicate whether the breaker is closed, open or tripped.
   2. The main breaker shall have sufficient interrupting capacity to properly close against and interrupt instantaneously, without damage, the maximum short circuit current available at the breaker. Minimum interrupting capacity shall be 65,000 amperes symmetrical at 480 volts.

C. Main Lugs Compartment:
   1. A front accessible main lugs compartment shall be provided in motor control centers were indicated on the Drawings. The main lugs shall be sized to terminate the incoming cables.

D. Power Monitor:

1. Provide a power monitor in motor control centers were indicated on the Drawings to provide complete electrical metering. The power monitor shall be microprocessor based and shall be furnished complete with current transformers. The power monitor shall be Allen-Bradley PM 5000, or equal by Square D.
2. The power monitor shall be furnished with an alarm contact for remote indication of a power failure. This contact shall be wired to terminals in the MCC cubicle for wiring to the control system.
3. The power monitor shall output a 4-20mA analog signal proportional to KW to the control system. The KW signal shall be wired to terminals in the MCC cubicle for wiring to the plant PLC System.

E. Transient Voltage Surge Suppressor:
1. A transient voltage surge suppressor shall be furnished in motor control centers were indicated on the Drawings. The surge suppressor shall be UL 1449 Second Edition Listed (1998). Unit shall protect all modes (L-L, L-N, L-G, N-G) applicable. Unit shall have 240kA of surge capacity per phase with a let-thru voltage of less than 1500V L-L and 700V L-G. A disconnecting means shall be provided ahead of the surge suppressor so the unit can be serviced without de-energizing the service.
2. Surge suppressor shall have AC tracking filter with EMI/RFI filtering. Each module shall be fused individually, thermally protected, and have LED indication.
3. The surge suppressor shall be furnished with a dry alarm contact to indicate a failure of any module. The alarm contact shall be wired to terminals in the MCC cubicle for wiring to the plant PLC System.
4. TVSS unit shall be provided and installed by MCC manufacturer. Surge suppressor shall be APT Transient Eliminator XGA Series.

F. Horizontal Wireways:
1. Adequate conduit entrance space and wire entry room shall be provided at both the top and bottom of each section. The bottom horizontal wireway shall be 12" and the top horizontal wireway shall be 6" and both shall extend through the length and depth of the control center section with openings between sections. Covers over these wireways shall be equipped with captive type screws to prevent loss of hardware during installation. These wireways shall be isolated from the bus bars.

G. Vertical Wireways:
1. A vertical wire trough located on the right-hand side of each standard section and having a cross-sectional area of not less than 28 sq.in. shall extend from the top horizontal wire trough to the bottom horizontal wire trough for the purpose of routing user's motor and control wires to the control units. The wire trough shall be isolated from the bus bars to guard against accidental contact. A separately hinged door having captive type screws shall cover the vertical wire trough for safe and easy access to wiring without disturbing control units.
2. Wire ties shall be furnished in the vertical wire trough to group and securely hold wires in place for a neat, orderly installation.
3. Where wire access ports between unit spaces and vertical wire trough are open, shutters shall be provided to prevent items, such as a fish tape, from accidentally entering the unit space. Snap-in wire grommets shall be provided in wire access ports for size 2 units and smaller for isolation and added protection of small wires. For larger units, snap-in wire guards shall be provided for added protection of larger wires.

H. Vertical Sections:

1. Each vertical section shall be divided into compartments, each containing a combination starter or other control assembly as indicated on the Drawings. Power shall be provided to these compartments from the main bus by bus bars extending the full height of the unit. Sections shall also be provided with horizontal spaces at the top and at the bottom, which shall line up with adjacent section to form horizontal wiring raceways along the entire length of the control center.

I. Compartments:
   1. Compartments shall be built in interchangeable combinations of modular heights. A full vertical section shall contain six equal NEMA size l modular compartments exclusive of top and bottom wiring spaces. Starter compartments shall not be less than 12" high. Only l/2 and integral multiples of the basic module will be allowed. Compartments for NEMA size 4 and smaller starters shall be draw out type.
   2. Guide rails shall be provided in the structure for supporting and aligning a unit during its removal or replacement. Draw out units shall have pressure type, line disconnecting stabs of high strength alloy and shall be held in place by means of quick acting, captive machine screw fasteners arranged so the units can be removed or remounted readily without access to the rear of the structure. Each compartment whether draw out or stationary, shall be enclosed and effectively baffled to isolate any fault which may occur and shall be covered by an individual door fixed to the structure with a continuous full length piano hinge or two (three for doors over 36" high) semi-concealed, heavy-duty, pin type hinges. Doors shall be secured with captive, quick acting machine screw fasteners and shall be arranged to completely cover all live parts whether the draw out unit is present or not.

J. Bus Bars:
   1. Main horizontal bus bars rated as indicated on Drawings but not less than 600 amperes shall be provided at the top or center of the control center and extend its entire length, except when cut and supplied with splice bars to divide the control center for ease in handling or when section is indicated on Drawings to be furnished without bus.
   2. Horizontal bus bars of copper shall be mounted edge-to-edge to provide greater mechanical strength.
   3. Vertical copper bus bars shall be rated not less than 300 amperes for adequate current carrying capacity in a variety of plug-in applications.
   4. Horizontal and vertical bus bars shall be electrolytically tin-plated copper. Connections between horizontal and vertical busses shall be joined by bolts, conical spring washers for constant pressure joints and self-clinching nuts to allow joint maintenance from the front.
   5. High strength glass reinforced alkyd insulators shall be used as bus supports and as unit plug-in insulators. Bus and plug-in insulators shall be red to indicate the proximity of energized bus parts.
   6. The temperature rise, above ambient temperature outside the enclosure, of bus bars and connections shall not exceed 50°C and that of connections to insulated cable shall not exceed 45°C when operated continuously at rated current. Buswork, wiring and equipment shall be rated to withstand short circuits of 65,000 rms symmetrical amperes at 480 volts or as noted on the Drawings.
   7. A copper ground lug shall be provided in each incoming line vertical section capable of accepting a #8 to 250 MCM cable. A horizontal and vertical copper ground bus shall be provided in each section of the motor control center. Horizontal ground bus shall run continuously throughout the control center except where splits are necessary for ease of shipment and handling; in which case, splice bars shall be provided. Ground bus shall be

tin plated copper and have a cross-sectional area of equal to 28% of the main horizontal bus cross-sectional area. Horizontal ground bus shall be located at the bottom of the motor control center.

K. Bus Barriers:
1. Insulated horizontal and vertical bus barriers shall be furnished to reduce the hazard of accidental contact. These barriers shall have a red color to indicate proximity to energized busses. Vertical bus barriers shall have interlocking front and back pieces to give added protection on all sides and shall segregate the phases from each other. Small, separate openings in the vertical bus barriers shall permit unit plug-in contacts to pass through and engage the vertical bus bars.
2. Bottom bus covers shall be provided below the vertical bus to protect the ends of this bus from contact with fish tapes or other items entering the bottom of the enclosure. Unused plug-in openings shall have plastic snap-in closing plates.

L. Unit Plug-In:
1. Unit plug-in contacts shall be provided for size l through size 5 motor starters and for branch circuit breakers.
2. The plug-in connection shall be 2-point connection for each phase designed to tighten during heavy current surge. The plug-in fingers shall be tin plated to yield a low resistance connection and shall be backed by spring steel clips to provide high-pressure connection points. Contact fingers shall be mounted in their support so these fingers become floating and self-aligning to allow solid seating onto the vertical bus bars.

M. Unit Doors:
1. Each unit shall have a door securely mounted with hinges, which allow the door to swing open a minimum of 112 degrees. Unit doors shall be fastened to the stationary structure so they can be closed to cover the unit space when the units have been temporarily removed. Unit doors shall be held closed with captive type screws, which engage self-aligning cage nuts. These screws shall provide at least 2 threads of engagement to help hold unit doors closed under fault conditions. Removable door panels held captive type screws shall be provided on starter unit doors for mounting push buttons, selector switches or pilot lights. Blank door panels capable of accepting future push button devices shall be furnished when push button devices are not originally specified for starter units. Starter units shall have an external low-profile overload reset button.
2. Pilot devices and instruments, including push buttons, reset buttons, and indicating lights, shall be flush mounted in the compartment doors. Equipment shall not be mounted on the rear of draw out units. All equipment within the unit shall be arranged to provide ample electrical clearances and easy access for maintenance. Draw out combination starter unit of a given type and size shall be made interchangeable. Only those items, which are common to all starters, shall be mounted in the unit.
3. Where a spare unit is indicated on the Drawings, it shall be a complete combination starter of the type and size shown.

N. Unit Support Pan:
1. Each plug-in unit shall be supported and guided by a tilt and lift-out removable pan so unit rearrangement is easily accomplished. For easy unit installation and rearrangement, transfer of this unit support pan from one location to another shall be accomplished without the use of tools after the unit and door have been removed.

O. Unit Saddles:

1. Each plug-in unit shall have a sheet steel saddle designed to physically isolate the unit from the bus compartment and adjacent units. Saddles shall be equipped with captive, self-aligning mounting screws, which hold the unit securely in place during shipment and maintain the unit and structure at the same potential. Handholds shall be provided on each plug-in unit to facilitate unit removal.

P. Disconnect Operator:
1. A flange mounted operator handle shall be supplied for each switch or breaker. To prevent false circuit indication, this mechanism shall be engaged with the switch or breaker at all times regardless of unit door position. The operator handle shall have a conventional up-down motion with the down position as "OFF." It shall be possible to lock this handle in the "OFF" position with up to three 3/8" diameter shackle padlocks. The operator handle shall be color coded to display red in the "ON" position and black in the "OFF" position.
2. The operator handle shall be interlocked with the unit door so the disconnect cannot be switched to the "ON" position unless the unit door is closed. It shall be possible to defeat this interlock by a deliberate act of an electrician should he desire to observe the operation of the operator handle assembly. This interlock shall also prevent opening the unit door, unless the disconnect is in the "OFF" position. A defeater for this action shall also be provided in the event an electrician must gain access to the unit without interrupting the service.

Q. Starter Units:
1. Starter units shall be completely draw out Type B, sizes as indicated on the Drawings, so units may be withdrawn without disconnecting any wiring. Units over three space units high may be bolt-in type. A positive guidance system shall be provided to assure proper alignment of wedge-shaped power stabs in dead-front openings in vertical power bus. The screw racking mechanism shall serve as a mechanical advantage to the operator during unit insertion or removal. Stab-in power terminals shall be of a type that will increase contact pressure on short circuits.
2. All starter units shall be rated to withstand short circuits of 65,000 rms symmetrical amperes at 480 volts or as noted on the Drawings.

R. Thermal Magnetic Type Circuit Breakers:
1. Thermal magnetic circuit breakers shall have quick-make, quick-break mechanisms and shall visually indicate whether the breaker is closed, open or tripped.
2. All breakers shall have sufficient interrupting capacity to properly close against and interrupt instantaneously, without damage, the maximum short circuit current available at the breaker. Minimum interrupting capacity of breakers shall be 65,000 amps rms symmetrical at 480 volts.
3. Provide auxiliary contacts on the circuit breakers were indicated on the Drawings.

S. Motor Circuit Protector Type Circuit Breakers:
1. Motor circuit protector type circuit breakers shall be used for all branch circuit breakers for motor circuits. Breakers shall be instantaneous trip, magnetic only type.
2. Each breaker shall be furnished with a single magnetic trip adjustment, which simultaneously sets the magnetic trip level of all poles. Adjustment shall be continuous throughout the trip range. Minimum interrupting capacity of breakers shall be 65,000 amps rms symmetrical at 480 volts.
3. Provide auxiliary contacts on the circuit breakers were indicated on the Drawings.

T. AC Magnetic Starters - Line Voltage Type:
   1. Motor starters shall be across-the-line magnetic type, rated in accordance with NEMA standards, sizes and horsepower ratings. Starter sizes shall be as indicated on the Drawings.
   2. Across-the-line magnetic starters shall be equipped with double-break, silver alloy contacts. All contacts shall be replaceable without removing power wiring or removing starter from panel.
   3. Coils shall be of molded construction and shall operate on 120 volts AC. All coils shall be replaceable from the front without removing the starter from the panel.
   4. Overload relays shall be solid state electronic type.

U. Solid State Reduced Voltage Starters:
   1. Solid state reduced voltage starters shall provide a soft start and shall limit the current during motor starting. The solid-state starters shall have an electronic overload and a built-in bypass to bypass the SCRs when the motor is up to full speed.
   2. The solid-state starters shall have a LCD display and a keypad for programming and configuring the starter.
   3. Provide protective modules containing metal oxide varistors for each starter to protect the power components from electrical transients.

V. Electrical Interlocks:
   1. All starters shall be furnished with electrical interlocks as shown on the Drawings plus one spare normally open and one spare normally closed contact. Arrangements shall be convertible from normally open to normally closed.

W. Control Transformers:
   1. Provide a control transformer for each motor starter control circuit as indicated on the Drawings. Control transformers shall be 480 volts to 120 volts and shall have primary and secondary fusing. The primary fuses shall be Class "CC".
   2. The control transformers shall be sized as required for the load being powered.

X. Control Relays:
   1. Relays shall be heavy-duty general-purpose type with 10 amp contacts. Relays shall have terminals, which plug-in to a socket, mounted to the inside of the MCC bucket. Contact configuration shall be a minimum of 2PDT.
   2. Relay coils shall operate on 120 volts AC, unless indicated otherwise on the Drawings. Relays shall have an indicator light to indicate the relay coil is energized.

Y. Selector Switches:
   1. Selector switches shall be non-illuminated. Switches shall be 30.5 mm, heavy-duty, oil tight. Switches shall have double-break silver contacts. All switches shall be maintained contact type unless otherwise indicated on Drawings.
   2. Provide auxiliary contact blocks as indicated on the Drawings, or in the Description of Operation.

Z. Push Buttons:
   1. Push buttons shall be non-illuminated. They shall be 30.5 mm, heavy-duty, oil tight. Contacts rated for 10 amps minimum. Push buttons shall be momentary contact type unless noted otherwise on the Drawings.

AA. Pilot Lights:

1. Pilot lights shall be LED, push to test, transformer type. They shall be 30.5 mm, heavy-duty, oil tight. Voltage rating shall be 120 volts. Color caps shall be red for "run", green for “stopped/off”, white for “indication” and amber/yellow for "alarm".

BB. Legend Plates:
1. Provide an engraved legend plate for each pilot device. Engraving shall be as indicated on the Drawings.

CC. Identification:
1. A control center identification number nameplate describing section catalog numbers and characteristics shall be fastened on the vertical wire trough door of every section. Each control center unit shall have its own identification number nameplate giving unit catalog number fastened to the unit saddle near the upper left-hand corner. These nameplates shall also have suitable references to factory records for efficient communication with supplier.
2. Each control center unit shall also have an engraved Bakelite nameplate fastened to the outside of each unit door. Nameplates shall be black with white engraving.

DD. Wiring:
1. The motor control center shall be wired in accordance with NEMA class and type previously specified and shall be furnished to be interconnected with a programmable controller system.
2. All 120 VAC control wiring shall be red. All wiring in each MCC cubicle shall be labeled.
3. Quick separating, pull apart terminals shall be mounted on lift-out brackets in the units. All terminals shall be labeled.

EE. Finish:
1. All painted parts shall undergo a phosphatizing prepainting treatment for rust resistance and good paint bond. All painting shall be with enamel, which shall be baked for a durable, hard finish. Unit saddles shall be painted white for easy interior visibility. Removable push button plates, flange mounted operator handles and trim plates, and top horizontal wire trough cover plates shall be painted a contrasting charcoal gray. Other painted parts shall be painted ANSI-49 medium light gray.
2. All unpainted parts shall be plated for resistance to corrosion.

2.03 SPARE PARTS

A. Provide the following spare parts for the motor control centers:
1. One (1) relay for each type utilized
2. Ten (10) Fuses for each type and size utilized

B. Spare parts shall be packaged individually in boxes that are clearly labeled with part name and manufacturer's part/stock number.

PART 3 EXECUTION

3.01 FIELD SERVICES

A. Provide an authorized manufacturers field service technician to perform visual and mechanical inspection and electrical testing of the MCC. The work shall include the following.

1. Visual and Mechanical Inspection
   a. Document equipment nameplate data on test report. Verify that equipment nameplate ratings are in accordance with the final approved or record drawings and specifications.
   b. Inspect the physical, electrical, and mechanical condition of structure and all electrical components.
   c. Confirm that lubricants have been correctly applied at the manufacturer's recommended locations.
   d. Verify appropriate anchorage, required area clearances, physical damage, and correct alignment and cleanliness.
   e. Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
   f. Verify that fuse and/or circuit breaker sizes and types correspond to drawings and coordination study, if available, as well as to the circuit breakers address for microprocessor-communication packages.
   g. Verify that current and potential transformer ratios correspond to drawings.
   h. Use the calibrated torque wrench method to verify that the tightness of accessible bolted connections and/or cable connections are in accordance with the manufacturer's published data.
   i. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
      1) Attempt closure on locked-open devices. Attempt to open locked closed devices.
      2) Make key exchange with devices operated in off-normal positions.
   j. Inspect insulators for evidence of physical damage or contaminated surfaces.
   k. Verify correct barrier and shutter installation and operation.
   l. Exercise all active components.
   m. Verify that filters are in place and/or vents are clear.
   n. Test the operation, alignment, and penetration of instrument transformer withdrawal disconnects, current carrying and grounding.
   o. Inspect control power transformers.
      1) Inspect for physical damage, such as cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
      2) Verify that primary and secondary fuse ratings or circuit breakers match drawings.
      3) Verify that both primary and secondary tap connections are in accordance with manufacturer’s recommendations and drawings.
   p. Verify that customer connections to remote power, operators, interlocks, and indicators have been made.
2. Electrical Tests
   a. NOTE: When performing dielectric tests, disconnect all Instrument and Control Transformers, Arresters, TVSS units, and other sensitive electronic equipment that may cause erroneous results or cause damage to equipment that is not rated in accordance with the equipment standards.
   b. Verify the proper selection and operation of the electrical test equipment.
   c. Record the date of the last calibration date and the date re-calibration is due for the test equipment being used.
      1) Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground at the minimum dc test voltage appropriate for the equipment and record the resistances. If the resistance is lower than the recommended

values dry the equipment for a minimum of 4 hours using heat and fans. Then re-measure. If low readings persist after vigorous drying, determine the cause and make repairs.

2) Perform a control wiring performance test by applying control voltage. Verify that the equipment operates as intended.
3) Verify that MCC heaters operate properly.
4) Perform tests on FVNR starters, Soft Start controllers, etc.

END OF SECTION

APPENDIX A

PRE-PURCHASED MCC DOCUMENTATION

SQUARE D
by Schneider Electric

Job Name:	Otter River Water Treatment Plant Finish	Square D Quotation #:	51352543
Job Location:	LYNCHBURG, VA	Quotation Revision #:	
		Sales Contact:	
		Sales Contact Location:	
Purchaser:	FOSTER ELECTRIC CO INC	Customer:	CAMPBELL COUNTY UTILITY
Purchaser PO #:		Customer PO #:	
User:		Architect:	
User Location:		Cons. Engineer:	0
Drawing Status:	RECORD		

TABLE OF CONTENTS

SQUARE D FACTORY ORDER NUMBER:51352543-000120

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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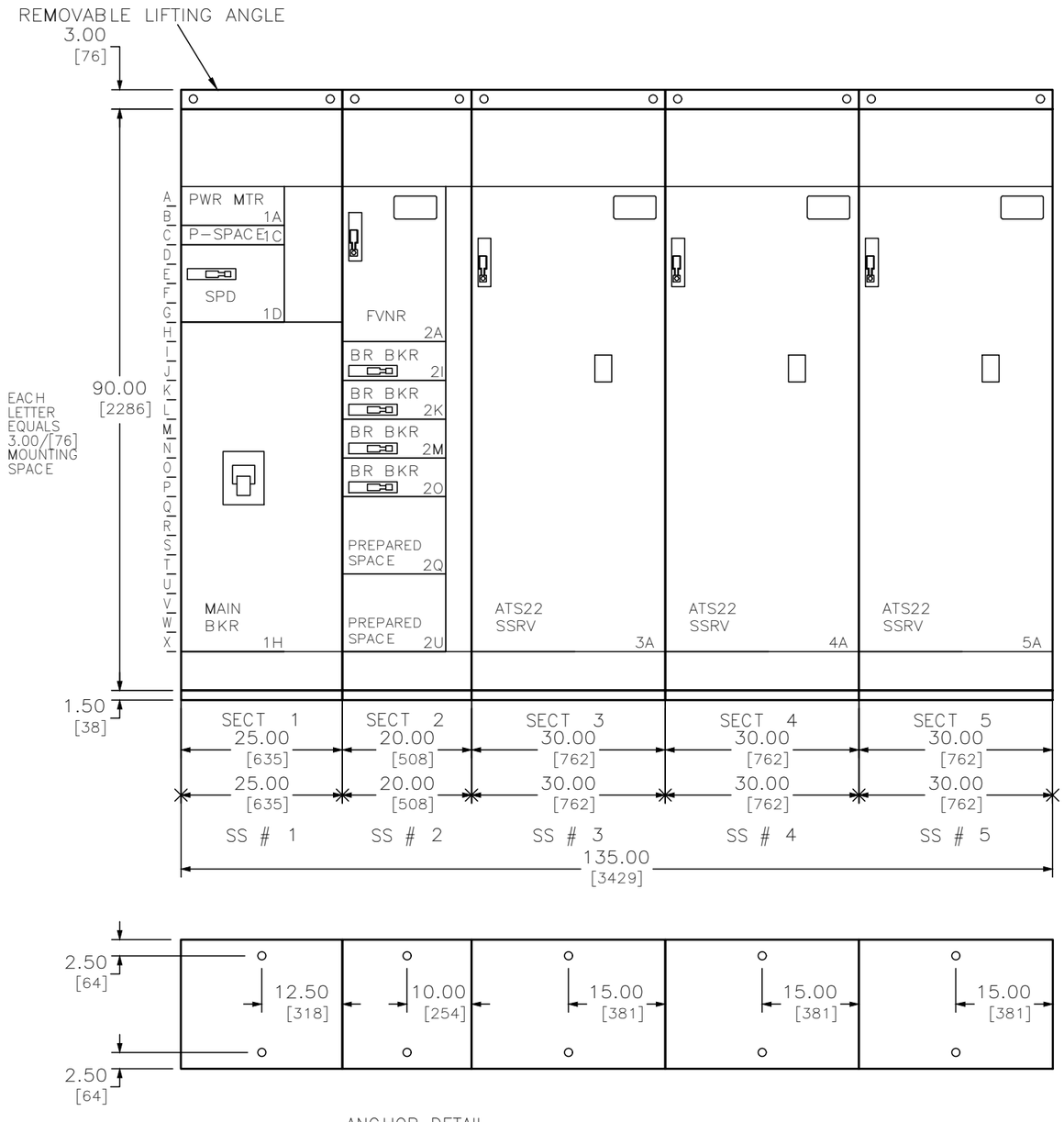

ANCHOR DETAIL

DUAL DIMENSIONS: INCHES
MILLIMETERS

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC-D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ELEVATION
ENGR:	JACOB BROWN		
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# F51352543-000120-01	PG 1 OF 3 REV –

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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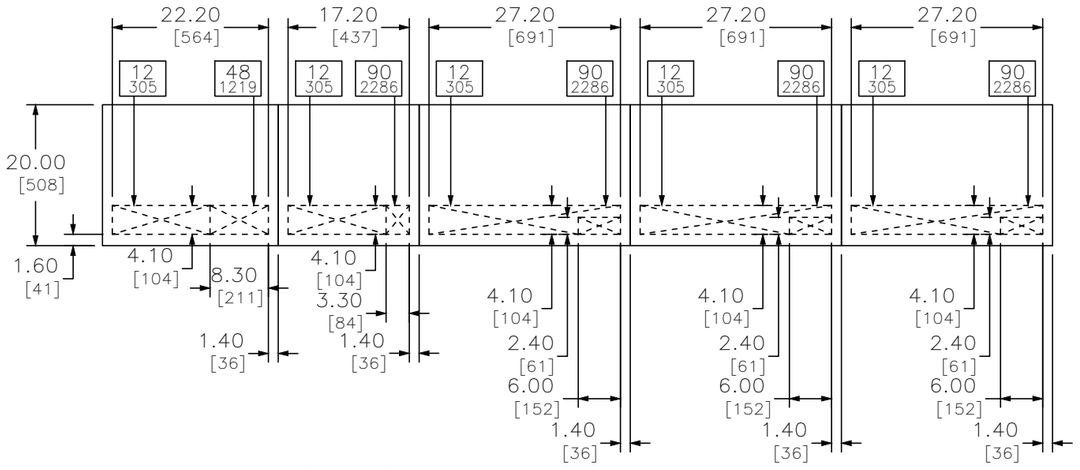
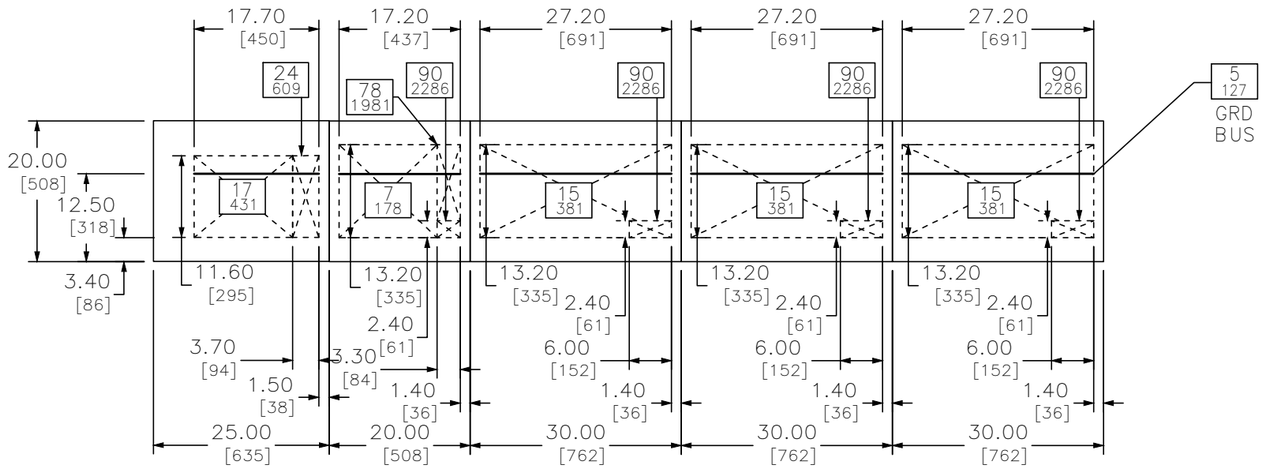


TOP VIEW



FLOOR VIEW

DUAL DIMENSIONS: INCHES
MILLIMETERS

CROSSED AREA REPRESENTS CONDUIT ENTRY AREA. NUMBERS IN BOXES INDICATE VERTICAL CLEARANCE TO NEAREST OBSTRUCTION.

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC-D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ELEVATION
ENGR:	JACOB BROWN		SQUARE D by Schneider Electric
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# F51352543-000120-01	PG 2 OF 3 REV –

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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GENERAL NOTES

Class 1 Type B Wiring

PRODUCT DESCRIPTION AND RATINGS

POWER SYSTEM DATA:

480Y/277V 3PH 4W 60Hz
POWER SYSTEM GROUND POINT: Common Point Grounded
SHORT CIRCUIT RATING: 65kA
POWER ENTERS: Main Breaker Bottom Section 1
CONTROL POWER: 120Vac

BUS SYSTEM DATA:

MAIN HORIZONTAL BUS: 1200 Amp Tin Plated Copper
BUS BRACING: 65kA
VERTICAL BUS: 300 Amp Tin Plated Copper
HORIZONTAL GROUND BUS: 300 Amp Tin Plated Copper
Units Securely Grounded To Structure

ENCLOSURE DATA:

ENCLOSURE TYPE: 20" Deep Type 1A
EXTERIOR COLOR: ANSI 49 Medium Light Grey
INTERIOR COLOR: White Unit Interiors
LIFTING ANGLE: 3" [76mm] Removeable

STRUCTURE MODIFICATIONS:

Ground Bus Lugs – 6 per Section 1,2,3,4,5
Rodent Barriers 1,5
Manual Bus Shutters 1,2
Main Section Partition 1
Fishtape Unit Plugs 1,2
600A Vertical Bus 1,2
Copper Vertical Ground Bus 1,2
Wire Retainers 1,2
Equipment Nameplate 1

EQUIPMENT WEIGHT:

SHIPPING SPLIT # 1: 770.00 Lbs. (349.27 Kg.)
SHIPPING SPLIT # 2: 750.00 Lbs. (340.20 Kg.)
SHIPPING SPLIT # 3: 740.00 Lbs. (335.66 Kg.)
SHIPPING SPLIT # 4: 740.00 Lbs. (335.66 Kg.)
SHIPPING SPLIT # 5: 740.00 Lbs. (335.66 Kg.)
TOTAL LINEUP WEIGHT (APPROX): 3740.00 Lbs. (1696.46 Kg.)

PRODUCT ACCESSORIES:

Certified Test Report
Stainless Steel N/P Screws

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC–D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ELEVATION
ENGR:	JACOB BROWN		SQUARE D by Schneider Electric
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# F51352543-000120-01	PG 3 OF 3 REV –

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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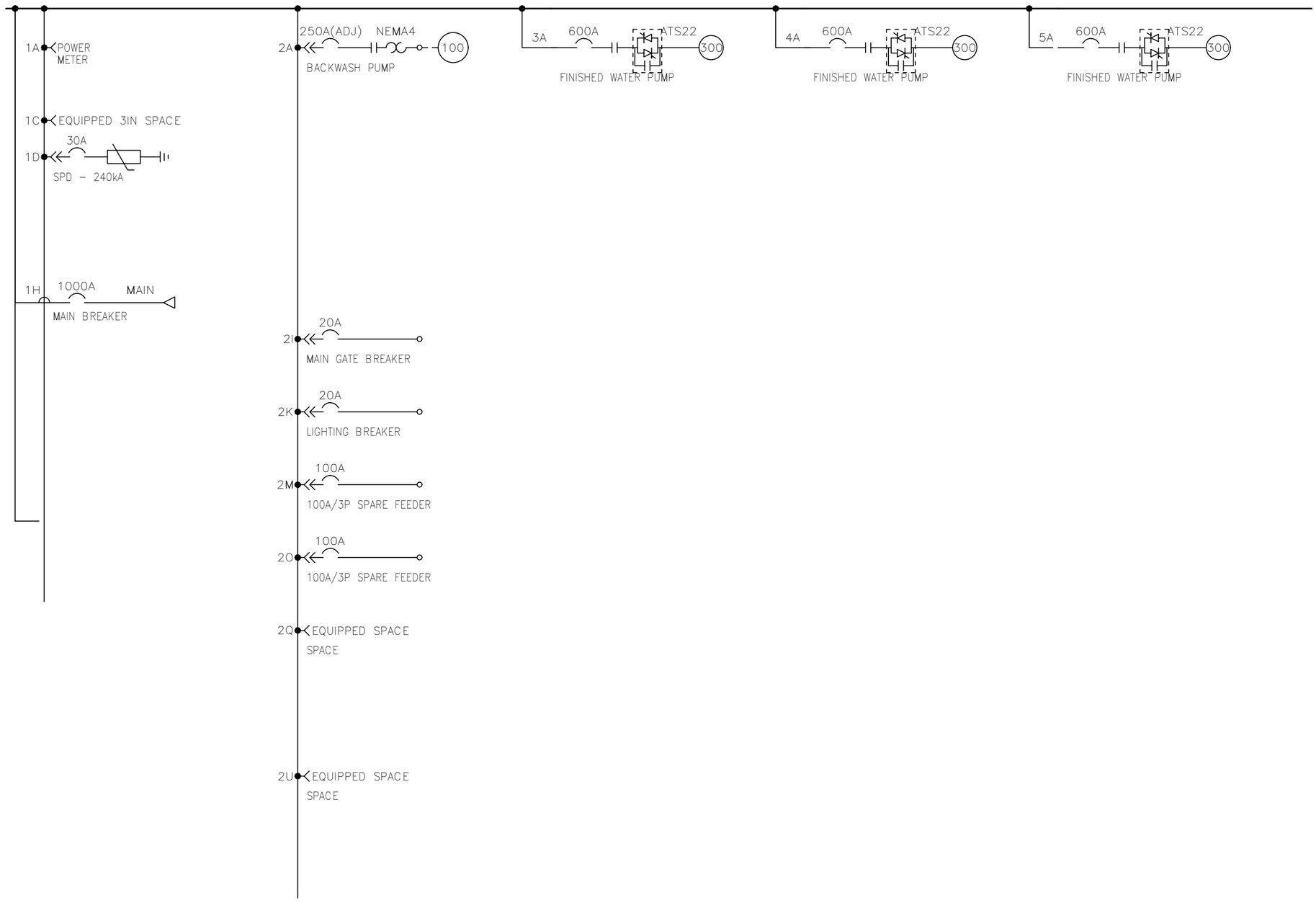

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC–D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ONE LINE DIAGRAM
ENGR:	JACOB BROWN		
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# 051352543–000120–01	PG 1 OF 1 REV –

REV	DESCRIPTION	BY	DATE	-	----	--	--/--/--	-	----	--	--/--/--
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UNIT LOC	UNIT NAMEPLATES (BLACK SURFACE/WHITE LETTERS)	UNIT TYPE	SIZE	HP	FRAME AMPS	TRIP AMPS	CONTROL SOURCE	VA	FUSE SIZE PRI	FUSE SIZE SEC	INTERLOCKS NO	INTERLOCKS NC	PILOT DEVICES: LED 30 mm ** ON LIGHT	OFF LIGHT	ADDL P/L	SS / PB	OTHER UNIT FEATURES	ELEMENTARY #
1A	MONITORING UNIT FOR MAIN MAIN BREAKER	POWER METER															FISHTAPE UNIT PLUGS, PM8244 W/DISPLAY, STD WIRE LABELS	E51352543-000120-02
1C	SPACE	3" SPACE																
1D	SURGE PROTECTION DEVICE	SPD	240kA		HLL 100	30											FISHTAPE UNIT PLUGS, SOLIDLY GROUNDED, SURGE COUNTER	E51352543-000120-01
1H	MAIN BREAKER	MAIN BKR			PL 1200	1000											(4) 3/0-500KCMIL WIRES/PH, 80% RATED, AL MECH LUG AL/CU CABLE, BASIC ELECTRONIC TRIP UNIT, FIXED L,	E51352543-000120-02
																	ADJ. I TRIP FUNCTION, SOLID NEUTRAL, 3 CT's, SPL	
2A	BACKWASH PUMP	FVNR	NEMA 4	100	JJ 250	ADJ 250	CONTROL TRANSFORMER	300	1.60	3.20	1	2	RED PTT	GREEN PTT	O/L TRIP YELLOW PTT	HOA SS EMERG STOP PB	#16 AWG MTW CONTROL WIRE, 2-ADD'L CONTACT BLK, 3" UNIT EXT, 4 ADDITIONAL WIRED TERMINAL(S),	E51352543-000120-03
																	CLASS 10/20 O/L (SELECTABLE), ETM, FISHTAPE UNIT PLUGS, MOTOR CIRCUIT PROTECTOR,	
																	MOTOR LOGIC O/L NEMA SIZE 4, STD WIRE LABELS, WIRED RELAY, SPL	
2I	MAIN GATE BREAKER	6" BRANCH BKR			HJ 150	20											(1) 14-3/0AWG WIRE/PH, 80% RATED, AL MECH LUG AL/CU CABLE, FISHTAPE UNIT PLUGS, T/M BKR	E51352543-000120-04
2K	LIGHTING BREAKER	6" BRANCH BKR			HJ 150	20											(1) 14-3/0AWG WIRE/PH, 80% RATED, AL MECH LUG AL/CU CABLE, FISHTAPE UNIT PLUGS, T/M BKR	E51352543-000120-04
2M	100A/3P SPARE FEEDER	6" BRANCH BKR			HJ 150	100											(1) 14-3/0AWG WIRE/PH, 80% RATED, AL MECH LUG AL/CU CABLE, FISHTAPE UNIT PLUGS, T/M BKR	E51352543-000120-05
UNIT LOC	UNIT NAMEPLATES	UNIT TYPE	SIZE	HP	FRAME AMPS	TRIP AMPS	CONTROL SOURCE	VA	PRI FUSE SIZE	SEC	NO INTERLOCKS	NC	ON LIGHT PILOT DEVICES: LED 30 mm **	OFF LIGHT	ADDL P/L	SS / PB	OTHER UNIT FEATURES	ELEMENTARY #

MCC NAMEPLATE – MCC-D
(BLACK SURFACE/WHITE LETTERS)

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC-D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	UNIT INFORMATION
ENGR:	JACOB BROWN	SQUARE D by Schneider Electric	
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# I51352543-000120-01	PG 1 OF 2 REV –

REV	DESCRIPTION	BY	DATE
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UNIT LOC	UNIT NAMEPLATES	UNIT TYPE	SIZE	HP	FRAME AMPS	TRIP AMPS	CONTROL SOURCE	VA	FUSE SIZE PRI	FUSE SIZE SEC	INTERLOCKS NO	INTERLOCKS NC	PILOT DEVICES: LED 30 mm ** ON LIGHT	PILOT DEVICES: LED 30 mm ** OFF LIGHT	PILOT DEVICES: LED 30 mm ** ADDL P/L	PILOT DEVICES: LED 30 mm ** SS / PB	OTHER UNIT FEATURES	ELEMENTARY #
2O	100A/3P SPARE FEEDER	6" BRANCH BKR			HJ 150	100											(1) 14-3/0AWG WIRE/PH, 80% RATED, AL MECH LUG AL/CU CABLE, FISHTAPE UNIT PLUGS, T/M BKR	E51352543-000120-05
2Q	SPACE	12" SPACE																
2U	SPACE	12" SPACE																
3A	FINISHED WATER PUMP	ATS22 SSRV	C41	300	LJ 600	600	CONTROL TRANSFORMER	300	1.6	3.2			RED PTT			HOA SS EMERG OFF PB	#16 AWG MTW CONTROL WIRE, 2-ADD'L CONTACT BLK, ETM, INPUT/ISOLATION CONTACTOR, SHUNT TRIP,	E51352543-000120-06
																	STD WIRE LABELS, Yellow Push-to-Test Add'l PL #1, ALARM SWITCH, SPL	
4A	FINISHED WATER PUMP	ATS22 SSRV	C41	300	LJ 600	600	CONTROL TRANSFORMER	300	1.6	3.2			RED PTT			HOA SS EMERG OFF PB	#16 AWG MTW CONTROL WIRE, 2-ADD'L CONTACT BLK, ETM, INPUT/ISOLATION CONTACTOR, SHUNT TRIP,	E51352543-000120-06
																	STD WIRE LABELS, Yellow Push-to-Test Add'l PL #1, ALARM SWITCH, SPL	
5A	FINISHED WATER PUMP	ATS22 SSRV	C41	300	LJ 600	600	CONTROL TRANSFORMER	300	1.6	3.2			RED PTT			HOA SS EMERG OFF PB	#16 AWG MTW CONTROL WIRE, 2-ADD'L CONTACT BLK, ETM, INPUT/ISOLATION CONTACTOR, SHUNT TRIP,	E51352543-000120-06
																	STD WIRE LABELS, Yellow Push-to-Test Add'l PL #1, ALARM SWITCH, SPL	
UNIT LOC	UNIT NAMEPLATES	UNIT TYPE	SIZE	HP	FRAME AMPS	TRIP AMPS	CONTROL SOURCE	VA	PRI	SEC	NO	NC	ON LIGHT	OFF LIGHT	ADDL P/L	SS / PB	OTHER UNIT FEATURES	ELEMENTARY #
									FUSE SIZE		INTERLOCKS		PILOT DEVICES: LED 30 mm **					

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC-D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	UNIT INFORMATION
ENGR:	JACOB BROWN		SQUARE D by Schneider Electric
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG#	I51352543-000120-01

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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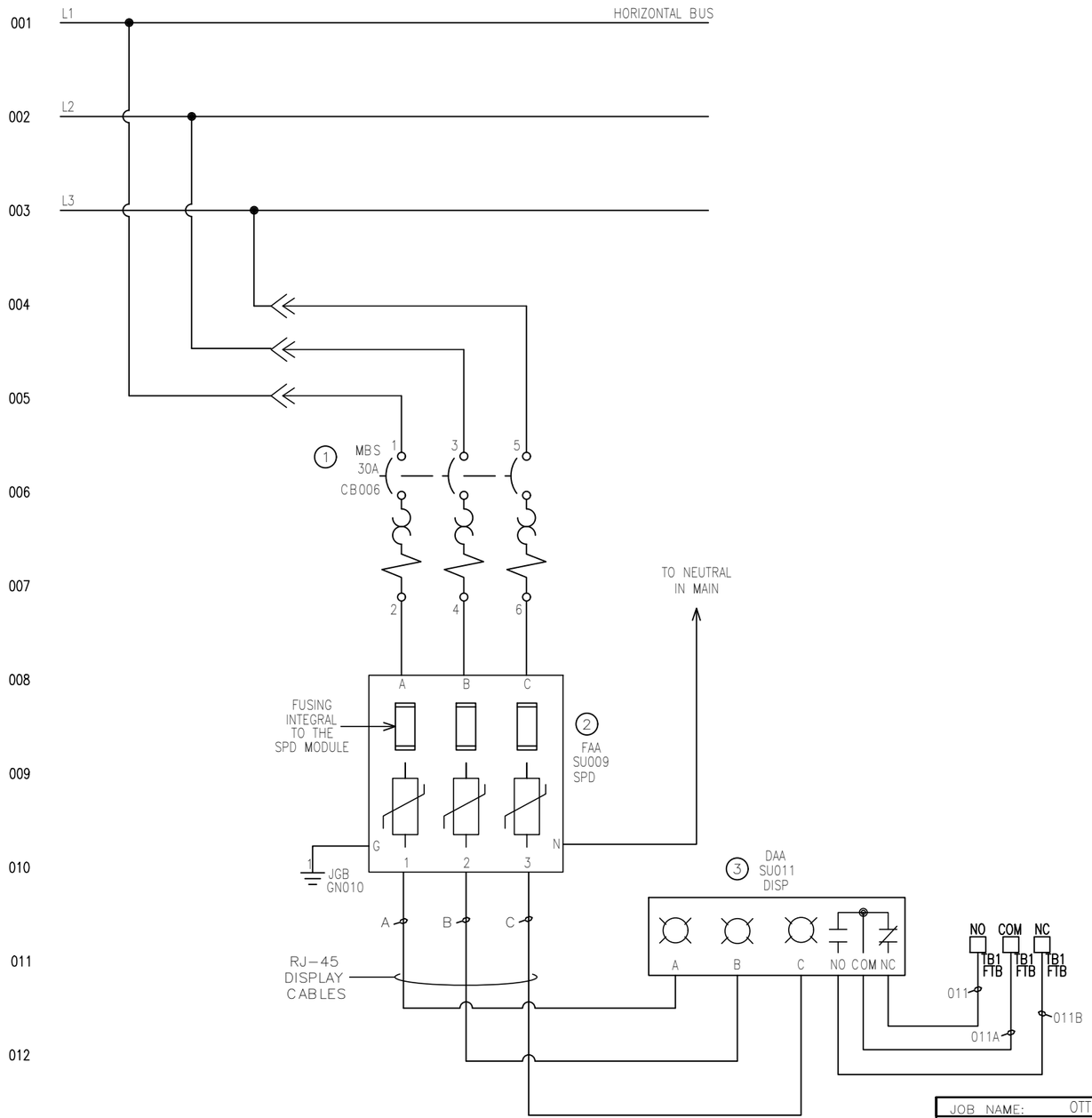
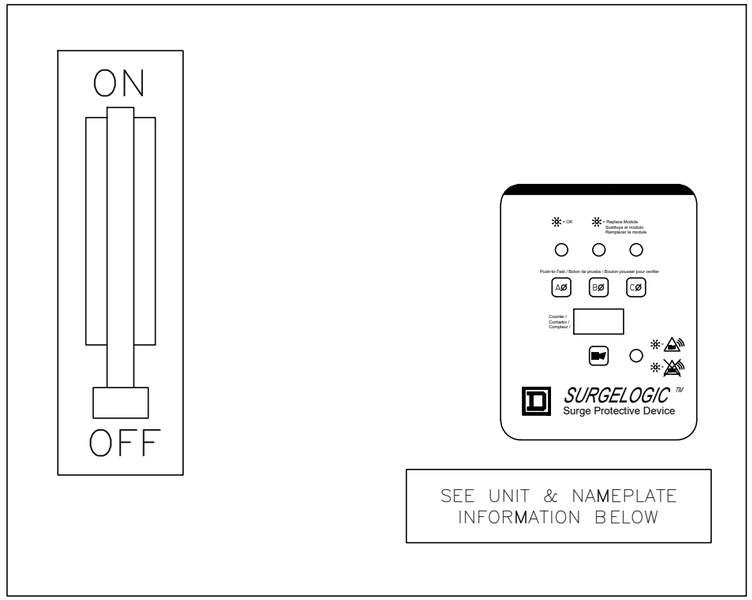
ITEM	CATALOG	DESCRIPTION
1	HLL36030	POWERPACT H–FRAME TM CIRCUIT BREAKER 30A
2	TVS4IMA24M	SURGE PROTECTION DEVICE 240KA
3	TVS3DSPVC	SPD DISPLAY





UNIT 1D SURGE PROTECTION DEVICE

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC–D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	JACOB BROWN		SQUARE D Schneider Electric
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# E51352543–000120–01	PG 1 OF 1 REV –

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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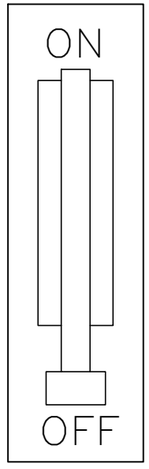
ITEM	CATALOG	DESCRIPTION
1	PLP34100	CIRCUIT BREAKER - P FRAME - 1000 A
2	7RL122	CURRENT TRANSFORMER MODEL 7RL
3	KUXSC4-BP	4 POLE SHORT CIRCUIT TERMINAL BLOCK
4	FNQ-R-1/4	FUSE - CLASS CC
5	NNZ70169	DISCONNECT SWITCH 3 POLE 30A 600V
6	9070T50D1	50VA CONTROL TRANSFORMER
7	KTK-R-1/2	FUSE - CLASS CC
8	RSL1PVFU	ZELIO SLIM INTERFACE RELAY
9	METSEPM8243	POWER METER 8000 SERIES
10	METSEPM89M0024	I/O MODULE
11	METSEPM89RD96	REMOTE DISPLAY

SEE UNIT & NAMEPLATE INFORMATION BELOW



SEE UNIT & NAMEPLATE INFORMATION BELOW

UNIT 1A MONITORING UNIT FOR MAIN MAIN BREAKER
UNIT 1H MAIN BREAKER

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC-D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	JACOB BROWN		SQUARE D Schneider Electric
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# E51352543-000120-02	PG 1 OF 2 REV –

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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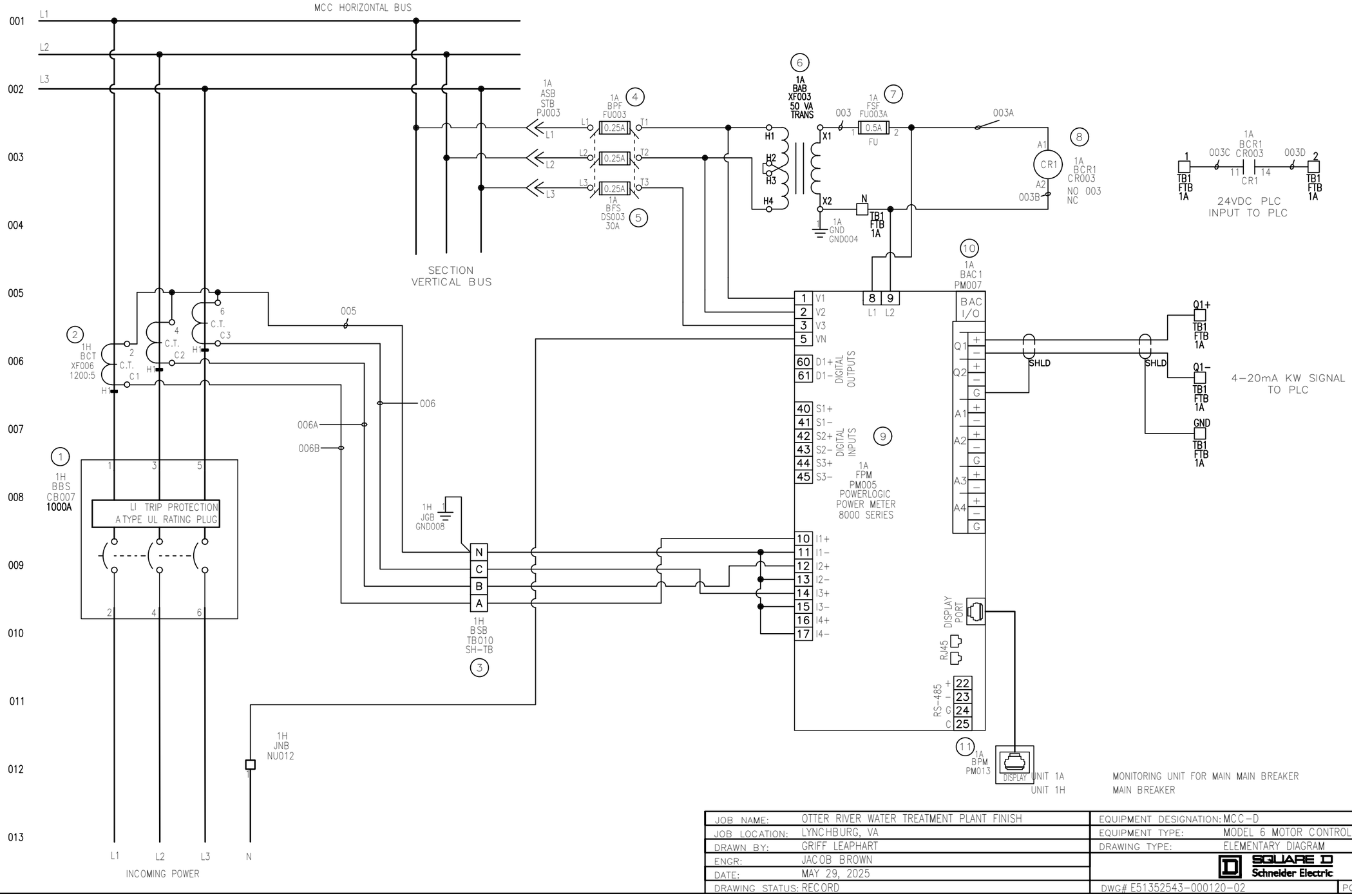

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC-D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	JACOB BROWN		SQUARE D Schneider Electric
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# E51352543-000120-02	PG 2 OF 2 REV –

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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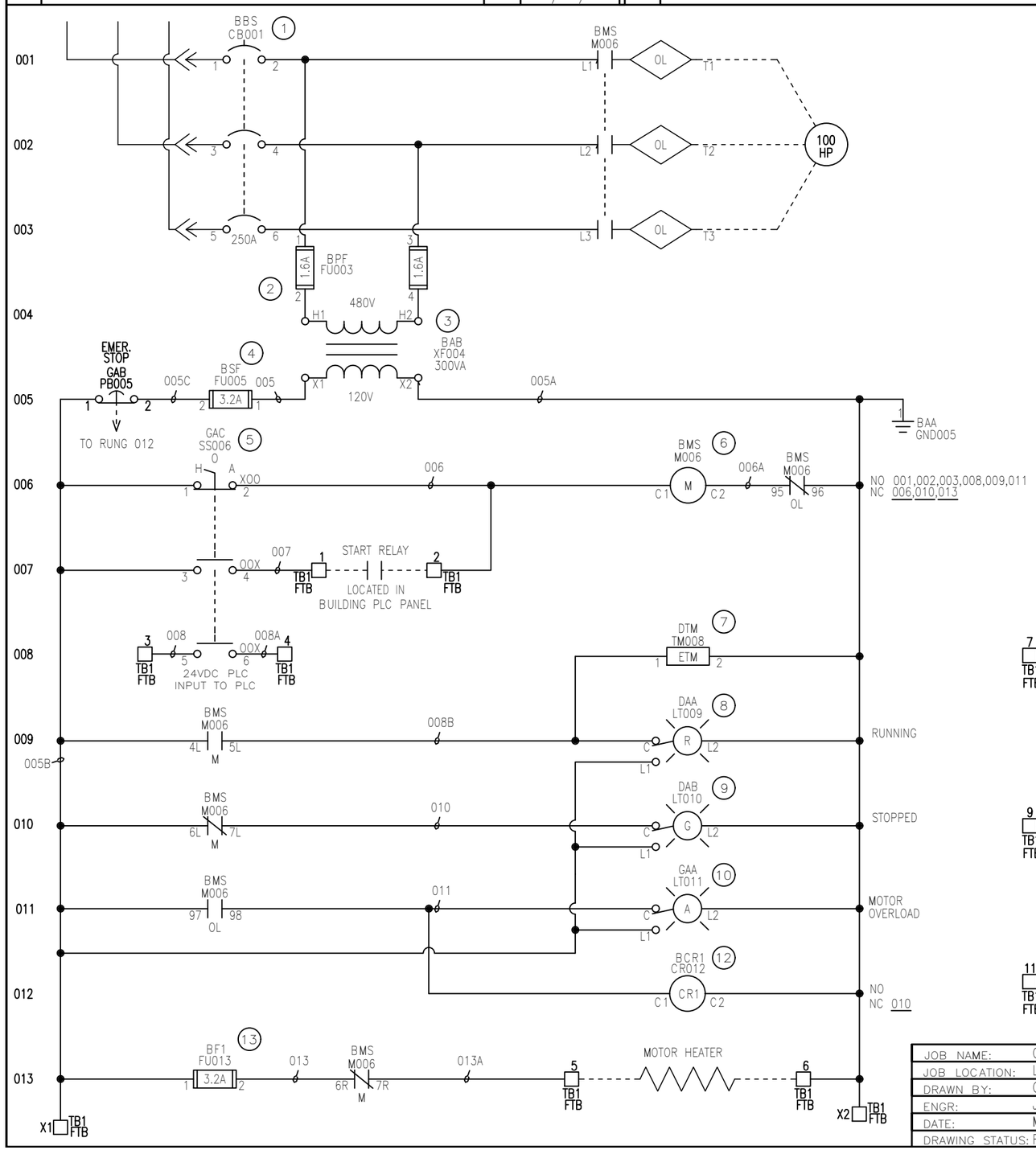
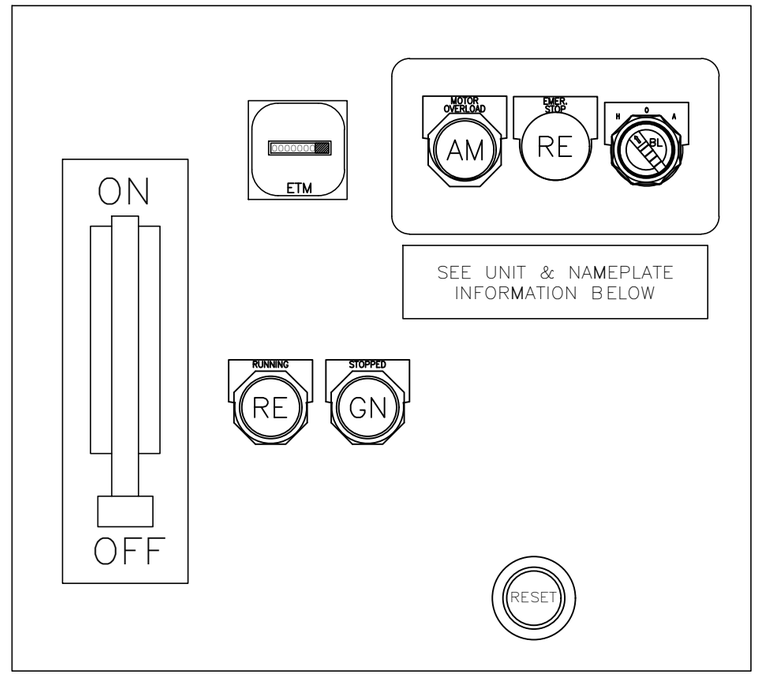


ITEM	CATALOG	DESCRIPTION
1	JJL36250M75	POWERPACT J–FRAME CIRCUIT BREAKER 250A
2	FNQ–R–1 6/10	FUSE – CLASS CC
3	9070KL300D9	300VA CONTROL TRANSFORMER
4	FRN–R–3 2/10	DUAL ELEMENT FUSE –CLASS RK5
5	9001–KS43BH24	SELECTOR SW – 3 POS MAINT, NEMA 4/13
6	8536–SF01V02H30S	FULL VOLTAGE MOTOR STARTER NEMA SIZE 4
	9999AC04	SSOR AUXILIARY CONTACT
7	26403–12030	KESSLER–ELLIS H57 ETM 120V
8	KT1LRR31	RED LED PILOT LIGHT – PRESS TO TEST, NEMA 4/13
9	KT1LGG31	GREEN PILOT LIGHT – PRESS TO TEST, NEMA 4/13
10	KT1LYY31	YELLOW LED PILOT LIGHT – PRESS TO TEST, NEMA 4/13
	A31	AMBER PILOT LIGHT LENS
11	KR9RH13	RED PUSH BUTTON – MUSHROOM, NEMA 4/13
12	8501XO40V02	RELAY TYPE X
13	FNQ–R–3 2/10	FUSE – CLASS CC



UNIT 2A BACKWASH PUMP

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC–D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	JACOB BROWN		SQUARE D Schneider Electric
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# E51352543–000120–03	PG 1 OF 1 REV –

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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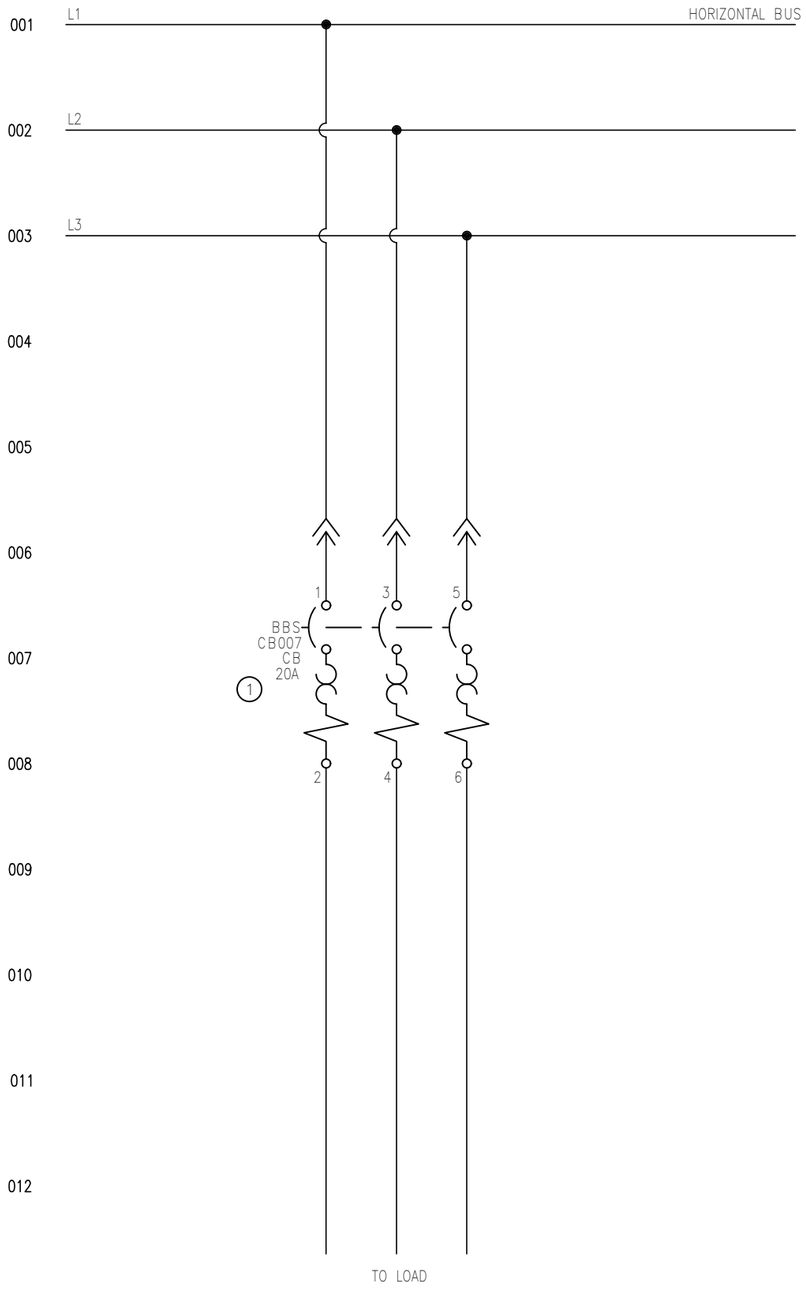
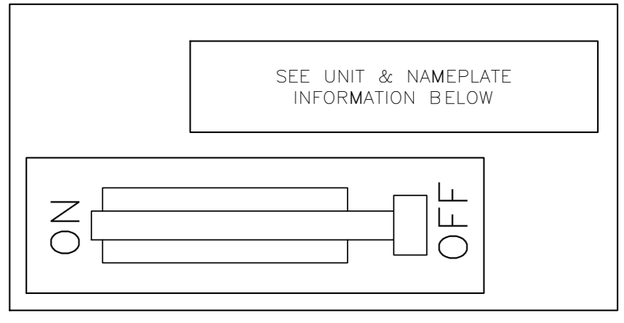
ITEM	CATALOG	DESCRIPTION
1	HJL36020	POWERPACT H–FRAME TM CIRCUIT BREAKER 20A





UNIT 2I MAIN GATE BREAKER
UNIT 2K LIGHTING BREAKER

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC–D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	JACOB BROWN		SQUARE D Schneider Electric
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# E51352543–000120–04	PG 1 OF 1 REV –

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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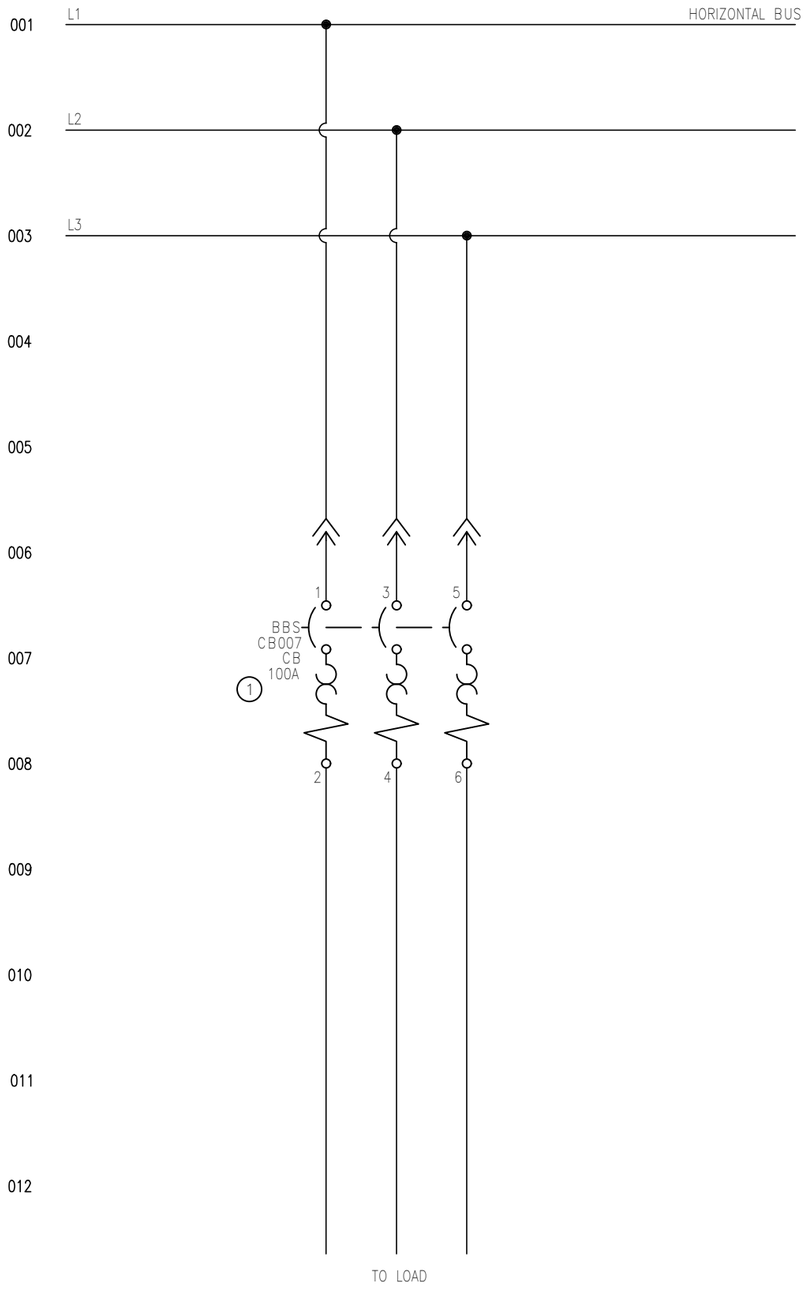
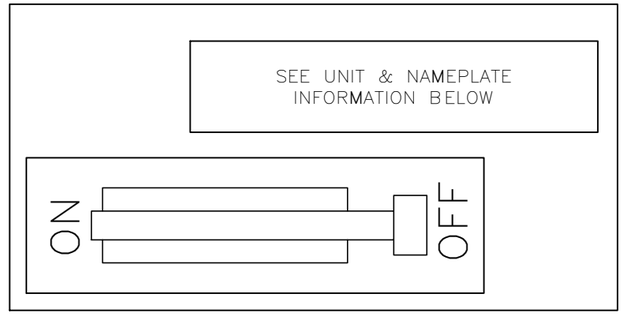
ITEM	CATALOG	DESCRIPTION
1	HJL36100	POWERPACT H–FRAME TM CIRCUIT BREAKER 100A





UNIT 2M 100A/3P SPARE FEEDER
UNIT 20 100A/3P SPARE FEEDER

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC–D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	JACOB BROWN		SQUARE D Schneider Electric
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# E51352543–000120–05	PG 1 OF 1 REV –

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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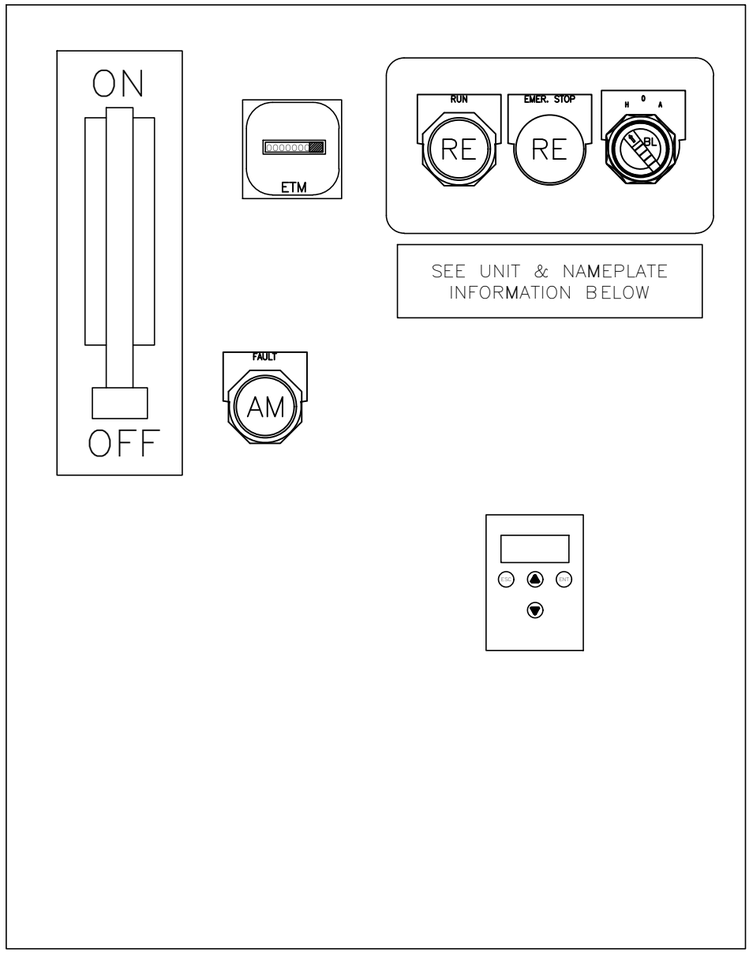
ITEM	CATALOG	DESCRIPTION
1	LJL36600U31X	CIRCUIT BREAKER 600A
	P29386	SHUNT TRIP
	S29450	CB AUXILIARY/ALARM/OVERCURRENT SWITCH
2	ATS22C41S6U	ALTISTART 22 SOFT START 410 AMP
3	9070TF300D1	300VA CONTROL TRANSFORMER
4	FNQ-R-1 6/10	FUSE – CLASS CC
5	FNQ-R-3 2/10	FUSE – CLASS CC
6	8501X040V02	RELAY TYPE X
7	FNQ-R-1 1/4	FUSE – CLASS CC
8	9001-KS43BH24	SELECTOR SW – 3 POS MAINT, NEMA 4/13
9	LA9D09980	COIL SUPPRESSOR
10	LC1F500G7	IEC CONTACTOR 120V / 500A
	LADN22	AUXILIARY CONTACTS
11	26403-12030	KESSLER-ELLIS H57 ETM 120V
12	KT1LRR31	RED LED PILOT LIGHT – PRESS TO TEST, NEMA 4/13
13	KT1LYY31	YELLOW LED PILOT LIGHT – PRESS TO TEST, NEMA 4/13
	A31	AMBER PILOT LIGHT LENS
14	KR9RH13	RED PUSH BUTTON – MUSHROOM, NEMA 4/13
15	CA2KN22G7	IEC INDUSTRIAL RELAY 120VAC
	LA2KT2U	TIME DELAY AUXILIARY CONTACT
16	LA4KE1FC	VARISTOR SUPPRESSOR MODULE

NOTE:
USE CAUTION WHEN CHANGING FACTORY-SET PARAMETERS.
FACTORY-SET PARAMETERS ARE CRITICAL FOR ALTISTART
CONTROL AND POWER CONFIGURATIONS.
DESCRIPTION OF PARAMETERS AND CODES CAN BE FOUND IN
THE "PROGRAMMING" SECTION OF THE USER MANUAL #BBV51330
AVAILABLE AT WEBSITE ADDRESS WWW.SCHNEIDER-ELECTRIC.COM.

(1) RESET LAC (ADVANCED MODE) TO OFF (0) AFTER
COMPLETING PROGRAMMING CHANGES.

ATS22 FACTORY CONFIGURATION – VARIATIONS FROM DEFAULT				
MENU	PARAMETER	MODBUS ADD.	DESCRIPTION	ADJ.
COnf	UIn	2	LINE VOLTAGE	460
COnf	In	3	MOTOR RATED CURRENT	361
COnf	LAC	5	ADVANCED MODE	ON (1)
SEt	ILt	17	CURRENT LIMIT	350
SEt	tHP	22	MOTOR THERMAL PROTECTION	10
AdJ	SLG	33	STARTS PERIOD (MIN)	60
IO	LI2	72	LOGIC INPUT	RUN



UNIT 3A FINISHED WATER PUMP
UNIT 4A FINISHED WATER PUMP
UNIT 5A FINISHED WATER PUMP

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC-D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	JACOB BROWN		SQUARE D Schneider Electric
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# E51352543-000120-06	PG 1 OF 3 REV –

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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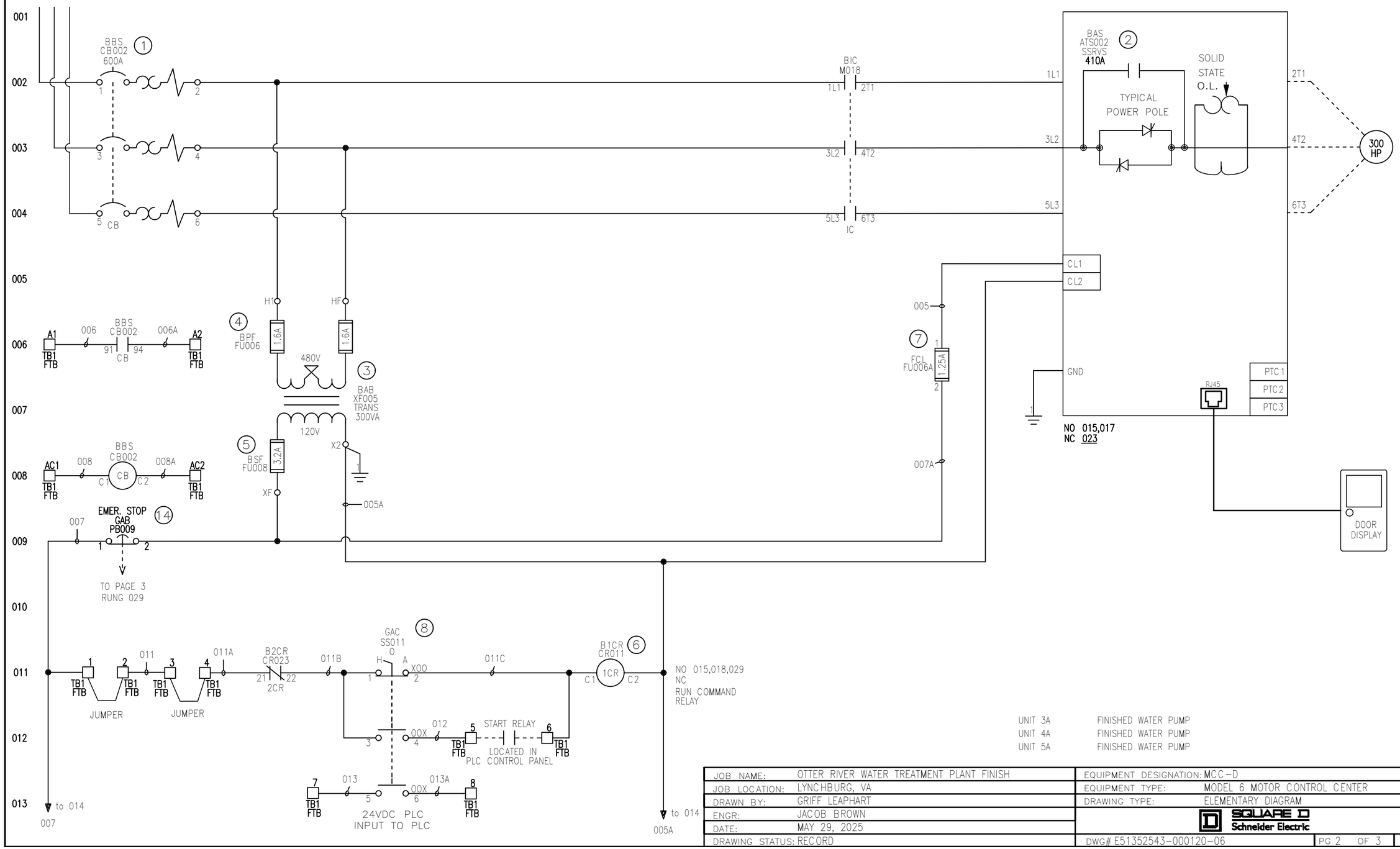

UNIT 3A FINISHED WATER PUMP
UNIT 4A FINISHED WATER PUMP
UNIT 5A FINISHED WATER PUMP

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC–D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	JACOB BROWN		SQUARE D Schneider Electric
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# E51352543–000120–06	PG 2 OF 3 REV –

REV	DESCRIPTION	BY	DATE	–	----	--	--/--/--	–	----	--	--/--/--
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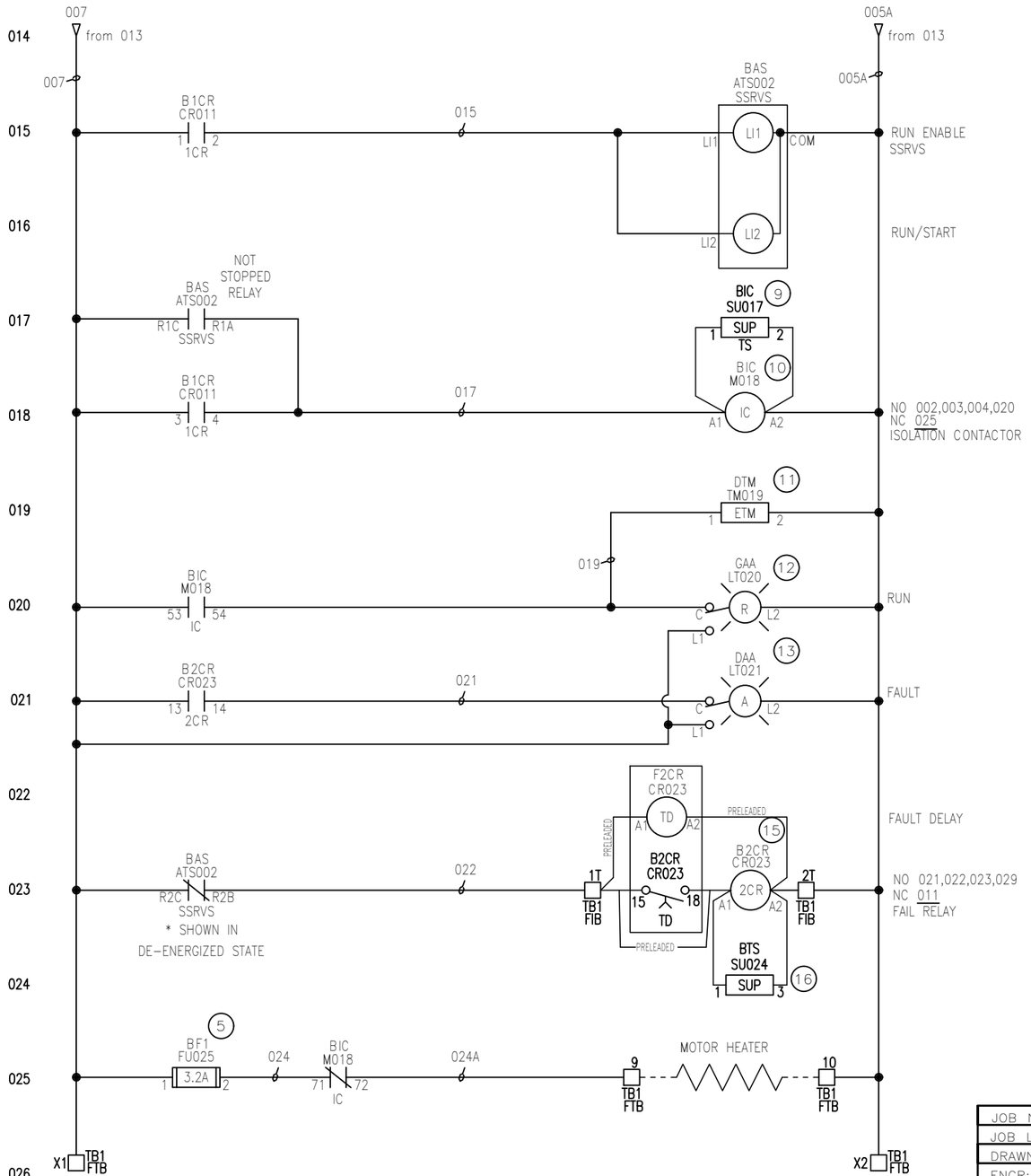

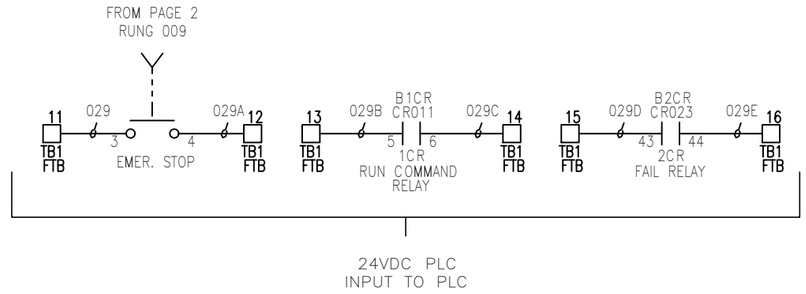

UNIT 3A FINISHED WATER PUMP
UNIT 4A FINISHED WATER PUMP
UNIT 5A FINISHED WATER PUMP

JOB NAME:	OTTER RIVER WATER TREATMENT PLANT FINISH	EQUIPMENT DESIGNATION:	MCC-D
JOB LOCATION:	LYNCHBURG, VA	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	GRIFF LEAPHART	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	JACOB BROWN		SQUARE D Schneider Electric
DATE:	MAY 29, 2025		
DRAWING STATUS:	RECORD	DWG# E51352543-000120-06	PG 3 OF 3 REV –