Naval Facilities Engineering Command

Naval Facilities Engineering Command Mid-Atlantic
Norfolk, Virginia

Technical Specifications

GM-38 Area-Groundwater Treatment Facility

Naval Weapons Industrial Reserve Plant
Bethpage, New York

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TECHNICAL SPECIFICATIONS

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REMEDIAL ACTION WORK PLAN

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 The Contractor shall provide a Remedial Action Work Plan (RAWP) and associated subplans in compliance with the Performance Work Statement (PWS) schedule. The RAWP shall identify project personnel and organization, equipment, material, instructions, records, forms, construction procedures, and schedule to be used and followed in performing the work in compliance with the PWS. The PWS provide details as to sub-plans associated with the RAWP.

1.2 RELATED DOCUMENTS

1.2.1 01 33 00 Submittals

1.3 CONTENTS OF THE REMEDIAL ACTION WORK PLAN

1.3.1 The RAWP shall outline the overall construction sequencing and procedures to be followed during the site work activities. The plan shall contain a thorough and concise summary of how the work will be accomplished and shall include at a minimum:

1.3.1.1 Contractor's technical approach including work sequence, major milestones, health and safety, and general work procedures.

1.3.1.2 Project Organization Chart showing lines of authority and responsibility. Number of personnel to be utilized on the job should be indicated in appropriate organizational elements. If significant changes in the organization are expected to occur during the life of the project or phases of construction, these should be discussed. Necessary substitutions, due to change of employment status and other unforeseen circumstances, must be submitted in writing for approval by the contracting officer prior to conducting work.

1.3.1.3 Names, qualifications, and work experience of all contractor supervisors, health and safety personnel, and employees with quality control responsibilities. If the personnel identified in the RAWP are not available at the start of the project, the Contractor shall submit, prior to mobilization, the names and qualifications of substitute personnel, with equal or more extensive experience, to the NAVFAC Remedial Project Manager/Contracting Officer Representative (RPM/COR) for approval.

1.3.1.4 Equipment to be utilized for the site activities.

1.3.1.5 Discussion of regulatory requirements applicable to the project and how compliance will be assured. Personnel training requirements should be listed and compliance demonstrated.

1.3.1.6 Proof of Contractors' permits required to successfully complete the PWS.

1.3.1.7 Provide names of personnel trained in spill control and list dedicated equipment to be provided on-site.

1.3.1.8 A description of provisions for controlling erosion, diverting surface run-off from excavations, and dewatering including pumping, if necessary.

1.3.1.9 Provisions for no major disruptions to the existing GM-38 treatment plant, and provisions for limiting non-routine down-time of the existing treatment plant to 2 hours per disruption for tie-ins or modifications.

1.3.1.10 Provisions for limiting non-routine downtime of the new treatment system to 24 hours for all subsystems.
1.3.1.11 Reporting procedures, including proposed reporting format.
1.3.1.12 Identification of proposed waste disposal facilities.

1.4 NOTIFICATION OF CHANGE

1.4.1 After submittal of the RAWP, the Contractor shall notify the RPM/COR, on a prescribed form, of any proposed change. At a minimum, the Contractor shall state the date and time of the submission of the form, the detailed description of the proposed change, the technical merit of the proposed change, the methods to implement the proposed change, the impact of the proposed change on other units or operations, the cost and schedule to implement the proposed change, and the person(s) of the Contractor and/or its subcontractor(s) who have proposed the change and will be responsible to implement the change.

1.5 SUBMITTALS

1.5.1 The Contractor shall submit the following to the RPM/COR for approval in accordance with Section 01 33 00, "Submittals"

1.5.1.1 RAWP
1.5.1.2 Electronic copies of Daily Log pages. (Hard copies to remain on site and be available for review).

1.6 PROJECT ORGANIZATION

1.6.1 Site Manager

1.6.1.1 The Contractor shall designate a Site Manager, who shall be responsible for overall management of the RAWP and have the authority to act on behalf of the Contractor.
1.6.1.2 The Site Manager for this Contract shall be an individual experienced in construction and operation of groundwater chemical treatment systems whose responsibility is to insure compliance with the PWS Basis of Design, Drawings, and Technical Specifications.
1.6.1.3 The Site Manager shall be on-site whenever work is in progress.

1.6.2 Personnel

1.6.2.1 A staff shall be maintained under the direction of the Site Manager to perform all project activities.
1.6.2.2 The personnel shall be fully qualified, by experience and technical training, to perform their assigned responsibilities and shall be hired directly by and work for the Contractor and its subcontractors.

1.7 CONTROL

1.7.1 The RAWP is the means by which the Contractor and the RPM/COR are assured that the construction complies with the requirements of the Basis of Design, Drawings, and Technical Specifications. The plan shall be adequate to cover all construction operations.

1.8 DOCUMENTATION

1.8.1 The Contractor shall maintain a daily log of work activities, including the work of suppliers and subcontractors. This log shall be in an acceptable form and indicate a description of trades working on the project, the number of personnel working, the weather conditions and delays encountered, and acknowledgement of deficiencies noted along with the corrective actions taken on current and previous deficiencies. In addition, the log shall include factual evidence that required activities have been performed, including, but not limited to, the following:

1.8.1.1 Type, number, and progress of activities.
1.8.1.2 All documentation and submittals that are required for the current activities.
1.8.1.3 Nature of defects, causes for rejection, etc.
1.8.1.4 Proposed remedial action.
1.8.1.5 Corrective actions taken.
1.8.1.6 Any proposed change(s) that are outstanding.
1.8.1.7 Schedule of current activities and upcoming activities within the next week.

1.8.2 The daily log shall cover both conforming and defective or deficient features, and shall include a statement that supplies and materials incorporated in the work comply with the Basis of Design, Drawings, and Technical Specifications. Legible copies of the log shall be furnished daily to the RPM/COR. The Contractor shall keep records of the pre-final and final inspections, including a "punch list" of items which do not conform to the approved plans and specifications. For each item on this list, the Contractor shall document corrective actions taken.

1.9 NOTIFICATION OF NON-COMPLIANCE

1.9.1 The Contracting Officer will provide written notification to the Contractor of any non-compliance with the foregoing requirements. After receipt of such notice, the Contractor shall immediately take corrective action. If the contractor fails or refuses to comply promptly, the Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 GENERAL

3.1.1 The Contractor shall perform all work related activities in compliance with the RAWP.

END OF SECTION

SECTION 01 01 00

SCOPE OF WORK

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 The Contractor shall provide all services and materials necessary for the installation of the “Advance Oxidation Process (AOP) System at the GM-38 Ground Water Treatment Facility for treatment of volatile organics and 1,4-Dioxane at Naval Weapons Industrial Reserve Plant”, located in, Bethpage, New York as shown on the General Vicinity Map in the Technical Drawings.

1.1.1.1 General Scope of Work

1.1.1.1.1 Section 1: Mobilization and Demobilization
1.1.1.1.2 Section 2: Site Preparation
1.1.1.1.3 Section 3: Process, Treatment, and Instrumentation Systems
1.1.1.1.4 Section 4: Building Systems
1.1.1.1.5 Section 5: Electrical Systems
1.1.1.1.6 Section 6: Process Control System
1.1.1.1.7 Section 7: Site Work and Restoration
1.1.1.1.8 Section 8: Plumbing System
1.1.1.1.9 Section 9: Special Requirements

1.1.2 The work shall be complete and includes furnishing, as applicable or required, all Contractor’s safety devices, labor, tool, materials, supplies, and services; and performing all operations necessary for or incidental to a complete project in conformance with the attached Basis of Design Report, Technical Drawings, and Technical Specifications.

1.1.3 The Contractor shall furnish all labor, materials, equipment and incidentals to install the above listed systems and equipment, including the piping, wiring, and instrumentation interconnections between all specified components and auxiliary equipment.

1.1.4 Contractor shall be responsible for the field erection of materials oversized for shipment.

1.2 REFERENCED SPECIFICATIONS

1.2.1 This section refers to all technical specification divisions.

1.3 SUBMITTALS

1.3.1 The Contractor shall submit the following to the RPM/COR and Engineer of Record (EOR) for review, comment, and approval prior to pre-construction meeting in accordance with Section 01330, “Submittals”:

1.3.1.1 Contractor’s markup drawings.

1.3.1.2 Product information for any proposed additions or changes per the Contractors markup drawings showing all important details, layout of components, materials of construction and dimensions.

1.4 OPERATING INSTRUCTIONS

1.4.1 The initial operations and maintenance of the AOP system is part of the Contractor's Scope of Work. Updating the O&M manual is also not part of the Contractor's Scope of Work. The Contractor shall turn over the manufacturer's operating and maintenance instructions that typically accompany equipment to the RPM/COR and EOR.

1.5 TOOLS, SPARE PARTS, AND CONSUMABLES

1.5.1 All special tools, spare parts, and consumables required for normal operation and maintenance shall be furnished in accordance with individual specifications.

1.6 EQUAL PRODUCTS

1.6.1 The Technical Drawings and Technical Specifications are based on a conceptual arrangement of equipment and piping. Should the Contractor propose to furnish equal equipment of a different configuration, the Contractor shall be responsible for all additions and modifications, as approved by the RPM/COR and EOR, necessary to incorporate the proposed equipment into the design and submit all the affected and revised Technical Drawings and Technical Specifications for review and approval by the RPM/COR and EOR prior to their implementation.

PART 2 - PRODUCTS

2.1 The Contractor shall ensure that the individual components, piping, wiring, and instrumentation interfaces are strategically located such that the complete AOP system incorporate straight runs of minimum distance, to the extent possible. In addition, the Contractor shall ensure that the components and auxiliary equipment fit within the allotted space shown on the Technical Drawings. The Contractor placement of individual units shall allow for adequate access to components within each unit, including instrumentation and valves, to allow for easy maintenance or replacement as may be required.

PART 3 - EXECUTION

3.1 DELIVERY AND STORAGE OF EQUIPMENT

3.1.1 No shipment shall be made until shop drawings have been submitted to and approved in writing by the RPM/COR and EOR.

3.1.2 All units shall be preassembled to the largest extent possible, compatible with transportation limitations and equipment protection considerations. Skid-mounted assemblies shall be shipped complete, to the extent possible. Where absolutely necessary, some piping may be match-marked and broken down in a minimum number of pieces for field assembly by the Contractor. Pressure gauges, local instruments and primary elements, etc., may be removed for protective shipment and shall be installed in field by the Contractor.

3.1.3 For protection of bearings during shipment and installation, the bearings shall be properly processed. Bearings, if pre-lubricated, shall be protected in accordance with the Manufacturer's recommendations against formation of rust while awaiting installation. Bearings which are not pre-lubricated shall be properly treated in accordance with the Manufacturer's recommendation against formation of rust while waiting installation and start-up by the application of rust preventive treatment.

3.1.4 Manholes, piping, or other fittings shall not be used for lifting.

3.1.5 All lifts for equipment receiving, storage, and placement will be required to comply with NAVFAC Lift Plan requirements.

3.2 INSTALLATION

3.2.1 Installation of units and auxiliary equipment shall be in accordance with the Suppliers and/or Manufacturers' instructions and recommendations, and as described in the Specifications and as shown on the Technical Drawings and approved Contractor markups.

3.3 INTEGRITY INSPECTION AND FIELD TESTING

3.3.1 The Contractor shall perform integrity testing of the new systems, shall be present for initial startup, and shall be present when the new systems are taken on-line with the existing system.

3.3.2 Field inspections and tests may be conducted periodically by the Contractor during installation. Integrity inspection and field testing shall be performed by the Contractor when the installations of the entire systems are complete and ready for testing.

3.3.3 The Contractor shall hydrostatically test the entire treatment/process system by filling it with potable water and perform blow-off testing.

3.3.4 After testing and following the Post-Construction AOP Startup meeting, the treatment system shall be taken on-line with the existing system, with the Contractor and EOR present at system startup.

3.3.5 Should any part of the new systems fail to perform in accordance with these specifications, the Contractor shall, at his own expense, make such modifications as necessary to provide satisfactory performance of the new systems. If retest still fails to demonstrate conformance with the specifications, the Contracting Officer may elect to require a replacement, a modification, a cost deduction, or a combination of the above.

SECTION 01 01 00

ATTACHMENT “A” – SCOPE OF WORK

PART A – GENERAL SCOPE OF WORK

Section 1: Mobilization and Demobilization

Mobilization and Demobilization consists of the following construction components:

1. Execute, the approved Contractor Remedial Action Work Plan and associated subplans

2. Execute the Accident Prevention Plan / Health and Safety Plan including quality control, spill control, health and safety, traffic control, and site security.

3. Provide permits, bonds, warranties, fees, insurance, and other similar expenses required by the contract.

4. Mobilization and Demobilization of all equipment, tools, materials, supplies, temporary facilities and utilities, and personnel required to perform the work.

5. Compliance with all regulatory requirements.

6. Pre-construction and construction period planning, management, scheduling, submittals, reporting, project closeout, administration and documentation.

7. Close out the project per the Remedial Action Work Plan, Accident Prevention Plan / Health and Safety Plan, and Performance Work Statement, including permits, and record drawings.

Section 2: Site Preparation and Temporary Facilities

Site Preparation and Temporary Facilities consist of the following construction components:

1. Execute the Erosion and Sedimentation Control Plan, and provide and execute a Dewatering Plan, if needed

2. Stake-out limits of construction locations and other important features such as water main centerlines, building corners, and property corners

3. Post project and safety signs, temporary security fencing, tree protection fencing, flagging, and other access restrictions

4. Layout and construct the construction laydown area including stabilized construction entrance.

5. Set up the contractor’s office (trailer with power and telephone connections) and coordinate any temporary access and security with the Navy’s onsite plant operator.

6. Clear and grub the site utility areas as shown on the Technical Drawings.

7. Remove asphalt and curb as-needed.

Section 3: Process, Treatment, and Instrumentation Systems

Process, Treatment, and Instrumentation Systems consists of the following components:

1. Furnish a single Advance Oxidation Process (AOP) reactor mounted on cradle and concrete pad as described in the specifications and shown on drawings. The associated two (2) power distribution center (PDC) panels will be mounted on the concrete pad as shown in the technical drawings. Furnish associated one (1) self-contained control (SCC) center for system monitoring and control, and all necessary piping, wiring, valves, and other appurtenances.

2. Furnish chemical feed systems including two (2) metering pumps and entire pump skid assembly including calibration cylinders, piping, valves and flow meters and chemical dosing system as shown in the technical drawings and as described in the design report and technical specifications

3. Furnish piping, valves, hydrogen peroxide storage tank with appurtenances, valve actuators with chain wheel operators as shown on contract drawings, monitoring equipment and appurtenances including brackets and pipe hangers for the proper installation and function of system.

4. Furnish secondary containment feed piping from the hydrogen peroxide chemical tank to the metering pumps outside and inside the treatment building. Provide insulation, jacketing and heat tracing for exposed piping outside the building and insulation and jacketing for exposed piping inside the building.

5. Furnish a NEMA4/4X enclosure along with a selector switch and wiring to allow for Manual/Auto control of the reactor and pumps.

Section 4: Building Systems

The Building Systems consist of the following components:

1. Furnish exterior steel structure canopy, foundation base material, foundation, and concrete slabs on grade as shown in the technical drawings and as described in the design report and technical specifications. This includes equipment pads with anchor bolts, process/treatment system tie-in (sumps, floor drains, etc.) and under-slab utility coordination.

2. Furnish exterior structural and architectural roof and systems (framing, sheet metal, roof drains, metal decking, hardware, etc.) as shown in the technical drawings and as described in the design report and technical specifications.

Section 5: Electrical Systems

The Electrical Systems consist of the following components:

1. The existing MCC-1 is currently being fed from a 500 KVA, 3Phase Concrete Pad Mounted Utility Transformer, which is fed from an overhead pole with 13.2KV line at the primary of the above cited transformer. The secondary of the said transformer is feeding the existing MCC-1, which is in the Control Room of Pump House Building via exterior wall mounted Utility CT-Meter.

2. The existing MCC-1 has 800A Main Circuit Breaker and with 800A Horizontal Buses and 300A vertical buses. This MCC has some spare circuit breakers (CBs) and Full Voltage

Non- Reversible (FVNR) starters. However, it is not possible to add any extra load on this this MCC-1 as it is already over-loaded beyond its maximum capacity of 800A.

3. The new electrical load of GWTP has been calculated based on the new addition of AOP (provided under Appendix D) along with existing to remain load in the existing MCC-1. The new electrical load for the pump house due to addition of AOP becomes approximately 1,000 KVA with 25% spare capacity (for future growth), which is entails the requirement of upgrading the power service. Based on our calculations and availability of a standard size utility transformer shall be 1,000KVA. So, we propose the new utility transformer size to be 1,000KVA.

4. A 1,000KVA Oil Cooled Concrete Pad Mounted Transformer shall be placed at location minimum of twenty-five (25) feet away from the existing building as per PSEG's requirement. The existing 500KVA Transformer shall be kept in place with feeder to existing MCC-1 during the construction period for with new Transformer. The new transformer needs a new concrete pad above an underground precast concrete vault, which would have conduit -entrances both for Medium Voltage (MV) underground cable (from new overhead pole) and the secondary outgoing cables to Current Transformer (CT) cabinet & Utility Meter to be mounted on a free-standing H-frame structure next to Transformer. The primary side (rated 15KV) cables and the secondary cables shall be installed in new underground concrete encased duct bank.

5. The feeder from secondary of the new Utility Transformer shall be terminated in the new Service Entrance type Disconnect Switches via. Current Transformer (CT) Cabinet and a Wire-Trough (WT), where the feeder would be tapped into two Service Entrance type Fused Disconnect Switches- (a) 800A & (b) 400A. The item (a) above will be feeding existing MCC-1 and item (b) will be feeding a new 400A, 480/277V, 3Phase, 4W Panelboard namely "P." All new incoming 120/208V, 3phase load shall be provided from a new Panelboard namely "L" which shall be fed from Panel "P" via a 45 KVA, 3Phase, Dry type Transformer. Provide private KWH-Meter capable of access through website via. Intranet.

6. The new Panelboards "P" & "L" along with a step-down transformer shall be installed inner north wall of the pump house building.

7. The new AOP will have two (2) Power Distribution Centers (PDC-1 & PDC-2) & one (1) System Control Center (SCC) and they will be fed power from Panel "P" & Panel "L" respectively.

8. Control and data wiring from the above PDCs & SCC shall be connected to existing Main Control I/O Cabinet (located in the Control Room) via 2-2" conduits.

Section 6: Process Control System

The Process Control System consists of the following components:

1. Furnish and install all process control instrumentation provided by system manufacturer in accordance with vendor specific installation instructions.

2. Furnish and install any conduit, wiring and other fittings for powering and communication of field instrumentation with the plants existing PLC/SCADA system as described in technical specifications.

3. Provide for all PLC/SCADA programming, networking equipment configuration, remote monitoring equipment configuration and remote alarm notification software as described in the technical specifications.

4. Provide for overall system functional testing as described in the technical specifications.

Section 7: Site Work and Restoration

The Site Work and Restoration consist of the following components:

1. Furnish all earthwork, including pad excavation and site re-grading, as shown in the technical drawings and as described in the design report and technical specifications.
2. Furnish site utilities, including trenching, as shown in the technical drawings and as described in the design report and technical specifications. This includes stormwater system tie-ins, water service lines, and electrical lines. All utilities outside 5 feet of the exterior of the building, as well as the roof drain tie-ins, may be considered “site work”.
3. Furnish all seeding and sodding (topsoil) per technical drawings.
4. Remove all remaining temporary features such as the office trailer, temporary utilities, laydown area, and stabilized construction entrance.
5. Repair or replace asphalt, fence, grass, or other permanent site features that were disrupted during construction to visual acceptance or otherwise working condition.
6. Remove all remaining erosion and sediment control, dewatering, and temporary features once the site is stabilized.
7. Close out Erosion and Sediment Control Plan and Dewatering Plan

Section 8: Plumbing System

The Plumbing system consists of the following components:

1. Furnish one (1) new combination Eye Wash & Safety Shower serving the Control Room. The combination Eye Wash & Safety Shower will be served by a new Emergency Tepid Water Heater.
2. Furnish one (1) new Exterior Combination Eye Wash & Safety Shower serving the Hydrogen Peroxide Tank located on the North-West side of the building. The combination Eye Wash & Safety Shower will be served by a new Emergency Tepid Water Heater.
3. Furnish a 120-gallon Emergency Tepid Water Heater serving the two (2) existing interior Eye Wash & Safety Showers and the two (2) new Eye Wash & Safety Showers.
4. Furnish 6 watts per foot heat trace for Tepid Water pipe run outside building to new exterior Eye Wash & Safety Shower.

Section 9: Special Requirements

Contractor shall include in the Bid the following:

1. Include an allowance for programming of the plant PLC to communicate with the vendor supplied PLC for monitoring and control of equipment.

END OF SECTION

SECTION 01 33 00

SUBMITTAL

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 The Contractor shall provide timely four (4) sets, unless otherwise directed, of the submittals required by this Section for review, comment, and approval, as required or deemed necessary by the Contracting Officer Representative (COR).

1.2 RELATED SECTIONS

1.2.1 Performance Work Statement.

1.3 SUMMARY OF SUBMITTIALS

1.3.1 The submittals which the Contractor is required to provide are detailed in the individual specifications. The contractor shall prepare the Submittal Registry. The submission dates represent the minimum number of working days for prior to, and maximum number of working days for after, the referenced bench mark dates.

1.4 SHOP DRAWINGS, MANUFACTURER'S PRODUCT DATA, AND SAMPLES

1.4.1 Shop Drawings

1.4.1.1 Engineering data covering all equipment and fabricated materials that will become a permanent part of the work under this Performance Work Statement (PWS) shall be submitted for review. Shop drawings as specified in individual work Sections include, but are not necessarily limited to, custom-prepared data such as fabrication and erection/installation drawings, scheduled information, setting diagrams, actual shop-work manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection, and test reports including performance curves and certifications, manufacturer's certificates, as applicable to the work.

1.4.1.2 To aid in expediting the project, shop drawings submitted by the Contractor's Subcontractors (i.e., Supplier, Manufacturer, etc.) for review shall be sent directly to both the Contractor and the COR for preliminary checking. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.

1.4.1.3 The Contractor shall check all his Subcontractors' shop drawings regarding measurements, size of members, materials, and details to satisfy himself that they conform to the intent of the PWS Drawings and Technical Specifications. Drawings found to be inaccurate or otherwise in error shall be returned to the Subcontractor for correction before final submission to the COR.

1.4.1.4 Each final submittal shall have affixed to it the following Certification Statement, signed by the Contractor: "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers, and similar data and I have checked and coordinated each item with other applicable reviewed shop drawings and all PWS requirements."

1.4.1.5 All deviations from the PWS Drawings or Technical Specifications shall be identified on each submittal and will be tabulated in the Contractor's letter of transmittal. Such submittal shall, as pertinent to the deviations, indicate essential details for all changes proposed by the Contractor (including modifications to other facilities that may be a result of the deviation) and all required piping and wiring diagrams.

1.4.1.6 Each submittal shall indicate the intended use of the item in the work. When catalog pages are submitted, applicable items shall be clearly identified. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data.

1.4.1.7 Submittals shall be sequentially numbered, with re-submittals of the same or supplementary information numbered with the original submittal number and a "-Revision 1" for the second submittal, "-Revision 2" for the third submittal, and so forth.

1.4.2 Manufacturer’s Product Data

1.4.2.1 Manufacturer’s Product Data, as specified in individual Sections, include, but are not necessarily limited to, standard prepared data for manufactured products (sometimes referred to as catalog data), such as the Manufacturer's product specification and installation instructions, availability of colors and patterns, Manufacturer's printed statements of compliances and applicability, roughing in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spare-parts listing, and printed product warranties, as applicable to the Work.

1.4.2.2 Manufacturer’s product data shall also include, if requested by the COR, items of disposable clothing, safety equipment, breathing apparatus, communication devices, items of equipment to be used on the site, and any other items which are required for the safety and health of all personnel on the site. This information shall be submitted to the COR to verify that the requirements for materials have been met. This information shall be required for, at a minimum, the concrete mix, crushed stone, seed mixture, gratings, and concrete manholes.

1.4.3 Samples

1.4.3.1 Samples specified in individual Sections, include, but are not necessarily limited to, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, and units of work to be used by the COR for independent inspection and testing, as applicable to the work.

1.4.4 Submission Requirements

1.4.4.1 Coordination of Submittal Items

1.4.4.1.1 Prepare and transmit each submittal within the time specified in the individual work sections of the Specifications, so that the installation will not be delayed by processing times including revision and re-submittal (if required), coordination with other submittals, testing, purchasing, fabrication, delivery, and similar sequenced activities. No extension of time will be authorized because of the Contractor's failure to transmit submittals sufficiently in advance of the work.

1.4.4.2 Number of Submittals Required

1.4.4.2.1 Shop drawings: Submit four (4) copies.
1.4.4.2.2 Manufacturer's Product Data: Submit four (4) copies.
1.4.4.2.3 Samples: Submit four (4) pieces or the number stated in the respective Specification Sections or as directed by the COR.
1.4.4.2.4 All other submittals: Submit four (4) copies or pieces, unless stated elsewhere in the Technical Specification or as directed by the COR.

1.4.4.3 All submittals, regardless of origin, shall have the following identification data, as applicable, contained thereon or permanently adhered thereto:

1.4.4.3.1 Date of submission and dates of any previous submissions.
1.4.4.3.2 Project Name and Contract and Task Order Number.
1.4.4.3.3 Contractor's name and address.
1.4.4.3.4 Supplier's name and address.
1.4.4.3.5 Manufacturer's name and address.
1.4.4.3.6 Submittal or re-submittal number.
1.4.4.3.7 Title or identification of submittal.
1.4.4.3.8 References to applicable Section and part of the Technical Specification paragraphs or to applicable PWS Drawings.
1.4.4.3.9 Contractor's Certification Statement.
1.4.4.3.10 Deviations from PWS Documents, to be adequately stated.

1.4.4.4 Resubmission Requirements

1.4.4.4.1 Make any corrections or changes in the submittals required by the COR and resubmit until approved.

1.4.4.5 Review of Shop Drawings, Manufacturer's Product Data, and Samples.

1.4.4.5.1 After review by the COR, shop drawings, manufacturer's product data, and samples will be returned to the Contractor denoted with the following classifications:

1.4.4.5.1.1 Approved.
1.4.4.5.1.2 Approved except as noted. Re-submittal not necessary.
1.4.4.5.1.3 Approved except as noted. Re-submittal necessary.
1.4.4.5.1.4 Disapproved. Re-submittal necessary.
1.4.4.5.1.5 Receipt acknowledged.
1.4.4.5.1.6 Submittal not required.

1.4.4.5.2 Re-submittals will indicate any changes that have been made in addition to those requested by the COR.
1.4.4.5.3 No portion of the work requiring a shop drawing, manufacturer's product data, or sample shall be commenced nor shall any material be fabricated or installed prior to review of that shop drawing, manufacturer's product data, or sample by the COR and the submittal returned to the Contractor denoted "APPROVED" or "APPROVED AS NOTED, RE-SUBMITTAL NOT NECESSARY". The COR will not be responsible for any expense or delay due to Contractor's corrections or remedies required to accomplish conformity.
1.4.4.5.4 Any need for more than one re-submission, or other delay in obtaining COR's review of submittals, will not entitle Contractor to a schedule extension.
1.4.4.5.5 It may be expected that the COR will review and return submittals to the Contractor within seven (7) working days of their receipt by COR.

1.4.4.6 Distribution

1.4.4.6.1 Distribute reproduction of shop drawings, manufacturer's product data, and samples returned to the Contractor marked "APPROVED" or "APPROVED AS NOTED, RE-SUBMITTAL NOT REQUIRED," where required, to the job site file and elsewhere as directed by the COR.

1.5 CONSTRUCTION PHOTOGRAPHS

1.5.1 The Contractor shall photographically record progress of construction on a biweekly basis and provide 3-1/2 inch x 5-inch photographs and negatives.

1.5.2 Each photographic print shall have attached to the backing a label, approximately 4 inches wide by 2 inches high containing thereon in typed lettering:

1.5.2.1 Project name and Contract and Task Order number.
1.5.2.2 Contractor's name.
1.5.2.3 Photographer's name.
1.5.2.4 Photographer's numbered identification of exposure.
1.5.2.5 Date and time of exposure.
1.5.2.6 Orientation of view.
1.5.2.7 Short description of view.

1.6 OPERATION AND MAINTENANCE MANUALS

1.6.1 The Contractor shall provide Operation and Maintenance Manual for all equipment provided.

PART 2 - PRODUCTS (NON-APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL PROCEDURES

3.1.1 The Contractor shall timely present all submittals in accordance with the Performance Work Statement.

END OF SECTION

SECTION 01 35 10

ENVIRONMENTAL PROTECTION

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 This Section describes the work required by the Contractor for the protection of the environment throughout the course of the project, except for those measures specifically set forth in other sections of these Specifications. Compliance with the provisions of this section by lower-tier subcontractors will be the responsibility of the Contractor. Items to be considered under this section are air, water, and land resources and shall include noise, equipment fuel management, land resource management, and management of other chemicals.

1.2 RELATED SECTIONS

1.2.1 Section Includes:

1.2.1.1 01 33 00 Submittals
1.2.1.2 01 39 40 Spill Control
1.2.1.3 01 41 00 Regulatory Requirements

1.3 DEFINITIONS

1.3.1 Environmental protection shall be defined as the retention of the environment in its natural state, to the greatest extent possible, during the project implementation, and the enhancement of the natural appearance in its final condition.

1.4 SUBMITTALS

1.4.1 The Contractor shall provide all labor, equipment, and materials necessary for environmental protection that could arise as a result of Contractor activities or conditions during the course of this project.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 The Contractor shall provide all labor, equipment, and materials necessary for environmental protection that could arise as a result of Contractor activities or conditions during the course of this project.

PART 3 - EXECUTION

3.1 GENERAL

3.1.1 The Contractor shall be responsible for complying with all applicable Federal, State, and local laws concerning the prevention, abatement, and control of all environmental pollution arising from the project activities in accordance with Section 01 41 00, “Regulatory Requirements”.

3.2 PROTECTION OF LAND RESOURCES

3.2.1 The Contractor shall confine project activities to work areas designated by the Contracting Officer Representative (COR) and/or construction oversight firm, and, at all times, perform work in a manner that minimizes the interference with or the disturbance to fish, wildlife, and vegetation.

3.2.2 The Contractor shall implement measures to prevent lubricants, chemicals, and fuels from entering natural land features.

3.3 BURNING

3.3.1 Under no circumstances shall the burning of debris or waste materials be conducted at the site.

3.4 SPILL CONTROL

3.4.1 Control of spills will be in accordance with Section 01 39 40, “Spill Control”.

3.5 TEMPERORY CONTROLS

3.5.1 All construction machinery and vehicles shall be equipped with practical sound-muffling devices and operated in a manner to cause the least noise, consistent with efficient performance of work. In addition, in order to minimize noise disturbances, the operation of machinery and large vehicles shall be confined to the hours of 8:00 a.m. to 5:00 p.m. Monday through Friday, or as otherwise approved by the Town.

3.5.2 The Contractor shall maintain all excavations, stockpiles, access roads, waste areas, and all other areas free from dust to such a degree as to avoid causing a hazard or nuisance. Earth surfaces subject to dusting may be kept moist with water or dust may be controlled by other measures, if approved by COR. Dusty materials in piles or in transit shall be covered to prevent blowing. The Contractor will maintain a mobile water tank complete with spray bar and pump on site, if dust control is to be performed by water sprinkling.

3.5.3 The Contractor shall provide for the drainage of stormwater and such water as may be applied or discharged on the site in performance of the work. Drainage facilities shall be adequate to prevent damage to the work, the site, and adjacent property.

3.5.4 Erosion and Sediment Control

3.5.4.1 The Contractor shall use the Erosion and Sediment Control measures specified on the technical drawings as the Erosion and Sediment Control Plan (E&SCP) and shall specify additional applicable erosion and sediment control measures and Best

Management Practices (BMPs) in accordance with the New York Standards and Specifications for Erosion and Sediment Controls. The Contractor shall be responsible for providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations.

3.5.4.2 The Contractor shall obtain an approval of the Erosion and Sediment Control Plan as identified in the New York State Standards and Specifications for Erosion and Sediment Control, if required.

3.5.4.3 The Contractor shall use the Erosion and Sediment Control measures to control adverse effects from erosion and sedimentation during construction activities.

3.5.4.4 The Contractor shall prevent erosion of soil on the site and adjacent property resulting from his construction activities. The Contractor shall design, construct, and maintain as a minimum the erosion control BMPs specified in the E&SCP. Protective erosion control measures shall be initiated prior to the commencement of clearing, grading, excavation, or other operations that will disturb the natural protection.

3.5.4.5 The Contractor shall construct or install temporary and permanent erosion and sediment control, as indicated on the drawings. BMPs may include, but not be limited to, vegetation cover, slope stabilization, silt fences, construction of terraces, interceptor channels, inlet and outfall protection, and diversion channels.

3.5.4.6 Work shall be scheduled to expose areas subject to erosion for the shortest possible time, and to maintain natural vegetation to the greatest extent possible. Any temporary measures shall be removed after the area has been stabilized.

3.6 NOTIFICATION OF NON-COMPLIANCE

3.6.1 Failure of the COR to notify the Contractor of non-compliance does not relieve the Contractor of responsibility of compliance with the aforementioned federal, state, or local laws or regulations. In the event the COR issues such a notice, the Contractor shall immediately inform the COR of the proposed corrective action(s) and take such action(s) as may be appropriate. If the Contractor fails or refuses to comply promptly, the COR may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost because of any such stop orders shall be made the subject of a claim for extension of time, or for excess costs or damages by the Contractor.

END OF SECTION

SECTION 01 39 40

SPILL CONTROL

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 This section details the requirements the Contractor and lower-tier contractors must follow regarding spill control procedures to be followed during completion of this project.

1.2 RELATED SECTIONS

1.2.1 Related Sections as follows:

1.2.1.1 01 33 00 Submittals
1.2.1.2 01 41 00 Regulatory Requirements
1.2.1.3 01 52 10 Health Safety Requirements

1.3 SUBMITTALS

1.3.1 Submit a spill report to the Contracting Officer Representative (COR) immediately after the occurrence of such spill in accordance with Section 01 33 00, “Submittals”.

1.3.2 A spill control plan shall be included as section of the Site-Specific Health and Safety Plan, submitted under Section 01 52 10, “Health Safety Requirements”.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL

3.1.1 Contractor shall ensure that all tanks containing hazardous materials which are required to complete the activities presented herein are located on-site such that any spill would be confined/contained.

3.1.2 The Contractor shall follow appropriate federal, state, and local regulations applicable and/or relevant to spill control in accordance with Section 01 41 00, “Regulatory Requirements”.

3.1.3 The Contractor shall immediately report all hazardous materials spills to the COR.

3.1.4 The Contractor shall be responsible for the timely cleanup of all hazardous materials spills and affected media, including the provision of all labor, equipment, and materials necessary for the cleanup. Cleanup of affected areas shall be subject to approval by the COR.

END OF SECTION

SECTION 01 41 00

REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 The Contractor shall comply with all applicable federal, state, and local laws, ordinances, rules and regulations. The Contractor shall comply with all authorities having jurisdiction over the work. The list of regulations provided in this specification does not necessarily include all regulations which may be applicable to site activities and off-site transportation and disposal. All necessary permits or certificates of inspection shall be paid for and obtained by the Contractor

1.2 REFERENCES

1.2.1 The following references are part of this specification to the extent referenced. These publications shall be the latest edition and are referred in the text by the basic designation only.

FEDERAL LAWS

PL 94-850/98-616	Resource Conservation and Recovery Act (RCRA) of 1976 as amended 1984
PL 94-469	Toxic Substance Control Act (TSCA) of 1976, as amended
PL 91-596	Occupational Safety and Health Act (OSHA) of 1970

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910.120	Hazardous Waste Operations and Emergency Response
40 CFR 260	Hazardous Waste Management Systems, General
40 CFR 261	Identification and Listing of Hazardous Wastes
40 CFR 262	Standards Applicable to Generators of Hazardous Wastes
40 CFR 263	Standards Applicable to Transporters of Hazardous Wastes
40 CFR 264	Standards for Hazardous Wastes TSDF Owners and Operators
40 CFR 265	Interim Standards for Hazardous Wastes TSDF Owners and Operators
40 CFR 270	Hazardous Waste Permits Program
49 CFR 172	Hazardous Materials
49 CFR 173	General Shipment Requirements

49 CFR 174-77	Transporter Requirements
49 CFR 178-79	Container Specifications

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 FEDERAL REGULATIONS

3.1.1 Conduct all site work in accordance with PL 91-596 and 29 CFR 1910.120, including hazardous waste cleanup or chemical spills.

3.1.2 Identify all hazardous wastes in accordance with PL 94-850/98-616 and 40 CFR 261.

3.1.3 Manage all hazardous wastes in accordance with PL 94-850/98-616, 40 CFR 260, and 40 CFR 262.

3.1.4 Transport all hazardous wastes in accordance with PL94-850/98-616, 40 CFR 263, and 49 CFR 172 through 49 CFR 179.

3.1.5 Dispose of all hazardous wastes at off-site facilities which are in compliance with PL 94-850/98-616, 40 CFR 264, 40 CFR 265, and 40 CFR 270.

3.2 STATE REGULATIONS

3.2.1 All Contractor activities within the State of New York boundaries shall be in compliance with New York State labor laws.

3.2.2 Transportation and disposal of non-hazardous wastes must comply with all State Solid Waste Management Program. Transporters must carry a State Waste Transporter Permit.

3.2.3 Transportation of wastes through states other than New York shall be in compliance with all applicable requirements of those states.

3.2.4 Hazardous waste treatment and disposal facilities shall be in compliance with all requirements of the state in which they are operated.

3.3 LOCAL REQUIREMENTS

3.3.1 Ascertain and comply with all applicable county and municipal ordinances, codes, rules and regulations, and obtain all required permits including building permits, building inspections, public health requirements, and seasonal load limits which may be imposed to cover transportation on certain roads.

END OF SECTION

SECTION 01 42 00

ABBREVIATIONS AND DEFINITIONS

PART 1 - GENERAL

1.1 ABBREVIATIONS

1.1.1	AASHTO	American Association of State Highway and Transportation Officials
1.1.2	AC	Alternating Current
1.1.3	ACI	American Concrete Institute
1.1.4	AFBMA	Anti-Friction Bearing Manufactures Association
1.1.5	ANSI	American National Standards Institute
1.1.6	ARAR	Applicable or Relevant and Appropriate Requirements
1.1.7	ASTM	American Society for Testing and Materials
1.1.8	AWG	American Wire Gauge
1.1.9	AWWA	American Water Works Association
1.1.10	BOCA	Building Officials and Code Administrators - National Building Code
1.1.11	cfm	Cubic feet per minute
1.1.12	CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
1.1.13	CFR	Code of Federal Regulations
1.1.14	CRSI	Concrete Reinforcing Steel Institute
1.1.15	DC	Direct Current
1.1.16	DEC	Department of Environmental Conservation
1.1.17	DOT	Department of Transportation
1.1.18	EPA	United States Environmental Protection Agency
1.1.19	FPM	Fluorocarbon rubber
1.1.20	gpd	gallons per day
1.1.21	gpm	gallons per minute
1.1.22	HASP	Health and Safety Plan
1.1.23	HP	Horsepower
1.1.24	HVAC	Heating, Ventilating, Air Conditioning
1.1.25	MCL	Maximum Contaminant Level
1.1.26	NCP	National Contingency Plan
1.1.27	NEC	National Electric Code
1.1.28	NEMA	National Electrical Manufacturers Association
1.1.29	NESC	National Electrical Safety Code
1.1.30	NFPA	National Fire Protection Association
1.1.31	NIOSH	National Institute of Occupational Safety and Health
1.1.32	NPDES	National Pollution Discharge Elimination System

1.1.33 NPL	National Priorities List
1.1.34 OSHA	Occupational Safety and Health Administration
1.1.35 PAC	Personal Authorization Code
1.1.36 PCA	Portland Cement Association
1.1.37 PP	Polypropylene
1.1.38 PPE	Personal Protective Equipment
1.1.39 psi	Pounds per Square Inch
1.1.40 psig	Pounds per Square Inch Gauge
1.1.41 PVDF	Ployvinylidene Fluoride
1.1.42 QA	Quality Assurance
1.1.43 QC	Quality Control
1.1.44 QCP	Quality Control Plan
1.1.45 RCRA	Resource Conservation and Recovery Act of 1976, as amended
1.1.46 RF	Radio Frequency
1.1.47 RFQ	Request for Quotation
1.1.48 ROD	Record of Decision
1.1.49 RPM	Revolutions per Minute
1.1.50 SARA	Superfund Amendments and Reauthorization Act of 1986
1.1.51 SSH	Straight Shell Height
1.1.52 SSPC	Steel Structure Painting Council
1.1.53 TDH	Total Displacement Head
1.1.54 TEFC	Totally Enclosed Fan Cooled
1.1.55 ToH	Town of Hempstead
1.1.56 TSCA	Toxic Substances Control Act of 1976, as amended
1.1.57 TSDF	Treatment, Storage, and Disposal Facility
1.1.58 TSP	Total Suspended Particulates
1.1.59 UL	Underwriter Laboratory
1.1.60 USDH	United States Department of Health and Human Services
1.1.61 USDOT	United States Department of Transportation
1.1.62 USEPA	United States Environmental Protection Agency
1.1.63 USN	United States Navy, US Navy, or Navy
1.1.64 V	Volts
1.1.65 VOC	Volatile Organic Compound
1.1.66 WP	Work Plan

1.2 DEFINITIONS

1.2.1 Contracting Officer or Contracting Officer Representative – Owner's representative in charge of the project, and his/her representative(s).

1.2.2 Completion of Work – Completion of all required on-site activities.

1.2.3 Contractor – The entity entering into the Contract with Contracting Officer to perform the work described in the Contract Documents.

1.2.4 Performance Work Statement drawings – These drawings prepared by the Engineer of Record to construct the Advanced Oxidation Process system.

1.2.5 Decontamination Area – Areas constructed by the Contractor, Materials, equipment, and personnel shall receive decontamination or cleaning in these areas.

1.2.6 Decontamination (equipment) – A thorough rinsing of the equipment with a high-pressure steam sprayer to remove all surface contamination

1.2.7 Decontamination (personnel) – This encompasses the procedure for performing proper decontamination. This item is detailed in the HASP.

1.2.8 Hazardous Waste – A material that has been sampled, analyzed, and meets the RCRA definition of a hazardous waste.

1.2.9 Manufacturer – The entity actually supplying any equipment or material component for one or more of the items of the groundwater extraction and treatment system.

1.2.10 Manufacturer's Representative – Person designated by the manufacturer to coordinate the supply and installation of equipment.

1.2.11 Non-Hazardous Waste – A material which has been sampled, analyzed, and exceeds the Contracting Officer Type B cleanup criteria, but does not satisfy the RCRA definition of hazardous waste.

1.2.12 Owner – United States Navy (USN)

1.2.13 Product – Materials, systems, and equipment.

1.2.14 Remedial Project Manager – US Navy Technical Lead

1.2.15 Project Manual – The compilation of documents which govern the work to be performed which includes instructions to Offerors, Contract Forms, Contract Conditions, Technical Specifications, and Contract Drawings.

1.2.16 Provide – To furnish and install in place.

1.2.17 Shop Drawings – Equipment specific drawings prepared by Manufacturer and showing all necessary equipment fabrication data.

1.2.18 Site – The GM38 Groundwater Treatment Plant near Naval Weapons Industrial Reserve Plant Site, Bethpage

1.2.19 Site Manager – Contractor's Field Representative who has the overall responsibility to manage and execute the work in accordance with the Project Manual and subsequent amendments.

1.2.20 Supplier – The entity actually supplying one or more complete groundwater extraction or treatment equipment items.

1.2.21 Support Plans – Documents required for the start of work as outlined in the Technical Specifications including, but not limited to, the WP, QCP, and HASP components of the Remedial Action Work Plan.

1.2.22 Technical Specifications – Specifications prepared by the Contracting Officer Representative for the Contractor.

1.2.23 Treatment, Storage, and Disposal Facility – A licensed Type I, II, or III treatment, storage, and disposal facility

1.2.24 Work – All engineering, labor equipment, and material required to design, procure, and install a complete Advanced Oxidation Process treatment system as specified herein.

1.2.25 Work Area – The area in which the Contractor can work and perform construction activities. The Contractor shall not go outside of this area without prior approval of Contracting Officer.

1.3 NOTE

1.3.1 Due to the nature of the work and the type of equipment required, it is possible and acceptable, that the same entity be at once Contractor, Supplier, and Manufacturer or any combination thereof.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01 45 00

QUALITY CONTROL

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 This section describes the minimum requirements the Contractor shall address and abide by with respect to quality control.

1.2 RELATED SECTIONS

1.2.1 The following are related sections

1.2.1.1 01 33 00 Submittals

1.2.2 Division 1 Sections for project management and coordination.

1.2.3 All other Division Sections for Specific Test and Inspection Requirement.

1.3 SUBMITTALS

1.3.1 Submit the following in accordance with Section 01 33 00, “Submittals”:

1.3.1.1 Quality Control Plan

1.3.1.1.1 Submit a Quality Control Plan detailing the quality control organization and procedures to be used during the project. The Quality Control Plan should be prepared for general construction only.

1.3.1.2 Quality Control Project Summary Report

1.3.1.2.1 Submit a Quality Control Project Summary Report that will summarize the overall quality of the data obtained and the work completed during the project. This report shall be submitted in accordance with the PWS schedule and will be an appendix to the Construction Completion Report.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 QUALITY CONTROL PROCEDURES

3.1.1 Through quality control (QC) procedures, the Contractor assures the Contracting Officer that the Contractor and all lower-tier contractors comply with the requirements of the specifications presented herein. The controls shall be adequate to cover all contract operations. The quality of all work shall be the responsibility of the Contractor. Sufficient inspections and tests of all items of work, including that of lower-tier contractors, shall be performed on a continuing basis to ensure conformance with respect to the quality of work. The Contractor shall furnish qualified personnel, appropriate facilities, instruments and testing devices necessary for the performance of the QC function. The controls shall be adequate to cover all operations both on and off-site, keyed to the proposed work sequence, and correlated by the Contractor's QC personnel.

3.2 QUALITY CONTROL RECORDS

3.2.1 The Contractor shall maintain up-to-date records of QC operations, activities, and tests performed. These records shall include the work of suppliers and lower-tier contractors. The records shall cover both conforming and defective or deficient features.

3.3 INSPECTIONS

3.3.1 After the substantial completion of work, the Contractor, in conjunction with the RPM, CM and/or EOR, shall conduct a completion inspection of the work and develop a list of any items that do not conform to the approved specifications presented herein. Such a list shall include the estimated date by which the deficiencies will be corrected. The substantial completion inspection and any deficiency correction required by this paragraph shall be accomplished within the time stated for completion of the entire work or any particular increment thereof. The Contractor shall keep records of the inspection, including the list of deficiency items. For each item on this list, the Contractor shall document the corrective actions taken.

3.3.2 Following corrective action measures, the Contractor, in conjunction with the RPM, CM and/or EOR, shall make a final completion inspection to ascertain that all deficiencies have been corrected.

3.4 QUALITY CONTROL PROJECT SUMMARY REPORT

3.4.1 , The Contractor shall submit to the RPM a Contractor Quality Control Project Summary Report. This report will summarize and state the overall quality of data obtained (where applicable) and work completed during the project. The report will certify the acceptability of data and work based on the QA/QC requirements defined in the Contractor quality control plan. The will be an appendix to the Construction Completion Report.

END OF SECTION

SCHEDULE OF SPECIAL INSPECTIONS

P – Perform these Special Inspections tasks for each welded joint or member. (AISC 360 & AISC 341)

O – Observe these Special Inspections items on a random daily basis. Operations need not be delayed pending these inspections. (AISC 360 & AISC 341)

D – Document, with a report, that the work has been performed in accordance with the Performance Work Statement documents. (AISC 341)

C – Continuous Special Inspections is the constant monitoring of specific tasks by a special inspector. These inspections must be carried out continuously over the duration of the particular tasks. (IBC)

P – Periodic Special Inspections is Special Inspections by the special inspector who is intermittently present where the work to be inspected has been or is being performed. (IBC)

STRUCTURAL STEEL

PRIOR TO WELDING (Table N5.4-1, AISC 360-10 & TABLE J6-1, AISC 341-10)				
Required	Task	Perform	Observe	Description
☒	1. Verify welding procedures (WPS) and consumable certificates	P	-	
☒	2. Material identification (Type/Grade)	-	O	
☒	3. Welder identification system	-	O	A system shall be maintained by which a welder who has welded a joint or member can be identified. Stamps, if used, shall be the low-stress dye type.
☒	4. Fit-up groove welds (including joint geometry)	-	O	• Joint preparation • Dimensions (alignment, root opening, root face, bevel) • Cleanliness (condition of steel surfaces) • Tacking (tack weld quality and location) • Backing type and fit (if applicable)
☒	5. Configuration and finish of access holes	-	O	
☒	6. Fit-up of fillet welds	-	O	• Dimensions (alignment, gaps at root) • Cleanliness (condition of steel surfaces) • Tacking (tack weld quality and location)

STRUCTURAL STEEL

DURING WELDING (Table N5.4-2, AISC 360-10 & TABLE J6-2, AISC 341-10)				
Required	Task	Perform	Observe	Description
☒	1. Use of qualified welders	-	O	
☒	2. Control and handling of welding consumables	-	O	• Packaging • Exposure control.
☒	3. No welding over cracked tack welds	-	O	
☒	4. Environmental conditions	-	O	• Wind speed within limits • Precipitation and temperature
☒	5. WPS followed	-	O	• Settings on welding equipment • Travel speed • Selected welding materials • Shielding gas type/flow rate • Preheat applied • Interpass temperature maintained (min./max.) • Proper position (F, V, H, OH) • Intermix of filler metals avoided unless approved
☒	6. Welding techniques	-	O	• Interpass and final cleaning • Each pass within profile limitations • Each pass meets quality requirements

STRUCTURAL STEEL

AFTER WELDING (TABLE N5.4-3, AISC 360-10 & TABLE J6-3, AISC 341-10):				
Required	Task	Perform	Observe	Description
☒	1. Welds cleaned	-	O	
☒	2. Size, length, and location of welds	P	-	
☒	3. Welds meet visual acceptance criteria	P	-	• Crack prohibition • Weld/base-metal fusion • Crater cross section • Weld profiles • Weld size • Undercut • Porosity
☒	4. Arc strikes	P	-	
☒	5. k-area	P	-	When welding of doubler plates, continuity plates or stiffeners has been performed in the k-area, visually inspect the web k-area for cracks within 3 in. of the weld.
☒	6. Backing removed and weld tabs removed (if required)	P	-	
☒	7. Backing removed, weld tabs removed and finished, and fillet welds added (if required)	P	-	
☒	8. Placement of reinforcing or contouring fillet welds (if required)	P	-	
☒	9. Repair activities	P	-	
☒	10. Document acceptance or rejection of welded joint/member	P	-	

STRUCTURAL STEEL

NONDESTRUCTIVE TESTING (SECTION N5.5, AISC 360-10 & SECTION J6.2, AISC 341-10):				
Required	Task	Perform	Observe	Description
☐	1. CJP welds (Risk Cat. II)	-	O	Ultrasonic testing shall be performed on 10% of CJP groove welds in butt, T- and corner joints subject to transversely applied tension loading in materials 5/16-inch thick or greater. Testing rate must be increased if > 5% of welds tested have unacceptable defects.
☒	2. CJP welds (Risk Cat. III, IV or V)	-	O	Ultrasonic testing shall be performed on all CJP groove welds in butt, T- and corner joints subject to transversely applied tension loading in materials 5/16-inch thick or greater.
☒	3. CJP welds	-	O	Ultrasonic testing shall be performed on 100% of CJP groove welds in materials 5/16-inch or greater. Magnetic particle testing shall be performed on 25% of all beam-to-column CJP groove welds.
☐	4. Access holes (flange > 2”)	-	O	Thermally cut surfaces of access holes shall be MT or PT when the flange thickness exceeds 2 in. for rolled shapes, or when the web thickness exceeds 2 in. for built-up shapes. Any cracks shall be deemed unacceptable regardless of size or location.
☒	5. Welded joints subject to fatigue	-	O	Radiographic or Ultrasonically inspect welded joints identified on the Performance Work Statement documents to be subject to fatigue per sections 5.1, 5.2, 5.3, 5.4, 6.1, 6.2, and 6.3 of Table A-3.1, AISC 360-10.

STRUCTURAL STEEL

NONDESTRUCTIVE TESTING (SECTION N5.5, AISC 360-10 & SECTION J6.2, AISC 341-10):				
Required	Task	Perform	Observe	Description
☒	6. K-area NDT	P	-	Where welding of doubler plates, continuity plates or stiffeners has been performed in the k-area, the web shall be tested for cracks using magnetic particle testing (MT). The MT inspection area shall include the k-area base metal within 3-inches of the weld. The MT shall be performed no sooner than 48 hours following completion of the welding.
☒	7. Base metal NDT for lamellar tearing and laminations	-	O	After joint completion, base metal thicker than 1 1/2 in. loaded in tension in the through-thickness direction in tee and corner joints, where the connected material is greater than 3/4 in. and contains CJP groove welds, shall be ultrasonically tested for discontinuities behind and adjacent to the fusion line of such welds.
☒	8. Beam cope and access hole	-	O	At welded splices and connections, thermally cut surfaces of beam copes and access holes shall be tested using magnetic particle testing or penetrant testing, when the flange thickness exceeds 1 1/2 in. for rolled shapes, or when the web thickness exceeds 1 1/2 in. for built-up shapes.
☒	9. Reduced beam section repair	-	O	Magnetic particle testing shall be performed on any weld and adjacent area of the reduced beam section (RBS) cut surface that has been repaired by welding, or on the base metal of the RBS cut surface if a sharp notch has been removed by grinding.
☒	10. Weld tab removal sites	-	O	At the end of welds where weld tabs have been removed, magnetic particle testing shall be performed on the same beam-to-column joints receiving UT.

STRUCTURAL STEEL

PRIOR TO BOLTING (TABLE N5.6-1, AISC 360-10 & TABLE J7-1, AISC 341-10):				
Required	Task	Perform	Observe	Description
☒	1. Manufacture’s certification available for fastener materials	P	-	
☒	2. Fasteners marked in accordance with ASTM requirements	-	O	
☒	3. Proper fasteners selected for joint detail (grade, type, bolt length if threads are to be excluded from shear plane	-	O	
☒	4. Proper bolting procedure selected for joint detail	-	O	
☒	5. Connecting elements, including appropriate faying surface condition and hole preparation, if specified, meet applicable requirements	-	O	
☒	6. Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used	-	O	
☒	7. Proper storage provided for bolts, nuts, washers, and other fastener components	-	O	

STRUCTURAL STEEL

DURING BOLTING (TABLE N5.6-2, AISC 360-10 & TABLE J7-2, AISC 341-10):				
Required	Task	Perform	Observe	Description
☒	1. Fastener assemblies of suitable condition, paced in all holes and washers (if required) are positioned as required	-	O	
☐	2. Joint brought to the snug-tight condition prior to pretensioning operations	-	O	
☒	3. Fastener component not turned by the wrench prevented from rotating	-	O	
☐	4. Fasteners are pretensioned in accordance with RCSC Specification, progressing systematically from the most rigid point toward the free edges	-	O	
AFTER BOLTING (TABLE N5.6-3, AISC 360-10 & TABLE J7-3, AISC 341-10):				
Required	Task	Perform	Observe	Description
☒	Document acceptance or rejection of bolted connections	P	-	
OTHER STEEL INSPECTIONS (SECTION N5.7, AISC 360-10):				
Required	Task	Perform	Observe	Description
☒	1. Anchor rods and other embedments supporting structural steel	P	-	Verify the diameter, grade, type, and length of the anchor rod or embedded item, and the extent or depth of embedment prior to placement of concrete.
☒	2. Fabricated steel or erected steel frame	-	O	Verify compliance with the details shown on the construction documents, such as braces, stiffeners, member locations and proper application of joint details at each connection.

STEEL CONSTRUCTION OTHER THAN STRUCTURAL STEEL

STEEL ROOF AND FLOOR DECKS (IBC TABLE 1705.2.2):				
Required	Task	Continuous	Periodic	Description
☒	1. Material verification of cold-formed steel deck	-	P	Confirm that identification markings are provided to conform to ASTM standards specified on approved construction documents. Verify material with manufacturer's certified test reports.
☒	2. Floor and roof deck welds	-	P	Visual inspection to confirm that welds meet acceptance criteria of AWS D1.3 and verify welder qualifications.
WELDING OF REINFORCING STEEL (IBC TABLE 1705.2.2):				
Required	Task	Continuous	Periodic	Description
☒	1. Verification of weldability	-	P	Verify weldability of reinforcing steel, other than ASTM A 706 based upon carbon equivalent and in accordance with AWS D1.4.
☐	2. Reinforcing steel resisting flexural and axial forces in intermediate or special moment fames, and boundary elements of special structural walls	C	-	Visually inspect all welds in accordance with AWS D1.4.
☒	3. Shear reinforcement	C	-	Visually inspect all welds in accordance with AWS D1.4.
☒	4. Other reinforcing steel	-	P	Visually inspect all welds in accordance with AWS D1.4.

CONCRETE CONSTRUCTION

IBC TABLE 1705.3, 1705.12.1:				
Required	Task	Continuous	Periodic	Description
☒	1. Reinforcing steel, including prestressing tendons	-	P	Verify prior to placing concrete that reinforcing is of specified type, grade and size; that it is free of oil, dirt and rust; that it is located and spaced properly; that hooks, bends, ties, stirrups and supplemental reinforcement are placed correctly; that lap lengths, stagger and offsets are provided; and that all mechanical connections are installed per the manufacturer's instructions and/or evaluation report.
☒	2. Anchors cast in concrete	-	P	Verify prior to placing concrete that cast in anchors have proper embedment, spacing and edge distance.
☒	3. Post-installed anchors or dowels	C		Inspect all post-installed anchors/dowels as required by the approved ICC-ES report.
☒	4. Use of required mix design	-	P	Verify that all mixes used comply with the approved construction documents
☒	5. Concrete slump, air content, and temperature	C	-	At the time fresh concrete is sampled to fabricate specimens for strength test verify these tests are performed.
☒	6. Concrete & shotcrete placement	C	-	Verify proper application techniques are used during concrete conveyance and depositing avoids segregation or contamination. Verify that concrete is properly consolidated.
☒	7. Curing temperature and techniques	-	P	Inspect curing , cold weather protection and hot weather protection procedures.
☐	8. Pre-stressed concrete	C	-	Verify application of prestressing forces and grouting of bonded prestressing tendons in the seismic force-resisting system.

CONCRETE CONSTRUCTION

IBC TABLE 1705.3, 1705.12.1:				
Required	Task	Continuous	Periodic	Description
☐	9. Erection of precast concrete	-	P	Verify that all precast elements are lifted, assembled and braced in accordance with the approved construction documents.
☒	10. In-situ concrete strength verification	-	P	Prior to the removal of shores and forms or the stressing of post-tensioned tendons verify that adequate strength has been achieved.
☒	11. Formwork	-	P	Inspect the forms to ensure that they are placed plumb and conform to the shapes, lines, and dimensions of the members as required by the approved construction documents.
☐	12. Reinforcement complying with ASTM A 615 in special moment frames, special structural walls and coupling beams (**)	-	P	Verify that ASTM A 615 reinforcing steel used in these areas complies with ACI 318: 21.1.5.2 by means of certified mill test reports. If this reinforcing steel is to be welded chemical tests shall be performed in accordance with ACI 318: 3.5.2.
☐	13. Reinforcement placement within progressive collapse resisting system (#)	C	-	Visual inspect reinforcing steel placement with a particular emphasis on reinforcing steel anchorages, laps and other details within the progressive collapse resisting system, including horizontal tie force elements, vertical tie force elements and bridging elements.

SOILS CONSTRUCTION

IBC TABLE 1705.6				
Required	Task	Continuous	Periodic	Description
☒	1. Foundation bearing capacity	-	P	Verify the materials below foundations are adequate to achieve the design bearing capacity.
☒	2. Excavations	-	P	Verify the excavations are extended to the proper depth and have reached proper material.
☒	3. Perform classification and testing of compacted fill materials	-	P	
☒	4. Compacted fill material	C	-	Verify the use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill.
☒	5. Subgrade	-	P	Prior to placement of compacted fill, observe sub-grade and verify that site has been prepared properly.

MECHANICAL & ELECTRICAL COMPONENTS

IBC 1705.11.4, 1705.11.6 & 1705.12.3 and UFC 3-301-01				
Required	Task	Continuous	Periodic	Description
☐	1. Anchorage of emergency or standby power systems (**)	-	P	Verify that anchorage complies with approved construction documents.
☐	2. Anchorage of electrical equipment not part of emergency or standby power systems (**)	–	P	Verify that anchorage complies with approved construction documents.
☐	3. Installation of piping systems carrying hazardous materials and their associated mechanical units (**)	-	P	Verify that installation and restraint comply with approved construction documents.
☐	4. Installation of HVAC ductwork containing hazardous materials (**)	-	P	Verify that installation and restraint comply with approved construction documents.
☐	5. Installation of vibration isolation systems having a clearance of less than 1/4 inch between the equipment support frame and restraint	-	P	Verify that installation complies with approved construction documents and manufacturer's recommendations.
☐	6. Designated seismic systems	-	P	Confirm that manufacturer's certificate of compliance conforms to the requirements of Section 13.2 of ASCE 7. Verify that the label, anchorage or mounting conforms to the manufacturer's certificate of compliance.
	7. Designated seismic system equipment verification	-	P	• Verify model number and serial number are in conformance with the Project Specific Seismic Qualification (PSSQ). • Verify Tag ID is correct and installed per specifications.
	8. Designated seismic system equipment mounting	-	P	• Verify that anchor base bolting is installed per PSSQ. • Verify that equipment bracing is installed per PSSQ. • Verify that bracing attachments are installed per PSSQ.

MECHANICAL & ELECTRICAL COMPONENTS

IBC 1705.11.4, 1705.11.6 & 1705.12.3 and UFC 3-301-01				
Required	Task	Continuous	Periodic	Description
	9. Designated seismic system utility conduit/piping	-	P	• Verify that conduit/piping is connected to the equipment per PSSQ (flex or rigid) • Verify that conduit/piping is seismically supported independently of equipment and in accordance with PSSQ support requirements.
	10. Designated seismic system clearance	-	P	• Adjacent equipment – Verify that there is adequate gap to eliminate the possibility of pounding. • Conduit/piping – Verify that there is adequate gap to eliminate possibility of pounding.

SECTION 01 52 00

HEALTH AND SAFETY REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 This section details the requirements the Contractor and lower-tier contractors must follow regarding health and safety procedures. These procedures shall be followed throughout this project.

1.2 RELATED SECTIONS

1.2.1 The following are related sections

1.2.1.1 01 33 00 Submittals
1.2.1.2 All other Division Sections Specifications

1.3 REFERENCES

1.3.1 The following publications are part of this specification to the extent referenced. These publications shall be the latest edition and are referred to in the text by the basic designation only:

FEDERAL LAWS

PL 91-596	Occupational Safety and Health Act (OSHA) of 1970 CFR
29 CFR 1910.120	Hazardous Waste Operations and Emergency Response EPA
OSWER 9285.1-03	Standard Operating Safety Guidelines
OSWER 9285.2-05	Standard Operating Procedures for Site Safety Planning
OHSS-87	1987, Guideline for the Selection of Chemical Protective Clothing, Third Edition

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 85-115	1985, Occupational safety and Health Guidance Manual for Hazardous Waste Site Activities

AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)

ANSI Z41.1	Protective Footwear
ANSI Z87.1	Practice for Occupational and Educational Eye and Face Protection
ANSI Z88.2	Practice for Respiratory Protection

ANSI Z88.6 Physical Qualifications for Respirator Use

AMERICAN CONFERENCE OF GOVERNMENT INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH Current Edition, Threshold Limit Values and Biological Exposure Indices

1.4 SUBMITTALS

1.4.1 Submit the following in accordance with Section 01 33 00, "Submittals":

1.4.1.1 Health and Safety Plan (HASP).
1.4.1.2 Training documentation and Certifications.

PART 2 - PRODUCTS

2.1 PRODUCTS

2.1.1 The Contractor shall provide all labor, equipment, and materials necessary to implement the requirements of this section.

2.2 HEALTH AND SAFETY PLAN

2.2.1 The Contractor shall develop a site-specific Health & Safety Plan (HASP) for submittal to the Contracting Officer Representative (COR) in accordance with the provisions outlined in Section 01 33 00, "Submittals".

2.2.2 The HASP shall be used for Contractor personnel and the personnel of all subcontractors performing activities during this project.

2.2.3 The HASP shall be prepared in accordance with provisions and requirements of 29 CFR 1910.120, OSWER 9285.1-03, OSWER 9285.2-05, OHSS-87, Order No. 1440.2, NIOSH 85-115, ANSI 287.1, ANSI 288.2, and ANSI 288.6. An outline of the HASP is attached as an example.

2.2.4 The HASP shall include, but is not limited to, specifications for levels of protection under which different site activities will be performed and required personal protective equipment, and procedures for all special site activities.

2.2.5 The HASP shall provide, at a minimum, that all Contractor personnel perform the specified work tasks at Level D respiratory and dermal protection.

2.2.6 The HASP shall comply with EM385-1-1.

2.3 OSHA CERTIFICATION

2.3.1 The Contractor shall submit written documentation that the training required by 29 CFR 1910.120(e) has been provided to each employee performing work which may result in exposure to hazardous materials at the site, in accordance with Section 01 33 00, "Submittals".

2.3.2 It is the responsibility of the Contractor to comply with all applicable PL 91-596 regulations.

2.3.3 Certification of site-specific training shall be documented by including (in the HASP) the signature of all Contractor personnel working at the site.

PART 3 - EXECUTION

3.1 GENERAL

3.1.1 The Contractor shall perform all work in accordance with applicable federal, state, and local health and safety regulations and guidance documents, including, but not limited to, PL 91-596, 29 CFR 1910.120, OSWER 9285.1.03, Order No. 1440.2, NIOSH 85-115, ANSI 241.1, ANSI 271.1, ANSI 288.2, ANSI 288.6, ACGIH, and the technical specifications for this project.

3.2 TRAINING REQUIREMENTS

3.2.1 The Contractor shall ensure that all site workers that may be exposed to hazardous materials have had training as required by 29 CFR 1910.120 prior to performing any on-site activities, and a minimum of three days actual field experience under the direct supervision of a trained, experienced supervisor. This training is anticipated to be required only for workers who may come into hazardous substances. The Contractor shall ensure that all on-site management and supervisors have received at least 8 hours of specialized training, in addition to the 40 hours in 3.1.1 of this section, as required by 29 CFR 1910.120.

3.2.2 The Contractor shall ensure that all training has been provided by qualified instructors as described in 29 CFR 1910.120(e)(5) and that each employee has been certified as having successfully completed the training.

3.2.3 The Contractor shall ensure that all site workers have had site-specific health and safety training. Certification of such training shall be documented by including the signature of all trained personnel in the HASP.

3.2.4 The Contractor shall ensure a person with excavation competency training (29 CFR 1926) is supervising during all excavation activities.

3.3 MEDICAL SURVEILLANCE REQUIREMENTS

3.3.1 The Contractor shall ensure that all site workers, including those persons excluded by 29 CFR 1910.120(f)(2), have had a medical examination in accordance with 29 CFR 1910.120(f) prior to performing work at the site.

3.4 HAZARD CONTROL REQUIREMENTS

3.4.1 The Contractor shall provide all necessary personal protective equipment (PPE) to their employees and ensure that such equipment is provided to the employees of lower-tier subcontractors.

3.5 SITE CONTROL REQUIREMENTS

3.5.1 The Contractor shall provide a barrier in the form of fence or equivalent, to restrict access to the construction area by unauthorized personnel. The barrier shall be removed at the start of each day and installed at the conclusion of each day.

3.5.2 The Contractor shall maintain a daily log of all personnel working within the construction area.

3.6 HEALTH AND SAFETY OFFICER

3.6.1 The Contractor shall provide at least one (1) qualified Site Safety Officer (SSO). The SSO must be on-site during all work activities.

3.6.2 The Contractor shall submit the name, qualifications and experiences of the SSO (and any alternates) for acceptance by the COR.

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE (O&M) DATA

PART 1 - GENERAL

1.1 SUMMARY

1.1.1 Compile data and related information in manuals appropriate for Navy's operation and maintenance (O&M) of each item of equipment identified in the Performance Work Statement (PWS) Technical Specification sections.

1.2 QUALITY ASSURANCE

1.2.1 Preparation of data shall be performed by personnel:

- 1.2.1.1 Trained and experienced in O&M of described equipment.
- 1.2.1.2 Familiar with requirements of this section.
- 1.2.1.3 Skilled as technical writer to extent required to communicate essential data.
- 1.2.1.4 Skilled as drafter competent to prepare required drawings.

1.3 FORMS OF MANUALS

1.3.1 Components:

- 1.3.1.1 Size: 8 1/2 in. by 11 in., or 11 in. by 17 in. folded, with standard 3 hole punching.
- 1.3.1.2 Paper: 20 lb minimum, white, for typed pages.
- 1.3.1.3 Text: Manufacturer's printed data, or neatly typewritten. Handwritten data is not acceptable.
- 1.3.1.4 Drawings:
  - 1.3.1.4.1 Bind in with text.
  - 1.3.1.4.2 Fold larger drawings and place in clear plastic pockets punched for inserting into binder. Place identification on outside of each pocket.

1.3.2 Binders:

- 1.3.2.1 Commercial quality D-Ring binder with durable and cleanable plastic covers. Paperboard and laminated paperboard covers are not acceptable.
- 1.3.2.2 Do not fill binders to more than 75% of capacity.
- 1.3.2.3 When multiple binders are used for an item of equipment, organize contents into related groupings. Each binder cover shall bear identification of specific contents.

1.4 SUBMITTAL SCHEDULE

1.4.1 Submit 3 copies of complete O&M data, bound in binders bearing identification label, for review by Navy's representative.

1.4.2 Submit scanned version of O&M data on CD or DVD in .pdf format to the Navy's representative.

1.4.3 Navy's representative's review and acceptance of O&M data will be only for conformance with requirements of this section, for form of submittal and organization of data and completeness of information provided, but not for technical content or coordination between individual suppliers of equipment or system(s).

1.4.4 Navy's representative will be sole judge of completeness of data.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 GENERAL CONTENTS OF DATA

3.1.1 Each manual shall contain appropriate subsections so that equipment data pertaining to not more than one Specification section number indicated in Performance Work Statement (PWS) Documents is in a subsection.

3.1.1.1 Name of equipment as described in PWS Documents.
3.1.1.2 Subcontractor's name, address, and telephone number if equipment is provided by Subcontractor.
3.1.1.3 Manufacturer's name, address, and telephone number.
3.1.1.4 Name, address, and telephone number for local source of supply for parts and service.

3.1.2 Equipment List: Immediately following title sheet containing following:

3.1.3 Table of Contents: Immediately following equipment list. Arrange in logical, systematic order and shall include as minimum each tabbed divider. Each page shall be numbered.

3.1.4 Tabbed Dividers: Insert tabbed section dividers between each major section

3.1.4.1 Provide title of section on each tab.
3.1.4.2 Provide table of contents for each tabbed section, arranged in systematic order.

3.1.5 Equipment Data Sheets: Provide catalog sheets showing configuration, manufacturer's specifications, models, options, and styles of equipment and major components being provided. Product data sheets will show project specific information with inapplicable information deleted by crossing out or removal. Include in tabbed section(s).

3.1.6 Text:

3.1.6.1 Include only those sheets applicable to Project.
3.1.6.2 Each sheet shall:

3.1.6.2.1 Identify specific equipment or part installed.
3.1.6.2.2 Identify text applicable to equipment or part installed.
3.1.6.2.3 Do not include inapplicable information.

3.1.7 Drawings:

3.1.7.1 Supplement text with drawings to clearly illustrate following:

3.1.7.1.1 Equipment and components.
3.1.7.1.2 Relations of component parts of equipment and systems.

3.1.7.1.3 Control and flow diagrams.

3.1.7.2 Actual drawings of equipment from manufacturer. "Typical" drawings are not acceptable, unless they accurately illustrate actual installation.

3.1.8 Specially written information, as required to supplement text for particular installation.

3.1.8.1 Provide explanation of interrelationships of equipment and components, and effects one component has on another or entire system.
3.1.8.2 Provide overall instructions and procedures for equipment tying in instructions and procedures for separate components into unified instructional package.
3.1.8.3 Provide glossary of special terms used by manufacturer.
3.1.8.4 Organize in consistent format under separate headings for different procedures.
3.1.8.5 Provide logical sequence of instructions for each procedure.

3.1.9 Copy of each warranty, bond or service contract issued.

3.2 SPECIFIC DATA FOR EACH EQUIPMENT AND SYSTEMS

3.2.1 For each item of equipment and system include:

3.2.1.1 Description of equipment and component parts:

3.2.1.1.1 Function, normal operating characteristics, and limiting conditions.
3.2.1.1.2 Performance curves, engineering data, and tests as applicable.
3.2.1.1.3 Complete nomenclature and commercial number of replaceable parts.
3.2.1.1.4 Complete nameplate data.
3.2.1.1.5 P&ID numbers for equipment as indicated on Drawings.

3.2.1.2 Operating Procedures:

3.2.1.2.1 Startup, break-in, and normal operating instructions.
3.2.1.2.2 Regulation, control, stopping, shutdown, and emergency instructions.
3.2.1.2.3 Summer and winter operating instructions, as applicable.
3.2.1.2.4 Special operating instructions.

3.2.1.3 Maintenance Procedures:

3.2.1.3.1 Routine maintenance operations.
3.2.1.3.2 Guide to troubleshooting.
3.2.1.3.3 Disassembly, repair, and reassembly instructions.
3.2.1.3.4 Alignment, adjusting, and checking instructions.

3.2.1.4 Servicing and Lubrication Schedule:

3.2.1.4.1 List of lubricants required and quantity to be applied.
3.2.1.4.2 Schedule of lubrication.
3.2.1.4.3 Schedule for other routine maintenance.

3.2.1.5 Manufacturer's printed instructions regarding safety precautions for both (a) protection of personnel operating equipment and systems and (b) prevention of damage to equipment and systems.
3.2.1.6 Description of sequence of operation of controls.

3.2.1.7 Manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

3.2.1.7.1 Predicted life of parts subject to wear.
3.2.1.7.2 Items recommended to be stocked as spare parts and quantities of same.

3.2.1.8 Approved control diagrams such as ladder diagrams, instrumentation loop diagrams, and electrical schematics as appropriate.
3.2.1.9 Bill of material.
3.2.1.10 Other data as required under applicable Specification sections.

3.2.2 Prepare and include additional data when need for such data becomes apparent during instruction of NAVY'S representative or as requested by NAVY.

END OF SECTION

SECTION 01 91 13

EQUIPMENT TESTING, STARTUP, AND OPERATION

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 Provide competent field services technicians of all equipment furnished to supervise installation, adjustment, initial operation and testing, performance testing, final acceptance testing and startup of the equipment.

1.1.2 Provide services of major process equipment manufacturer's representatives (advance oxidation process reactor, chemical storage tank, chemical feed system – metering pumps and dosing system etc..) as per Technical Specifications.

1.1.3 Perform specified equipment field performance tests, final acceptance tests and startup services.

1.1.4 Duration of equipment manufacturer's representatives at the facility shall be as long as necessary to demonstrate the equipment meets all requirements of the equipment/system specification including flow rate and constituent removal performance.

1.1.5 Operate the system for a period of one year. Operation to consist of any operation or maintenance required for the system to run and successfully treat the 1,4-dioxane to the performance goals. Specific cost items include, but are limited to:

1.1.5.1 Labor to operate and maintain the AOP system, including the electrical, bulks, pumps, tank, and hydrogen peroxide.

1.1.5.2 Labor, shipping, and testing costs for analytical sampling, analysis, and reporting of AOP influent, AOP effluent, GAC effluent (one set), and quality assurance/quality control (QA/QC) trip blanks, duplicates (1 in 10 per samples), and matrix spike/matrix spike duplicates samples, in accordance with the following schedule.

1.1.5.2.1 Weeks 1 to 4, VOCs and 1,4-dioxane, three sets of influent and effluent per week, plus QA/QC to evaluate daily variability.

1.1.5.2.2 Weeks 5 to 13, VOCs and 1,4-dioxane, one set of influent and effluent per week, plus QA/QC.

1.1.5.2.3 Weeks 13 to 39, VOCs and 1,4-dioxane, one set of influent and effluent every other week, plus QA/QC.

1.1.5.2.4 Weeks 40 to 52. VOCs and 1,4-dioxane, one set of influent and effluent one per month, plus QA/QC.

1.1.5.3 VOCs are to be analyzed by method SW846-8260 and 1,4-dioxane to be analyzed by method EPA Method 522 using a Navy and New York State Environmental Laboratory Accreditation Program-approved company.

RELATED SECTIONS

1.1.6 The related sections are as follows:

1.1.6.1 01 78 23 Operation and Maintenance Data

1.2 SUBMITTALS

1.2.1 In accordance with Section 01 33 00, submit name, address and resume of proposed field services technicians at least 30 days in advance of the need for such services.

1.2.2 This section provides general guidelines for various steps required for the equipment startup and testing phase. The Contractor shall prepare and, submit, a detailed Equipment Startup and Testing Plan for equipment testing and startup as specified in the various equipment sections. At a minimum, submittals shall include the following:

1.2.2.1 The Equipment Startup and Testing Plan shall be submitted at least 60 days in advance of the proposed test dates and shall include at least the following information:

1.2.2.1.1 Name of equipment to be tested, including reference to specifications section number and title.
1.2.2.1.2 Testing schedule of proposed dates and times for testing.
1.2.2.1.3 Summary of power, lighting, chemical, water, etc., needs and identification of who will provide them and the quantity needed for testing.
1.2.2.1.4 Outline specific assignment of the responsibilities of the Contractor and manufacturers' factory representatives or field service personnel.
1.2.2.1.5 Detailed description of step-by-step testing requirements, with reference to appropriate standardized testing procedures and laboratory analyses by established technical organizations (e.g., ASTM, EPA Standard Methods, etc).
1.2.2.1.6 Samples of forms to be used to collect and record test data and to present tabulated test results.

1.2.2.2 Copies of test reports upon completion of specified shop, performance and acceptance tests. Test reports shall incorporate the information provided in the test procedures submittals and modified to reflect actual conduct of the tests and the following additional information:

1.2.2.2.1 Copy of all test data sheets and laboratory analytical reports.
1.2.2.2.2 Summary comparison of specified test and performance requirements vs. actual test results.
1.2.2.2.3 Should actual test results fail to meet specified test and performance requirements, describe action(s) to be taken prior to retest the equipment.

1.2.2.3 Copies of the field service technician's report summarizing the results of his/her initial inspection, operation, adjustment and pre-tests. The report shall include detailed descriptions and tabulations of the points inspected, tests and adjustments made, quantitative results obtained, suggestions for precautions to be taken to ensure proper maintenance, final setting for the equipment, a copy of all the manufacturer’s startup checklists and other applicable paperwork.

1.3 QUALITY ASSURANCE

1.3.1 Field service technicians shall be competent and experienced in the proper installation, adjustment, operation, testing and startup of the equipment and systems being installed.

1.3.2 Manufacturers' sales and marketing personnel will not be accepted as field service technicians.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 PRELIMINARY REQUIREMENTS

3.1.1 After installation of the equipment has been completed and the equipment is ready for operation, complete functional test. Verify that the field service technician shall inspect, operate, test and adjust the equipment. The inspection shall include at least the following points where applicable:

3.1.1.1 Soundness (without cracks or otherwise damaged parts).
3.1.1.2 Correctness of setting, alignment and relative arrangement of various parts.
3.1.1.3 Check that all equipment, skids, and piping are properly fastened to a concrete foundation and that all bolts are completely tight.
3.1.1.4 Adequacy and correctness of packing, sealing and lubricants.
3.1.1.5 Check adequacy and tightness of all connections and verification that all power, control cabling, communications, and other utilities are properly connected and functional.

3.1.2 The operation, testing and adjustment shall be as required to prove that the equipment has been left in proper condition for satisfactory operation under the conditions specified.

3.1.3 Upon completion of this work, the field service technician shall submit a signed report of the results of his/her inspection, operation, adjustments and tests. The report shall contain copies of all of the field notes from the inspection.

3.2 STARTUP OF THE TREATMENT PLANT AND RELATED SYSTEMS

3.2.1 General Requirements

3.2.1.1 Successfully execute the step-by-step procedure of startup specified herein.
3.2.1.2 The startup shall be successfully executed prior to Substantial Completion and acceptance by the Navy for the one year of operation Phase.

3.2.2 Preparation for Startup

3.2.2.1 Upon completion of the installation of the advance oxidation reactor and all its related systems, all tanks, equipment and piping shall be flushed with potable water and hydraulically checked for leaks, cracks, and defects.
3.2.2.2 All mechanical and electrical equipment shall be checked to ensure that it is in good working order and properly connected. Preliminary run-ins of the various pumps and other remaining equipment shall be made.
3.2.2.3 All systems shall be cleaned and purged as required Check that all valves shall be checked for proper operation and control, and there are no hindrances to valves fully opening and closing.

3.2.2.4 All instruments and controls shall be calibrated through their full range. All other adjustments required for proper operation of all instrumentation and control equipment shall be made. All settings for all instrumentation shall be recorded and provided in separate cover.

3.2.2.5 No testing or equipment operation shall take place until it has been verified by the Navy's representative that all specified safety equipment has been installed and is in good working order.

3.2.2.6 No testing or equipment operation shall take place until it has been verified by the Navy's representative that all lubricants, tools, maintenance equipment, spare parts and approved equipment operation and maintenance manuals have been furnished as specified.

3.2.3 Facilities Startup

3.2.3.1 Startup period shall not begin until all new treatment facilities and equipment have been tested as specified and are ready for operation. The Navy shall receive spare parts, safety equipment, tools and maintenance equipment, lubricants, approved operation and maintenance data and the specified operation and maintenance instruction prior to the startup. All valve tagging shall also be complete prior to this startup.

3.2.3.2 In the event of failure to demonstrate satisfactory performance of the facility on the first or any subsequent attempt, all necessary alterations, adjustments, repairs and replacements shall be made. When the facility is again ready for operation, it shall be brought on line and a new test shall be started. This procedure shall be repeated as often as necessary until the facility has operated continuously to the satisfaction of the Navy and ENGINEER.

3.2.3.3 The CONTRACTOR shall provide all necessary personnel of the various construction trades, i.e., electricians, plumbers, etc., and field service personnel on as need basis during the following three testing/startup phases.

3.2.3.4 Do not, at any time, during startup allow the facility to be operated in a manner which subjects equipment to conditions that are more severe than the maximum allowable operating conditions and tolerances for which the equipment was designed.

3.3 PERFORMANCE TEST OF ADVANCE OXIDATION REACTOR WITH POTABLE WATER

3.3.1 During this test phase, entire treatment system will be tested with potable water as follows:

3.3.1.1 Verify programming and testing of PLC and HMI (including vendor supplied systems) is complete and the vendor PLC can communicate with the plant PLC through ethernet connection providing operation, control and status of all systems.

3.3.1.2 CONTRACTOR shall perform a system function test including the existing pumps, piping, valves and equipment with potable water for 30 minutes at the design capacity on a continuous basis. For the system performance testing procedure, the Contractor shall fill the advance oxidation reactor with flow from the equalization tank and recycle the flow from the reactor back to the equalization tank using motor operated valves and the loop connection. This operation shall be maintained for up to 5 minutes until the manufacturer's recommended warm-up and start-up period. The outlet valve of the reactor shall be closed, and the equalization tank recycle valve shall be open during this period to allow flow to circulate back to the equalization tank. Pumps 4A and 4B shall be used to send flow to the reactor at the design flow rate and back to the equalization tank. This full system testing shall be on a continuous basis for 30 minutes.

3.3.1.3 CONTRACTOR shall be responsible for full system check and to fix any leaks or other installation or operational issues identified during the performance testing. Any leaks from reactors shall be drained to the plant's process sump for reprocessing through the system.

Upon successful completion of water test as per Paragraph 3.3 above, entire treatment system shall be tested with ground water as follows:

3.3.1.4 During the test collect three rounds of AOP inlet, AOP outlet, and GAC outlet samples and analyze them for VOCs and 1,4-dioxane. Discharge outlet water from reactor back to equalization tank. The contractor shall provide test results within 7 days of the testing.

3.3.1.5 Once the sampling analysis data of the three rounds for inlet and outlet samples are available, provide it to the Navy's representative. If the sampling analysis indicates that the reactor can meet the treatment and performance requirements as specified CONTRACTOR shall begin operation of the advance oxidation system along with the existing LGAC units.

3.3.1.6 If the AOP system does not meet performance and treatment goal requirements as specified in the Technical Specifications, the CONTRACTOR shall make necessary modifications to the satisfaction of the Navy's representative and above tests shall be repeated.

3.3.1.7 Upon completion of successful tests, obtain a final inspection certificate from all major process equipment manufacturer's representatives that they have inspected and certified their equipment for proper operation. A sample of such certificate is provided in this section.

3.3.1.8 The CONTRACTOR shall be responsible to operate and maintain the AOP system successfully for one (1) year period. The operation services shall include labor and any cost associated with repairs, troubleshooting, lamp replacement, hydrogen peroxide purchase, and unloading, and other operation and maintenance requirements (except electricity) during the one (1) year period.

3.3.1.9 The system shall run a minimum of 95 percent of time during this one (1) year period. If the GM38 Groundwater Treatment System is not operational for reasons not related to the AOP, (e.g., carbon changeout), the associated downtime does not effect the AOP system run time calculation. The one year period does not include any substantial time (greater than one day) that the AOP is down due to AOP operation or maintenance requirements.

3.3.1.10 The CONTACTOR shall be responsible to have the manufacturer representative or have a subcontractor provide labor necessary to operate the system successfully during the one (1) year period.

3.3.1.11 During the one year period, the contractor shall optimize AOP operation (minimize hydrogen peroxide and power use), yet remain fully compliant with the performance requirements.

3.4 FINAL TREATMENT SYSTEM DEMONSTRATION TEST

3.4.1 Upon successful completion of performance test as per Para 3.3 above, Contractor shall handover the operations to the Navy.

EQUIPMENT SUPPLIER'S CERTIFICATE OF OPERATION

Navy ____

Project ____

Contract No. ____

EQUIPMENT SPECIFICATION SECTION NO. ____

EQUIPMENT DESCRIPTION ____

I ____, Authorized representative of
(Print Name)

____
(Print Manufacturer's Name)

hereby CERTIFY that ____
(Print equipment name and model with serial no.)

____

installed for the subject project has (have) been tested, operated and adjusted, and is (are) ready for place in operation for its intended use.

Date_____________

Time_____________

CERTIFIED BY: ____
(Signature of Manufacturer's Representative)

Date:_____________

END OF SECTION

SECTION 03 10 00

CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

- 1.2.1.1 Form-facing material for cast-in-place concrete.
- 1.2.1.2 Form liners.
- 1.2.1.3 Shoring, bracing, and anchoring.

1.3 DEFINITIONS

1.3.1 Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.

1.3.2 Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 PREINSTALLATION MEETINGS

1.4.1 Preinstallation Conference: Conduct conference at Project site.

- 1.4.1.1 Review the following:
  - 1.4.1.1.1 Special inspection and testing and inspecting agency procedures for field quality control.
  - 1.4.1.1.2 Construction, movement, contraction, and isolation joints
  - 1.4.1.1.3 Forms and form-removal limitations.
  - 1.4.1.1.4 Shoring and reshoring procedures.
  - 1.4.1.1.5 Anchor rod and anchorage device installation tolerances.

1.5 ACTION SUBMITTALS

1.5.1 Product Data: For each of the following:

- 1.5.1.1 Exposed surface form-facing material.
- 1.5.1.2 Concealed surface form-facing material.
- 1.5.1.3 Form liners.
- 1.5.1.4 Form ties.

1.5.1.5 Waterstops.
1.5.1.6 Form-release agent.

1.5.2 Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

1.5.2.1 For exposed vertical concrete walls, indicate dimensions and form tie locations.
1.5.2.2 Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.

1.5.2.2.1 Location of construction joints is subject to approval of the Architect.

1.5.2.3 Indicate location of waterstops.
1.5.2.4 Indicate form liner layout and form line termination details.
1.5.2.5 Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.

1.6 INFORMATIONAL SUBMITTALS

1.6.1 Qualification Data: For testing and inspection agency.

1.6.2 Field quality-control reports.

1.6.3 Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

1.7.1 Testing and Inspection Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

1.8.1 Form Liners: Store form liners under cover to protect from sunlight.

1.8.2 Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

2.1.1.1 Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."

2.1.1.2 Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

2.2 FORM-FACING MATERIALS

2.2.1 As-Cast Surface Form-Facing Material:

2.2.1.1 Provide continuous, true, and smooth concrete surfaces.
2.2.1.2 Furnish in largest practicable sizes to minimize number of joints.
2.2.1.3 Acceptable Materials: As required to comply with Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete, and as follows:

2.2.1.3.1 Plywood, metal, or other approved panel materials.
2.2.1.3.2 Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

2.2.1.3.2.1 APA HDO (high-density overlay).
2.2.1.3.2.2 APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
2.2.1.3.2.3 APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
2.2.1.3.2.4 APA Plyform Class I, B-B or better; mill oiled and edge sealed.

2.2.2 Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

2.2.2.1 Provide lumber dressed on at least two edges and one side for tight fit.

2.3 WATERSTOPS

2.3.1 Flexible PVC Waterstops: U.S. Army Corps of Engineers CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints, with factory fabricate corners, intersections, and directional changes.

2.3.1.1 Profile: Ribbed with center bulb.
2.3.1.2 Dimensions: 6 inches by 3/8 inch thick; nontapered.

2.3.2 Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

2.4 RELATED MATERIALS

2.4.1 Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

2.4.2 Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

2.4.3 Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

2.4.3.1 Formulate form-release agent with rust inhibitor for steel form-facing materials.
2.4.3.2 Form release agent for form liners shall be acceptable to form liner manufacturer.

2.4.4 Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

2.4.4.1 Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2.4.4.2 Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

3.1.1 Comply with ACI 301.

3.1.2 Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete" for as-cast finishes.

3.1.3 Limit concrete surface irregularities as follows:

3.1.3.1 Surface Finish-1.0: ACI 117 Class D, 1 inch.
3.1.3.2 Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
3.1.3.3 Surface Finish-3.0: ACI 117 Class A, 1/8 inch.

3.1.4 Construct forms tight enough to prevent loss of concrete mortar.

3.1.4.1 Minimize joints.
3.1.4.2 Exposed Concrete: Symmetrically align joints in forms.

3.1.5 Construct removable forms for easy removal without hammering or prying against concrete surfaces.

3.1.5.1 Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
3.1.5.2 Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3.1.5.3 Install keyways, recesses, and other accessories, for easy removal.

3.1.6 Do not use rust-stained, steel, form-facing material.

3.1.7 Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

3.1.7.1 Provide and secure units to support screed strips
3.1.7.2 Use strike-off templates or compacting-type screeds.

3.1.8 Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

3.1.8.1 Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
3.1.8.2 Locate temporary openings in forms at inconspicuous locations.

3.1.9 Chamfer exterior corners and edges of permanently exposed concrete.

3.1.10 At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

3.1.11 Form openings, chases, offsets, keyways, blocking, screeds, and bulkheads required in the Work.

3.1.11.1 Determine sizes and locations from trades providing such items.
3.1.11.2 Obtain written approval of Architect prior to forming openings not indicated on Drawings.

3.1.12 Construction and Movement Joints:

3.1.12.1 Construct joints true to line with faces perpendicular to surface plane of concrete.
3.1.12.2 Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3.1.12.3 Place joints perpendicular to main reinforcement.

3.1.13 Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

3.1.13.1 Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
3.1.13.2 Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

3.1.14 Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

3.1.15 Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

3.1.16 Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

3.2.1 Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

3.2.1.1 Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3.2.1.2 Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3.2.1.3 Clean embedded items immediately prior to concrete placement.

3.3 INSTALLATION OF WATERSTOPS

3.3.1 Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.

3.3.1.1 Install in longest lengths practicable.
3.3.1.2 Locate waterstops in center of joint unless otherwise indicated on Drawings.
3.3.1.3 Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 03 30 00 "Cast-In-Place Concrete."
3.3.1.4 Secure waterstops in correct position at 12 inches on center.
3.3.1.5 Field fabricate joints in accordance with manufacturer's instructions using heat welding.

3.3.1.5.1 Miter corners, intersections, and directional changes in waterstops.
3.3.1.5.2 Align center bulbs.

3.3.1.6 Clean waterstops immediately prior to placement of concrete.
3.3.1.7 Support and protect exposed waterstops during progress of the Work.

3.3.2 Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.

3.3.2.1 Install in longest lengths practicable.
3.3.2.2 Locate waterstops in center of joint unless otherwise indicated on Drawings.
3.3.2.3 Protect exposed waterstops during progress of the Work.

3.4 REMOVING AND REUSING FORMS

3.4.1 Formwork for sides of beams, walls, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

3.4.1.1 Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

3.4.2 Clean and repair surfaces of forms to be reused in the Work.

3.4.2.1 Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
3.4.2.2 Apply new form-release agent.

3.4.3 When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.

3.4.3.1 Align and secure joints to avoid offsets.
3.4.3.2 Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.5 SHORING AND RESHORING INSTALLATION

3.5.1 Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

3.5.1.1 Do not remove shoring or reshoring until measurement of slab tolerances is complete.

3.5.2 Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.6 FIELD QUALITY CONTROL

3.6.1 Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.

3.6.2 Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

3.6.3 Inspections:

3.6.3.1 Inspect formwork for shape, location, and dimensions of the concrete member being formed.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Steel reinforcement bars.

1.3 PREINSTALLATION MEETINGS

1.3.1 Preinstallation Conference: Conduct conference at Project site.

1.3.1.1 Review the following:

1.3.1.1.1 Special inspection and testing and inspecting agency procedures for field quality control.
1.3.1.1.2 Construction contraction and isolation joints.
1.3.1.1.3 Steel-reinforcement installation.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For the following:

1.4.1.1 Each type of steel reinforcement.
1.4.1.2 Epoxy repair coating.
1.4.1.3 Zinc repair material.
1.4.1.4 Bar supports.
1.4.1.5 Mechanical splice couplers.

1.4.2 Shop Drawings: Comply with ACI SP-066:

1.4.2.1 Include placing drawings that detail fabrication, bending, and placement.
1.4.2.2 Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

1.4.3 Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1.4.3.1 Location of construction joints is subject to approval of the Engineer of Record.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Qualification Statements: For testing and inspection agency.

1.5.2 Welding certificates.

1.5.2.1 Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M

1.5.3 Material Certificates: For each of the following, signed by manufacturers:

1.5.3.1 Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."

1.5.4 Material Test Reports: For the following, from a qualified testing agency:

1.5.4.1 Steel Reinforcement:

1.5.4.1.1 For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

1.5.4.2 Mechanical splice couplers.

1.5.5 Field quality-control reports.

1.5.6 Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

1.6.1 Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.6.2 Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. and to avoid damaging coatings on steel reinforcement.

1.7.1.1 Store reinforcement to avoid contact with earth.

1.7.1.2 Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

2.1.1 Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

2.1.2 Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.

2.1.3 Headed-Steel Reinforcing Bars: ASTM A970/A970M.

2.1.4 Epoxy-Coated Reinforcing Bars:

2.1.4.1 Steel Bars: ASTM A615/A615M, Grade 60, deformed bars.
2.1.4.2 Epoxy Coating: ASTM A775/A775M with less than 2 percent damaged coating in each 12-inch bar length.

2.1.5 Steel Bar Mats: ASTM A184/A184M, fabricated from ASTM A615/A615M, Grade 60, deformed bars, assembled with clips.

2.2 REINFORCEMENT ACCESSORIES

2.2.1 Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

2.2.2 Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, ASTM A775/A775M epoxy coated.

2.2.3 Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars in place.

2.2.3.1 Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

2.2.3.1.1 For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
2.2.3.1.2 For epoxy-coated reinforcement, use CRSI Class 1A epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.2.4 Mechanical Splice Couplers: ACI 318 Type 1, same material of reinforcing bar being spliced; tension-compression type.

2.2.5 Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

2.2.5.1 Finish: Galvanized.

2.2.6 Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.

2.2.7 Zinc Repair Material: ASTM A780/A780M.

2.3 FABRICATING REINFORCEMENT

2.3.1 Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

3.2.1 Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

3.2.2 Accurately position, support, and secure reinforcement against displacement.

3.2.2.1 Locate and support reinforcement with bar supports to maintain minimum concrete cover.
3.2.2.2 Do not tack weld crossing reinforcing bars.

3.2.3 Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

3.2.4 Provide concrete coverage in accordance with ACI 318.

3.2.5 Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.2.6 Splices: Lap splices as indicated on Drawings.

3.2.6.1 Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
3.2.6.2 Stagger splices in accordance with ACI 318.
3.2.6.3 Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
3.2.6.4 Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.

3.2.7 Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating in accordance with ASTM D3963/D3963M.

3.3 JOINTS

3.3.1 Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer on Record.

3.3.1.1 Place joints perpendicular to main reinforcement.
3.3.1.2 Continue reinforcement across construction joints unless otherwise indicated.
3.3.1.3 Do not continue reinforcement through sides of strip placements of floors and slabs.

3.3.2 Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

3.4.1 Comply with ACI 117.

3.5 FIELD QUALITY CONTROL

3.5.1 Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.

3.5.2 Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

3.5.3 Inspections:

3.5.3.1 Steel-reinforcement placement.
3.5.3.2 Steel-reinforcement mechanical splice couplers.
3.5.3.3 Steel-reinforcement welding.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement (PWS), including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

1.2.2 Related Requirements:

1.2.2.1 Section 03 10 00 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
1.2.2.2 Section 03 20 00 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
1.2.2.3 Section 31 20 00 "Earth Moving" for drainage fill under slabs-on-ground.

1.3 DEFINITIONS

1.3.1 Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

1.3.2 Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

1.4.1 Preinstallation Conference: Conduct conference at Project site.

1.4.1.1 Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

1.4.1.1.1 Contractor's superintendent.
1.4.1.1.2 Independent testing agency responsible for concrete design mixtures.
1.4.1.1.3 Ready-mix concrete manufacturer.
1.4.1.1.4 Concrete Subcontractor.
1.4.1.1.5 Special concrete finish Subcontractor.

1.4.1.2 Review the following:

1.4.1.2.1 Special inspection and testing and inspecting agency procedures for field quality control.

1.4.1.2.2 Construction joints, control joints, isolation joints, and joint-filler strips.
1.4.1.2.3 Semirigid joint fillers.
1.4.1.2.4 Anchor rod and anchorage device installation tolerances.
1.4.1.2.5 Cold and hot weather concreting procedures.
1.4.1.2.6 Concrete finishes and finishing.
1.4.1.2.7 Curing procedures.
1.4.1.2.8 Forms and form-removal limitations.
1.4.1.2.9 Shoring and reshoring procedures.
1.4.1.2.10 Methods for achieving specified floor and slab flatness and levelness.
1.4.1.2.11 Floor and slab flatness and levelness measurements.
1.4.1.2.12 Concrete repair procedures.
1.4.1.2.13 Concrete protection.
1.4.1.2.14 Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
1.4.1.2.15 Protection of field cured field test cylinders.

1.5 ACTION SUBMITTALS

1.5.1 Product Data: For each of the following.

1.5.1.1 Portland cement.
1.5.1.2 Fly ash.
1.5.1.3 Slag cement.
1.5.1.4 Blended hydraulic cement.
1.5.1.5 Silica fume.
1.5.1.6 Performance-based hydraulic cement
1.5.1.7 Aggregates.
1.5.1.8 Admixtures:

1.5.1.8.1 Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.

1.5.1.9 Fiber reinforcement.
1.5.1.10 Floor and slab treatments.
1.5.1.11 Liquid floor treatments.
1.5.1.12 Curing materials.
1.5.1.13 Joint fillers.
1.5.1.14 Repair materials.

1.5.2 Design Mixtures: For each concrete mixture, include the following:

1.5.2.1 Mixture identification.
1.5.2.2 Minimum 28-day compressive strength.
1.5.2.3 Durability exposure class.
1.5.2.4 Maximum w/cm.
1.5.2.5 Slump limit.
1.5.2.6 Air content.
1.5.2.7 Nominal maximum aggregate size.
1.5.2.8 Synthetic macro-fiber content.
1.5.2.9 Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
1.5.2.10 Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
1.5.2.11 Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.

1.5.2.12 Intended placement method.
1.5.2.13 Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5.3 Shop Drawings:

1.5.3.1 Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1.5.3.1.1 Location of construction joints is subject to approval of the Engineer of Record (EOR).

1.5.4 Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1.5.4.1 Concrete Class designation.
1.5.4.2 Location within Project.
1.5.4.3 Exposure Class designation.
1.5.4.4 Formed Surface Finish designation and final finish.
1.5.4.5 Final finish for floors.
1.5.4.6 Curing process.
1.5.4.7 Floor treatment if any.

1.6 INFORMATIONAL SUBMITTALS

1.6.1 Qualification Data: For the following:

1.6.1.1 Installer: Include copies of applicable ACI certificates.
1.6.1.2 Ready-mixed concrete manufacturer.
1.6.1.3 Testing agency: Include copies of applicable ACI certificates.

1.6.2 Material Certificates: For each of the following, signed by manufacturers:

1.6.2.1 Cementitious materials.
1.6.2.2 Admixtures.
1.6.2.3 Fiber reinforcement.
1.6.2.4 Curing compounds.
1.6.2.5 Floor and slab treatments.
1.6.2.6 Bonding agents.
1.6.2.7 Adhesives.
1.6.2.8 Semirigid joint filler.
1.6.2.9 Joint-filler strips.
1.6.2.10 Repair materials.

1.6.3 Material Test Reports: For the following, from a qualified testing agency:

1.6.3.1 Portland cement.
1.6.3.2 Fly ash.
1.6.3.3 Slag cement.
1.6.3.4 Blended hydraulic cement.
1.6.3.5 Silica fume.
1.6.3.6 Performance-based hydraulic cement.
1.6.3.7 Aggregates.
1.6.3.8 Admixtures:

1.6.3.8.1 Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

1.6.4 Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

1.6.5 Research Reports:

1.6.5.1 For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.

1.6.6 Preconstruction Test Reports: For each mix design.

1.6.7 Field quality-control reports.

1.6.8 Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

1.7.1 Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician with experience installing and finishing concrete, incorporating permeability-reducing admixtures.

1.7.1.1 Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

1.7.2 Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1.7.2.1 Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

1.7.3 Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.

1.7.3.1 Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

1.7.4 Field Quality Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.7.4.1 Personnel conducting field tests shall be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

1.8 PRECONSTRUCTION TESTING

1.8.1 Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

1.8.1.1 Include the following information in each test report:

1.8.1.1.1 Admixture dosage rates.
1.8.1.1.2 Slump.
1.8.1.1.3 Air content.
1.8.1.1.4 Seven-day compressive strength.
1.8.1.1.5 28-day compressive strength.
1.8.1.1.6 Permeability.

1.9 DELIVERY, STORAGE, AND HANDLING

1.9.1 Comply with ASTM C94/C94M and ACI 301.

1.10 FIELD CONDITIONS

1.10.1 Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.

1.10.1.1 Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1.10.1.2 When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
1.10.1.3 Do not use frozen materials or materials containing ice or snow.
1.10.1.4 Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
1.10.1.5 Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

1.10.2 Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1.10.2.1 Maintain concrete temperature at time of discharge to not exceed 95 deg F.
1.10.2.2 Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

2.1.1 ACI Publications: Comply with ACI 301unless modified by requirements in the PWS Documents.

2.2 CONCRETE MATERIALS

2.2.1 Source Limitations:

2.2.1.1 Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2.2.1.2 Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
2.2.1.3 Obtain aggregate from single source.
2.2.1.4 Obtain each type of admixture from single source from single manufacturer.

2.2.2 Cementitious Materials:

2.2.2.1 Portland Cement: ASTM C150/C150M, Type I, Type II, or Type I/II, gray.
2.2.2.2 Fly Ash: ASTM C618, Class C or F.
2.2.2.3 Slag Cement: ASTM C989/C989M, Grade 100 or 120.
2.2.2.4 Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag cement.
2.2.2.5 Silica Fume: ASTM C1240 amorphous silica.
2.2.2.6 Performance-Based Hydraulic Cement: ASTM C1157/C1157M: Type GU, general use.

2.2.3 Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.

2.2.3.1 Alkali-Silica Reaction: Comply with one of the following:

2.2.3.1.1 Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
2.2.3.1.2 Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
2.2.3.1.3 Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.

2.2.3.2 Maximum Coarse-Aggregate Size: 1 inch nominal.
2.2.3.3 Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

2.2.4 Air-Entraining Admixture: ASTM C260/C260M.

2.2.5 Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

2.2.5.1 Water-Reducing Admixture: ASTM C494/C494M, Type A.
2.2.5.2 Retarding Admixture: ASTM C494/C494M, Type B.
2.2.5.3 Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
2.2.5.4 High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
2.2.5.5 High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
2.2.5.6 Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

2.2.5.7 Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

2.2.5.8 Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing crystalline admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).

2.2.5.8.1 Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRC C48 at a hydraulic pressure of 200 psi for 14 days.

2.2.6 Water and Water Used to Make Ice: ASTM C94/C94M, potable

2.3 FIBER REINFORCEMENT

2.3.1 Synthetic Macro-Fiber: Synthetic macro-fibers engineered and designed for use in concrete, complying with ASTM C1116/C1116M, Type III, 1 to 2-1/4 inches long.

2.4 LIQUID FLOOR TREATMENTS

2.4.1 Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2.5 CURING MATERIALS

2.5.1 Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

2.5.2 Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

2.5.3 Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

2.5.3.1 Color:

2.5.3.1.1 Ambient Temperature Below 50 deg F: Black.
2.5.3.1.2 Ambient Temperature between 50 deg F and 85 deg F: Any color.
2.5.3.1.3 Ambient Temperature Above 85 deg F: White.

2.5.4 Water: Potable or complying with ASTM C1602/C1602M.

2.5.5 Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

2.5.6 Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B, certified by curing compound manufacturer to not interfere with bonding of floor covering.

2.5.7 Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

2.6 RELATED MATERIALS

2.6.1 Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.

2.6.2 Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.

2.6.3 Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

2.6.4 Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:

2.6.4.1 Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 REPAIR MATERIALS

2.7.1 Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

2.7.1.1 Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2.7.1.2 Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
2.7.1.3 Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
2.7.1.4 Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.7.2 Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

2.7.2.1 Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2.7.2.2 Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
2.7.2.3 Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
2.7.2.4 Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.8 CONCRETE MIXTURES, GENERAL

2.8.1 Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.

2.8.1.1 Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

2.8.2 Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

2.8.2.1 Fly Ash or Other Pozzolans: 25 percent by mass.
2.8.2.2 Slag Cement: 50 percent by mass.
2.8.2.3 Silica Fume: 10 percent by mass.
2.8.2.4 Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
2.8.2.5 Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

2.8.3 Admixtures: Use admixtures in accordance with manufacturer's written instructions.

2.8.3.1 Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
2.8.3.2 Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
2.8.3.3 Use water-reducing admixture in pumped concrete.
2.8.3.4 Use corrosion-inhibiting admixture in concrete mixtures.
2.8.3.5 Use permeability-reducing admixture in concrete mixtures.

2.9 CONCRETE MIXTURES

2.9.1 Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

2.9.1.1 Exposure Class: ACI 318 - F3.
2.9.1.2 Minimum Compressive Strength: 4,500 psi at 28 days.
2.9.1.3 Maximum w/cm: 0.45.
2.9.1.4 Slump Limit: 4 inches, plus or minus 1 inch; 8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site.
2.9.1.5 Slump Flow Limit: 22 inches, plus or minus 1.5 inches
2.9.1.6 Air Content:
2.9.1.6.1 Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size; 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size; 5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size.

2.9.1.7 Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.

2.9.2 Class B : Normal-weight concrete used for foundation walls.

2.9.2.1 Exposure Class: ACI 318 - F3.
2.9.2.2 Minimum Compressive Strength: 4,500 psi at 28 days.
2.9.2.3 Maximum w/cm: 0.45.
2.9.2.4 Slump Limit: 4 inches, plus or minus 1 inch; 8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site.
2.9.2.5 Slump Flow Limit: 22 inches, plus or minus 1.5 inches.
2.9.2.6 Air Content:

2.9.2.6.1 Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size; 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size; 5.5 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-1/2-inch nominal maximum aggregate size.

2.9.2.7 Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.

2.9.3 Class C : Normal-weight concrete used for slabs-on-ground.

2.9.3.1 Exposure Class: ACI 318 - C2.
2.9.3.2 Minimum Compressive Strength: 5,000 psi at 28 days.
2.9.3.3 Maximum w/cm: 0.40.
2.9.3.4 Minimum Cementitious Materials Content: 540 lb/cu. yd.

2.9.3.5 Slump Limit: 4 inches, plus or minus 1 inch ; 8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site
2.9.3.6 Slump Flow Limit: 22 inches, plus or minus 1.5 inches
2.9.3.7 Air Content:

2.9.3.7.1 Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

2.9.3.8 Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
2.9.3.9 Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of 4.0 lb/cu. yd.

2.10 CONCRETE MIXING

2.10.1 Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M, and furnish batch ticket information.

2.10.2 Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

2.10.2.1 For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2.10.2.2 For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
2.10.2.3 Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Verification of Conditions:

3.1.1.1 Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
3.1.1.2 Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

3.2.1 Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

3.2.1.1 Daily access to the Work.
3.2.1.2 Incidental labor and facilities necessary to facilitate tests and inspections.
3.2.1.3 Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
3.2.1.4 Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

3.3.1 Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

3.3.1.1 Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3.3.1.2 Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.

3.4 JOINTS

3.4.1 Construct joints true to line, with faces perpendicular to surface plane of concrete.

3.4.2 Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

3.4.2.1 Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by EOR.
3.4.2.2 Place joints perpendicular to main reinforcement.

3.4.2.2.1 Continue reinforcement across construction joints unless otherwise indicated.

3.4.2.3 Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3.4.2.4 Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
3.4.2.5 Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

3.4.3 Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:

3.4.3.1 Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
3.4.3.2 Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

3.4.4 Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

3.4.4.1 Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
3.4.4.2 Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 07 92 00 "Joint Sealants," are indicated.
3.4.4.3 Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.4.5 Doweled Joints:

3.4.5.1 Install dowel bars and support assemblies at joints where indicated on Drawings.

3.4.5.2 Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

3.5 CONCRETE PLACEMENT

3.5.1 Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

3.5.2 Notify EOR and testing and inspection agencies 24 hours prior to commencement of concrete placement.

3.5.3 Do not add water to concrete during delivery, at Project site, or during placement unless approved by EOR in writing, but not to exceed the amount indicated on the concrete delivery ticket.

3.5.3.1 Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

3.5.4 Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.

3.5.4.1 Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

3.5.5 Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

3.5.5.1 If a section cannot be placed continuously, provide construction joints as indicated.
3.5.5.2 Deposit concrete to avoid segregation.
3.5.5.3 Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
3.5.5.4 Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

3.5.5.4.1 Do not use vibrators to transport concrete inside forms.
3.5.5.4.2 Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
3.5.5.4.3 Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
3.5.5.4.4 At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

3.5.6 Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

3.5.6.1 Do not place concrete floors and slabs in a checkerboard sequence.
3.5.6.2 Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3.5.6.3 Maintain reinforcement in position on chairs during concrete placement.
3.5.6.4 Screed slab surfaces with a straightedge and strike off to correct elevations.
3.5.6.5 Level concrete, cut high areas, and fill low areas.
3.5.6.6 Slope surfaces uniformly to drains where required.
3.5.6.7 Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
3.5.6.8 Do not further disturb slab surfaces before starting finishing operations.

3.6 FINISHING FORMED SURFACES

3.6.1 As-Cast Surface Finishes:

3.6.1.1 ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.

3.6.1.1.1 Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
3.6.1.1.2 Remove projections larger than 1 inch.
3.6.1.1.3 Tie holes do not require patching.
3.6.1.1.4 Surface Tolerance: ACI 117 Class D.
3.6.1.1.5 Apply to concrete surfaces not exposed to public view.

3.6.1.2 ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.

3.6.1.2.1 Patch voids larger than 3/4 inch wide or 1/2 inch deep.
3.6.1.2.2 Remove projections larger than 1/4 inch.
3.6.1.2.3 Patch tie holes.
3.6.1.2.4 Surface Tolerance: ACI 117 Class B.
3.6.1.2.5 Locations: Apply to concrete surfaces exposed to public view.

3.6.2 Related Unformed Surfaces:

3.6.2.1 At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a color and texture matching adjacent formed surfaces.
3.6.2.2 Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.7 FINISHING FLOORS AND SLABS

3.7.1 Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

3.7.2 Float Finish:

3.7.2.1 When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
3.7.2.2 Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3.7.2.3 Apply float finish to surfaces to receive trowel finish.

3.7.3 Trowel Finish:

3.7.3.1 After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
3.7.3.2 Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3.7.3.3 Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
3.7.3.4 Do not add water to concrete surface.
3.7.3.5 Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
3.7.3.6 Apply a trowel finish to surfaces exposed to view.

3.7.3.7 Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:

3.7.3.7.1 Slabs on Ground:

3.7.3.7.1.1 Specified overall values of flatness, F_F 35; and of levelness, F_L 25; with minimum local values of flatness, F_F 24; and of levelness, F_L 17.

3.7.4 Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated on Drawings. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

3.7.4.1 Coordinate required final finish with EOR before application.
3.7.4.2 Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

3.7.5 Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

3.7.5.1 Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
3.7.5.2 Coordinate required final finish with EOR before application.

3.8 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

3.8.1 Filling In:

3.8.1.1 Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
3.8.1.2 Mix, place, and cure concrete, as specified, to blend with in-place construction.
3.8.1.3 Provide other miscellaneous concrete filling indicated or required to complete the Work.

3.8.2 Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

3.8.3 Equipment Bases and Foundations:

3.8.3.1 Coordinate sizes and locations of concrete bases with actual equipment provided.
3.8.3.2 Construct concrete bases 6 inches high unless otherwise indicated on Drawings, and extend base not less than 12 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3.8.3.3 Minimum Compressive Strength: 5,000 psi at 28 days.
3.8.3.4 Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3.8.3.5 For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
3.8.3.6 Prior to pouring concrete, place and secure anchorage devices.

3.8.3.6.1 Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3.8.3.6.2 Cast anchor-bolt insert into bases.
3.8.3.6.3 Install anchor bolts to elevations required for proper attachment to supported equipment.

3.9 CONCRETE CURING

3.9.1 Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

3.9.1.1 Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
3.9.1.2 Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3.9.1.3 Maintain moisture loss no more than 0.2 lb/sq. ft. x h before and during finishing operations.

3.9.2 Curing Formed Surfaces: Comply with ACI 308.1 as follows:

3.9.2.1 Cure formed surfaces, and other similar surfaces.
3.9.2.2 If forms remain during curing period, moist cure after loosening forms.
3.9.2.3 If removing forms before end of curing period, continue curing for remainder of curing period, as follows:

3.9.2.3.1 Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
3.9.2.3.2 Continuous Sprinkling: Maintain concrete surface continuously wet.
3.9.2.3.3 Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
3.9.2.3.4 Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
3.9.2.3.5 Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

3.9.2.3.5.1 Recoat areas subject to heavy rainfall within three hours after initial application.
3.9.2.3.5.2 Maintain continuity of coating and repair damage during curing period.

3.9.3 Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

3.9.3.1 Begin curing immediately after finishing concrete.
3.9.3.2 Interior Concrete Floors:

3.9.3.2.1 Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:

3.9.3.2.1.1 Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

3.9.3.2.1.1.1 Lap edges and ends of absorptive cover not less than 12 inches.
3.9.3.2.1.1.2 Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

3.9.3.2.1.2 Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

3.9.3.2.1.2.1 Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
3.9.3.2.1.2.2 Cure for not less than seven days.

3.9.3.2.1.3 Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

3.9.3.2.1.3.1 Water.
3.9.3.2.1.3.2 Continuous water-fog spray.

3.9.3.2.2 Floors to Receive Curing Compound:

3.9.3.2.2.1 Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
3.9.3.2.2.2 Recoat areas subjected to heavy rainfall within three hours after initial application.
3.9.3.2.2.3 Maintain continuity of coating, and repair damage during curing period.
3.9.3.2.2.4 Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

3.9.3.2.3 Floors to Receive Curing and Sealing Compound:

3.9.3.2.3.1 Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
3.9.3.2.3.2 Recoat areas subjected to heavy rainfall within three hours after initial application.
3.9.3.2.3.3 Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.10 TOLERANCES

3.10.1 Conform to ACI 117.

3.11 APPLICATION OF LIQUID FLOOR TREATMENTS

3.11.1 Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

3.11.1.1 Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
3.11.1.2 Do not apply to concrete that is less than 14 days old.
3.11.1.3 Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
3.11.1.4 Rinse with water; remove excess material until surface is dry.
3.11.1.5 Apply a second coat in a similar manner if surface is rough or porous.

3.11.2 Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.12 JOINT FILLING

3.12.1 Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

3.12.1.1 Defer joint filling until concrete has aged at least two months.
3.12.1.2 Do not fill joints until construction traffic has permanently ceased.

3.12.2 Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

3.12.3 Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

3.12.4 Overfill joint, and trim joint filler flush with top of joint after hardening.

3.13 CONCRETE SURFACE REPAIRS

3.13.1 Defective Concrete:

3.13.1.1 Repair and patch defective areas when approved by EOR.
3.13.1.2 Remove and replace concrete that cannot be repaired and patched to EOR's approval.

3.13.2 Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

3.13.3 Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

3.13.3.1 Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.

3.13.3.1.1 Limit cut depth to 3/4 inch.
3.13.3.1.2 Make edges of cuts perpendicular to concrete surface.
3.13.3.1.3 Clean, dampen with water, and brush-coat holes and voids with bonding agent.
3.13.3.1.4 Fill and compact with patching mortar before bonding agent has dried.
3.13.3.1.5 Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

3.13.3.2 Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.

3.13.3.2.1 Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
3.13.3.2.2 Compact mortar in place and strike off slightly higher than surrounding surface.

3.13.3.3 Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by EOR.

3.13.4 Repairing Unformed Surfaces:

3.13.4.1 Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

3.13.4.1.1 Correct low and high areas.
3.13.4.1.2 Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

3.13.4.2 Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

3.13.4.3 After concrete has cured at least 14 days, correct high areas by grinding.
3.13.4.4 Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.

3.13.4.4.1 Finish repaired areas to blend into adjacent concrete.

3.13.4.5 Correct other low areas scheduled to remain exposed with repair topping.

3.13.4.5.1 Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
3.13.4.5.2 Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

3.13.4.6 Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.

3.13.4.6.1 Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
3.13.4.6.2 Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
3.13.4.6.3 Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
3.13.4.6.4 Place, compact, and finish to blend with adjacent finished concrete.
3.13.4.6.5 Cure in same manner as adjacent concrete.

3.13.4.7 Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

3.13.4.7.1 Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
3.13.4.7.2 Dampen cleaned concrete surfaces and apply bonding agent.
3.13.4.7.3 Place patching mortar before bonding agent has dried.
3.13.4.7.4 Compact patching mortar and finish to match adjacent concrete.
3.13.4.7.5 Keep patched area continuously moist for at least 72 hours.

3.13.5 Perform structural repairs of concrete, subject to EOR's approval, using epoxy adhesive and patching mortar.

3.13.6 Repair materials and installation not specified above may be used, subject to EOR's approval.

3.14 FIELD QUALITY CONTROL

3.14.1 Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

3.14.2 Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

3.14.2.1 Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
3.14.2.2 Testing agency shall immediately report to EOR, Contractor, and concrete manufacturer any failure of Work to comply with PWS Documents.
3.14.2.3 Testing agency shall report results of tests and inspections, in writing, to Owner, Engineer of Record, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

3.14.2.3.1 Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:

3.14.2.3.1.1 Project name.
3.14.2.3.1.2 Name of testing agency.
3.14.2.3.1.3 Names and certification numbers of field and laboratory technicians performing inspections and testing.
3.14.2.3.1.4 Name of concrete manufacturer.
3.14.2.3.1.5 Date and time of inspection, sampling, and field testing.
3.14.2.3.1.6 Date and time of concrete placement.
3.14.2.3.1.7 Location in Work of concrete represented by samples.
3.14.2.3.1.8 Date and time sample was obtained.
3.14.2.3.1.9 Truck and batch ticket numbers.
3.14.2.3.1.10 Design compressive strength at 28 days.
3.14.2.3.1.11 Concrete mixture designation, proportions, and materials.
3.14.2.3.1.12 Field test results.
3.14.2.3.1.13 Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
3.14.2.3.1.14 Type of fracture and compressive break strengths at seven days and 28 days.

3.14.3 Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

3.14.4 Inspections:

3.14.4.1 Verification of use of required design mixture.
3.14.4.2 Concrete placement, including conveying and depositing.
3.14.4.3 Curing procedures and maintenance of curing temperature.
3.14.4.4 Verification of concrete strength before removal of shores and forms from beams and slabs.
3.14.4.5 Batch Plant Inspections: On a random basis, as determined by EOR.

3.14.5 Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:

3.14.5.1 Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

3.14.5.1.1 When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3.14.5.2 Slump: ASTM C143/C143M:

3.14.5.2.1 One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
3.14.5.2.2 Perform additional tests when concrete consistency appears to change.

3.14.5.3 Slump Flow: ASTM C1611/C1611M:

3.14.5.3.1 One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
3.14.5.3.2 Perform additional tests when concrete consistency appears to change.

3.14.5.4 Air Content: ASTM C231/C231M pressure method, for normal-weight concrete;.

3.14.5.4.1 One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

3.14.5.5 Concrete Temperature: ASTM C1064/C1064M:

3.14.5.5.1 One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.

3.14.5.6 Compression Test Specimens: ASTM C31/C31M:

3.14.5.6.1 Cast and laboratory cure two sets of two 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.
3.14.5.6.2 Cast, initial cure, and field cure two sets of two standard cylinder specimens for each composite sample.

3.14.5.7 Compressive-Strength Tests: ASTM C39/C39M.

3.14.5.7.1 Test one set of two laboratory-cured specimens at seven days and one set of two specimens at 28 days.
3.14.5.7.2 Test one set of two field-cured specimens at seven days and one set of two specimens at 28 days.
3.14.5.7.3 A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

3.14.5.8 When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
3.14.5.9 Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
3.14.5.10 Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by EOR but will not be used as sole basis for approval or rejection of concrete.
3.14.5.11 Additional Tests:

3.14.5.11.1 Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by EOR.
3.14.5.11.2 Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by EOR.

3.14.5.11.2.1 Acceptance criteria for concrete strength shall be in accordance with ACI 301 section 1.6.6.3.

3.14.5.12 Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.14.5.13 Correct deficiencies in the Work that test reports and inspections indicate do not comply with the PWS Documents.

3.14.6 Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 48 hours of completion of floor finishing and promptly report test results to EOR.

3.15 PROTECTION

3.15.1 Protect concrete surfaces as follows:

3.15.1.1 Protect from petroleum stains.
3.15.1.2 Diaper hydraulic equipment used over concrete surfaces.
3.15.1.3 Prohibit vehicles from interior concrete slabs.
3.15.1.4 Prohibit use of pipe-cutting machinery over concrete surfaces.
3.15.1.5 Prohibit placement of steel items on concrete surfaces.
3.15.1.6 Prohibit use of acids or acidic detergents over concrete surfaces.
3.15.1.7 Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Structural steel.
1.2.1.2 Shrinkage-resistant grout.

1.2.2 Related Requirements:

1.2.2.1 Section 05 31 00 "Steel Decking" for field installation of shear stud connectors through deck.

1.3 DEFINITIONS

1.3.1 Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

1.4 COORDINATION

1.4.1 Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 ACTION SUBMITTALS

1.5.1 Product Data:

1.5.1.1 Structural-steel materials.
1.5.1.2 High-strength, bolt-nut-washer assemblies.
1.5.1.3 Anchor rods.
1.5.1.4 Threaded rods.
1.5.1.5 Shop primer.
1.5.1.6 Galvanized-steel primer.
1.5.1.7 Galvanized repair paint.
1.5.1.8 Shrinkage-resistant grout.

1.5.2 Shop Drawings: Show fabrication of structural-steel components.

1.5.2.1 Include details of cuts, connections, splices, camber, holes, and other pertinent data.
1.5.2.2 Include embedment Drawings.
1.5.2.3 Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
1.5.2.4 Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
1.5.2.5 Identify members not to be shop primed.

1.5.3 Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint qualified by testing, including the following:

1.5.3.1 Power source (constant current or constant voltage).
1.5.3.2 Electrode manufacturer and trade name, for demand-critical welds.

1.6 INFORMATIONAL SUBMITTALS

1.6.1 Qualification Data: For Installer and testing agency.

1.6.2 Welding certificates.

1.6.3 Mill test reports for structural-steel materials, including chemical and physical properties.

1.6.4 Product Test Reports: For the following:

1.6.4.1 Bolts, nuts, and washers, including mechanical properties and chemical analysis.
1.6.4.2 Direct-tension indicators.
1.6.4.3 Tension-control, high-strength, bolt-nut-washer assemblies.

1.6.5 Survey of existing conditions.

1.6.6 Source quality-control reports.

1.6.7 Field quality-control reports.

1.7 QUALITY ASSURANCE

1.7.1 Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.

1.7.2 Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1.7.2.1 Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

1.8 DELIVERY, STORAGE, AND HANDLING

1.8.1 Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1.8.1.1 Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.8.2 Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1.8.2.1 Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
1.8.2.2 Clean and relubricate bolts and nuts that become dry or rusty before use.
1.8.2.3 Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Comply with applicable provisions of the following specifications and documents:

2.1.1.1 ANSI/AISC 303.
2.1.1.2 ANSI/AISC 341.
2.1.1.3 ANSI/AISC 360.
2.1.1.4 RCSC's "Specification for Structural Joints Using High-Strength Bolts."

2.1.2 Connection Design Information:

2.1.2.1 Option 1: Connection designs have been completed and connections are indicated on the Drawings.

2.2 STRUCTURAL-STEEL MATERIALS

2.2.1 W-Shapes: ASTM A992/A992M.

2.2.2 Channels, Angles-Shapes: ASTM A36/A36M.

2.2.3 Plate and Bar: ASTM A36/A36M.

2.2.4 Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C structural tubing.

2.2.5 Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.

2.2.5.1 Weight Class: Standard.
2.2.5.2 Finish: Galvanized

2.2.6 Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

2.3.1 High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with hot-dipped galvanized (G90) finish.

2.3.1.1 Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with hot-dipped galvanized (G90) finish.

2.3.2 Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

2.3.2.1 Finish: Hot-dip zinc coating (G90).
2.3.2.2 Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with mechanically deposited zinc coating finish (G90).

2.3.3 Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies, consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.

2.3.3.1 Finish: Mechanically deposited zinc coating (G90).

2.4 RODS

2.4.1 Unheaded Anchor Rods: ASTM F1554, Grade 55, weldable.

2.4.1.1 Configuration: Straight.
2.4.1.2 Nuts: ASTM A563 heavy-hex carbon steel.
2.4.1.3 Plate Washers: ASTM A36/A36M carbon steel.
2.4.1.4 Washers: ASTM F436, Type 1, hardened carbon steel.
2.4.1.5 Finish: Hot-dip zinc coating (G90), ASTM A153/A153M, Class C.

2.4.2 Headed Anchor Rods: ASTM F1554, Grade 55, weldable, straight.

2.4.2.1 Nuts: ASTM A563 heavy-hex carbon steel.
2.4.2.2 Plate Washers: ASTM A36/A36M carbon steel.
2.4.2.3 Washers: ASTM F436, Type 1, hardened carbon steel.
2.4.2.4 Finish: Hot-dip zinc coating (G90), ASTM A153/A153M, Class C.

2.4.3 Threaded Rods: ASTM A36/A36M.

2.4.3.1 Nuts: ASTM A 63 heavy-hex carbon steel.
2.4.3.2 Washers: ASTM A36/A36M carbon steel.
2.4.3.3 Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

2.5 PRIMER

2.5.1 Galvanized-Steel Primer: MPI#26.

2.5.1.1 Etching Cleaner: MPI#25, for galvanized steel.

2.5.1.2 Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.6 SHRINKAGE-RESISTANT GROUT

2.6.1 Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

2.7.1 Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.

2.7.1.1 Camber structural-steel members where indicated.
2.7.1.2 Fabricate beams with rolling camber up.
2.7.1.3 Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
2.7.1.4 Mark and match-mark materials for field assembly.
2.7.1.5 Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

2.7.2 Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

2.7.2.1 Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

2.7.3 Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

2.7.4 Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

2.7.5 Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 3.

2.7.6 Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

2.7.6.1 Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2.7.6.2 Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
2.7.6.3 Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.8 SHOP CONNECTIONS

2.8.1 High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.

2.8.1.1 Joint Type: Snug tightened.

2.8.2 Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.9 GALVANIZING

2.9.1 Hot-Dip Galvanized Finish: Apply zinc coating (G90) by the hot-dip process to structural steel in accordance with ASTM A123/A123M.

2.9.1.1 Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2.9.1.2 Galvanize lintels attached to structural-steel frame and located in exterior walls.

2.10 SOURCE QUALITY CONTROL

2.10.1 Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.

2.10.1.1 Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

2.10.1.2 Bolted Connections: Inspect shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

2.10.1.3 Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

2.10.1.3.1 Liquid Penetrant Inspection: ASTM E165/E165M.

2.10.1.3.2 Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.

2.10.1.3.3 Ultrasonic Inspection: ASTM E164.

2.10.1.3.4 Radiographic Inspection: ASTM E94/E94M.

2.10.1.4 In addition to visual inspection, test and inspect shop-welded shear stud connectors in accordance with requirements in AWS D1.1/D1.1M for stud welding and as follows:

2.10.1.4.1 Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear stud connector.

2.10.1.4.2 Conduct tests in accordance with requirements in AWS D1.1/D1.1M on additional shear stud connectors if weld fracture occurs on shear stud connectors already tested.

2.10.1.5 Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedment’s for compliance with requirements.

3.1.1.1 Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

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

3.2 PREPARATION

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

3.2.1.1 Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

3.3.1 Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.

3.3.2 Baseplates, Bearing Plates and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

3.3.2.1 Set plates for structural members on wedges, shims, or setting nuts as required.
3.3.2.2 Weld plate washers to top of baseplate.
3.3.2.3 Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
3.3.2.4 Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.

3.3.3 Maintain erection tolerances of structural steel within ANSI/AISC 303.

3.3.4 Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

3.3.4.1 Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
3.3.4.2 Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

3.3.5 Splice members only where indicated.

3.3.6 Do not use thermal cutting during erection.

3.3.7 Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

3.4.1 High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.

3.4.1.1 Joint Type: Snug tightened.

3.4.2 Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

3.4.2.1 Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
3.4.2.2 Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

3.5 FIELD QUALITY CONTROL

3.5.1 Special Inspections: Owner will engage a special inspector to perform the following special inspections:

3.5.1.1 Verify structural-steel materials and inspect steel frame joint details.
3.5.1.2 Verify weld materials and inspect welds.
3.5.1.3 Verify connection materials and inspect high-strength bolted connections.

3.5.2 Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

3.5.2.1 Bolted Connections: Inspect bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
3.5.2.2 Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.

3.5.2.2.1 In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

3.5.2.2.1.1 Liquid Penetrant Inspection: ASTM E165/E165M.
3.5.2.2.1.2 Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3.5.2.2.1.3 Ultrasonic Inspection: ASTM E164.
3.5.2.2.1.4 Radiographic Inspection: ASTM E94/E94M.

3.6 PROTECTION

3.6.1 Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION

SECTION 05 31 00

STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Roof deck.

1.2.2 Related Requirements:

1.2.2.1 Section 05 12 00 "Structural Steel Framing" for shop- and field-welded shear connectors.

1.3 ACTION SUBMITTALS

1.3.1 Product Data: For each type of deck, accessory, and product indicated.

1.3.2 Shop Drawings:

1.3.2.1 Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

1.4.1 Welding certificates.

1.4.2 Product Certificates: For each type of steel deck.

1.4.3 Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1.4.3.1 Power-actuated mechanical fasteners.

1.4.4 Evaluation Reports: For steel deck, from ICC-ES.

1.4.5 Field quality-control reports.

1.5 QUALITY ASSURANCE

1.5.1 Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.5.2 Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.5.3 Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's "Electrical Construction Equipment Directory" for use with standard header ducts and outlets for electrical distribution systems.

1.5.4 FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

1.6.2 Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

2.2 ROOF DECK

2.2.1 Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

- 2.2.1.1 Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 33, G90 zinc coating.
- 2.2.1.2 Deck Profile: As indicated.
- 2.2.1.3 Profile Depth: As indicated.
- 2.2.1.4 Design Uncoated-Steel Thickness: As indicated.
- 2.2.1.5 Span Condition: Single span.
- 2.2.1.6 Side Laps: Overlapped.

2.3 ACCESSORIES

2.3.1 General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

2.3.2 Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws. See Performance Work Statement Drawings.

2.3.3 Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

2.3.4 Galvanizing Repair Paint: ASTM A780/A780M.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION, GENERAL

3.2.1 Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

3.2.2 Install temporary shoring before placing deck panels if required to meet deflection limitations.

3.2.3 Locate deck bundles to prevent overloading of supporting members.

3.2.4 Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

3.2.5 Place deck panels flat and square and fasten to supporting frame without warp or deflection.

3.2.6 Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

3.2.7 Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

3.2.8 Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.2.9 Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

3.3.1 Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

3.3.2 Field welds will be subject to inspection.

3.3.3 Prepare test and inspection reports.

3.4 PROTECTION

3.4.1 Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA 46	(1978) Standards for Anodized Architectural Aluminum
AA DAF-45	(2003) Designation System for Aluminum Finishes

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2005) Code of Standard Practice for Steel Buildings and Bridges

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2008; Errata 2009) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B18.2.1	(1996; Addenda A 1999; Errata 2003; R 2005) Square and Hex Bolts and Screws (Inch Series)
ASME B18.21.1	(1999; R 2005) Lock Washers (Inch Series)
ASME B18.22.1	(1965; R 2008) Plain Washers
ASME B18.6.2	(1998; R 2005) Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws: Inch Series
ASME B18.6.3	(2003; R 2008) Machine Screws and Machine Screw Nuts

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 307	(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 36/A 36M	(2008) Standard Specification for Carbon Structural Steel

ASTM A 467/A 467M	(2007) Standard Specification for Machine Coil and Chain
ASTM A 47/A 47M	(1999; R 2004) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 475	(2003) Standard Specification for Zinc-Coated Steel Wire Strand
ASTM A 48/A 48M	(2003; R 2008) Standard Specification for Gray Iron Castings
ASTM A 500/A 500M	(2007) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 653/A 653M	(2009) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 780/A 780M	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A 786/A 786M	(2005) Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A 924/A 924M	(2009) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 108/B 108M	(2008) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B 209	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(2008) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B 26/B 26M	(2009) Standard Specification for Aluminum-Alloy Sand Castings
ASTM D 1187	(1997; R 2002e1) Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM E 488	(1996; R 2003) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
ASTM F 1267	(2007) Metal, Expanded, Steel
ASTM F 1679	(2004e1) Standard Test Method for Using a Variable Incidence Tribometer

MASTER PAINTERS INSTITUTE (MPI)

MPI 79	(Jan 2004) Alkyd Anti-Corrosive Metal Primer

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2000) Metal Bar Grating Manual
NAAMM MBG 532	(2000) Heavy Duty Metal Bar Grating Manual

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6	(2007) Commercial Blast Cleaning

1.2 RELATED DOCUMENTS

1.2.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

1.3.1 Section Includes:

1.3.1.1 Steel framing and supports for mechanical and electrical equipment.
1.3.1.2 Steel framing and supports for applications where framing and supports are not specified in other Sections.
1.3.1.3 Slotted channel framing.
1.3.1.4 Shelf angles.
1.3.1.5 Miscellaneous steel trim including Metal bollards.
1.3.1.6 Downspout guards.
1.3.1.7 Metal downspout boots.

1.3.2 Products furnished, but not installed, under this Section include the following:

1.3.2.1 Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
1.3.2.2 Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

1.3.3 Related Requirements:

1.3.3.1 Section 05 12 00 "Structural Steel Framing" for steel framing, supports, and other steel items attached to the structural-steel framing.

1.4 COORDINATION

1.4.1 Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

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

1.5 ACTION SUBMITTALS

1.5.1 Product Data: For the following:

- 1.5.1.1 Metal bollards.
- 1.5.1.2 Downspout guards.
- 1.5.1.3 Metal downspout boots.

1.5.2 Delegated-Design Submittal: Shop drawings. Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide submittals for the following:

- 1.5.2.1 Steel framing and supports for applications where framing and supports are not specified in other Sections.

1.6 INFORMATIONAL SUBMITTALS

1.6.1 Qualification Data: For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.

1.6.2 Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.

1.6.3 Welding certificates.

1.6.4 Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.6.5 Research Reports: For post-installed anchors.

1.7 QUALITY ASSURANCE

1.7.1 Welding Qualifications: Qualify procedures and personnel in accordance with the following:

- 1.7.1.1 AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.8 FIELD CONDITIONS

1.8.1 Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Delegated Design: Engage a qualified professional engineer, "Quality Requirements," to design ladders.

2.1.2 Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

2.1.2.1 Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces

2.2 METALS

2.2.1 Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2.2 Steel Plates, Shapes, and Bars: ASTM A36/A36M.

2.2.3 Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, Type 316L.

2.2.4 Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 316L.

2.2.5 Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

2.2.6 Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.2.7 Aluminum Plate and Sheet: ASTM B209, Alloy 6061-T6.

2.2.8 Aluminum Extrusions: ASTM B221, Alloy 6063-T6.

2.2.9 Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.

2.3 FASTENERS

2.3.1 General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

2.3.1.1 Provide stainless steel fasteners for fastening stainless steel.
2.3.1.2 Provide bronze fasteners for fastening bronze.

2.3.2 Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

2.3.3 High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.

2.3.4 Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers;

2.3.5 Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.

2.3.6 Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

2.3.7 Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

2.3.8 Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Shop Primers: Provide primers that comply with Section 09 96 00 "High-Performance Coatings."

2.4.2 Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

2.4.2.1 Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

2.4.3 Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

2.4.4 Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

2.4.5 Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

2.4.6 Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.4.7 Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.4.8 Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

2.5.1 Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

2.5.2 Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

2.5.3 Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

2.5.4 Form exposed work with accurate angles and surfaces and straight edges.

2.5.5 Weld corners and seams continuously to comply with the following:

2.5.5.1 Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2.5.5.2 Obtain fusion without undercut or overlap.
2.5.5.3 Remove welding flux immediately.
2.5.5.4 At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing

2.5.6 Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

2.5.7 Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.5.8 Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

2.5.9 Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

2.6.1 General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

2.6.2 Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

2.6.2.1 Fabricate units from slotted channel framing where indicated.
2.6.2.2 Furnish inserts for units installed after concrete is placed.

2.6.3 Galvanize miscellaneous framing and supports where indicated.

2.6.4 Prime miscellaneous framing and supports with primer specified in Section 09 96 00 "High-Performance Coatings" where indicated.

2.7 SHELF ANGLES

2.7.1 Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

2.7.1.1 Provide mitered and welded units at corners.
2.7.1.2 Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

2.7.2 Galvanize, prime and Two (2) Finish coats of paint to shelf angles located in exterior walls.

2.7.3 Prime shelf angles located in exterior walls with primer specified in Section 09 96 00 "High-Performance Coatings."

2.7.4 Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.8 MISCELLANEOUS STEEL TRIM

2.8.1 Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

2.8.2 Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

2.8.2.1 Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

2.8.3 Galvanize and prime miscellaneous steel trim.

2.9 METAL BOLLARDS

2.9.1 Fabricate metal bollards from Schedule 80 steel pipe.

2.9.1.1 Cap bollards with 1/4-inch-thick, steel plate with domed top.

2.9.2 Fabricate bollards with 3/8-inch-thick, steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.

2.9.2.1 Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

2.9.3 Fabricate sleeves for bollard anchorage from steel or stainless steel pipe or tubing with 1/4-inch-thick, steel or stainless steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.

2.9.4 Fabricate internal sleeves for removable bollards from Schedule 80 stainless steel pipe or 1/4-inch wall-thickness stainless steel tubing with an OD approximately 1/16 inch less than ID of bollards. Match drill sleeve and bollard for 3/4-inch stainless steel machine bolt.

2.9.5 Prime steel bollards with zinc-rich primer.

2.10 DOWNSPOUT GUARDS

2.10.1 Fabricate downspout guards from 3/8-inch-thick by 12-inch-wide, stainless steel, ASTM A480/A480M, No. 4 finish plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch clearance between pipe and pipe guard. Drill each end for two 3/4-inch anchor bolts.

2.11 LOOSE BEARING AND LEVELING PLATES

2.11.1 Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

2.11.2 Galvanize bearing and leveling plates.

2.11.3 Prime plates with zinc-rich primer.

2.12 STEEL WELD PLATES AND ANGLES

2.12.1 Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.13 GENERAL FINISH REQUIREMENTS

2.13.1 Finish metal fabrications after assembly.

2.13.2 Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.14 STEEL AND IRON FINISHES

2.14.1 Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

2.14.1.1 Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

2.14.2 Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

2.14.3 Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, or masonry, or unless otherwise indicated.

2.14.4 Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

2.14.4.1 Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2.14.4.2 Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2.14.4.3 Items Indicated to Receive Primers Specified in Section 09 96 00 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2.14.4.4 Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
2.14.4.5 Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

2.14.5 Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

2.14.5.1 Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.15 ALUMINUM FINISHES

2.15.1 As-Fabricated Finish: AA-M12.

2.15.2 Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

3.1.1 Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

3.1.2 Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

3.1.3 Field Welding: Comply with the following requirements:

3.1.3.1 Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
3.1.3.2 Obtain fusion without undercut or overlap.
3.1.3.3 Remove welding flux immediately.
3.1.3.4 At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

3.1.4 Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

3.1.5 Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.1.6 Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

3.1.6.1 Cast Aluminum: Heavy coat of bituminous paint.
3.1.6.2 Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

3.2.1 General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.2.2 Anchor shelf angles securely to existing construction with expansion or anchor bolts Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

3.2.2.1 Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

3.2.3 Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installation of Bearing and Leveling Plates" Article.

3.2.3.1 Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLATION OF METAL BOLLARDS

3.3.1 Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

3.3.1.1 Do not fill removable bollards with concrete.

3.3.2 Anchor bollards in concrete with pipe sleeves preset and anchored into concrete not less than 42 inches deep and 3/4 inch larger than OD of bollard. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

3.3.3 Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

3.3.4 Anchor internal sleeves for removable bollards in concrete by inserting in pipe sleeves preset into concrete. Fill annular space around internal sleeves solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward internal sleeve.

3.3.5 Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.

3.3.6 Place removable bollards over internal sleeves and secure with 3/4-inch machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner furnishes padlocks.

3.4 INSTALLATION OF BEARING AND LEVELING PLATES

3.4.1 Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

3.4.2 Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 REPAIRS

3.5.1 Touchup Painting:

3.5.1.1 Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

3.5.1.1.1 Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

3.5.1.2 Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint.

3.5.2 Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION

SECTION 06 61 00

FIBER REINFORCED PLASTIC FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

1.1.1 Section includes the following:

1.1.1.1 FRP structural shapes.
1.1.1.2 FRP gratings and frames.

1.1.2 Related Documents: Drawings and general provisions of Performance Work Statement, including General and Supplementary Conditions and Division 1, apply to Work of this Section

1.2 DEFINITIONS

1.2.1 Definitions in ASTM E 985 for railing related terms apply to this Section.

1.2.2 Pultrusion: Process of pulling fiberglass rovings (strands), mats, and other forms of reinforcements such as woven fiberglass through baths of thermosetting liquid resin, and then through a heated forming die (made of steel) to form a completed composite fiberglass structural shape.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

1.3.1 Structural Performance: Design, engineer, fabricate, and install the following FRP fabrications to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each FRP fabrication.

1.3.2 Design Criteria:

1.3.2.1 Refer to Design Criteria on Sheet S-001 for Load Requirements.
1.3.2.2 All FRP connections shall be 316 Stainless Steel
1.3.2.3 All primary and secondary supports shall be FRP structural sections, designed and furnished by the FRP manufacturer.

1.3.3 All perimeter edge support angles shall be FRP structural sections.

1.4 SUBMITTALS

1.4.1 Shop Drawings: Submit in accordance with Section 01 33 00 – Shop Drawings, Working Drawings, and Samples covering the items included under this Section. Shop Drawing submittals shall include:

1.4.1.1 Shop Drawings detailing fabrication and erection of each FRP fabrication indicated. Include plans, elevations, sections, and details of FRP fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.

1.4.1.2 Product Data for products used in miscellaneous FRP fabrications including paint products and grout.

1.4.1.3 Where installed FRP fabrications are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by the qualified Delegate Engineer, licensed in the State of New York, responsible for their preparation.

1.4.1.4 Samples representative of materials and finished products as may be requested by Owner’s Representative.

1.4.2 Quality Control Submittals: Qualification data for firms and persons specified in "Quality Assurance" Paragraph to demonstrate their capabilities and experience. Include list of completed projects with project name, addresses, names of Architects, Engineers and Owners, and other information specified.

1.5 QUALITY ASSURANCE

1.5.1 Fabricator Qualifications: Firm experienced in successfully producing FRP fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in Work.

1.5.1.1 Arrange for installation of FRP fabrications specified in this Section by same firm that fabricated them.

1.5.2 Engineer Qualifications: Professional Engineer licensed to practice in jurisdiction where Project is located and experienced in providing engineering services of the kind indicated that have resulted in the successful installation of metal fabrications similar in material, design, and extent to that indicated for this Project shall sign and seal the shop drawings.

1.6 PROJECTION CONDITIONS

1.6.1 Field Measurements: Check actual locations of walls, equipment, piping, required openings and other construction to which FRP fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.1.1 Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:

2.1.1.1 FRP Pultruded Grating, and Frame Materials:
2.1.1.2 Grating Pacific, Inc.
2.1.1.3 Fibergrate Composite Structures
2.1.1.4 Strongwell
2.1.1.5 American Grating
2.1.1.6 Or alternative manufacturer approved by Owner’s Representative and owner.

2.2 FRP SURFACES

2.2.1 For FRP fabrications exposed to view upon completion of Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, and, for FRP sheet, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet.

2.2.2 FRP resin shall be a corrosion resistant, fire resistant, pultruded-type premium grade isophthalic polyester.

2.3 MATERIALS

2.3.1 FRP structural shapes and plates shall be manufactured using a pultruded process utilizing either flame-retardant isophthalic polyester containing an ultraviolet (UV) inhibitor. A synthetic surface veil shall be the outermost layer of reinforcement covering the entire exterior surface. The FRP shapes and plates shall achieve a flame spread of 25 or less in accordance with ASTM test method E 84. The exterior of the pultruded shapes and plates shall have a 1 mil (0.025 mm) minimum polyurethane protective coating for added UV protection. Dimensional tolerances shall be in accordance with ASTM specification D 3917. FRP shapes and plates shall comply with the following material properties:

Table 1 - Fiberglass Pultruded Material Properties

Material Properties	ASTM Test Method	Psi (MPa)
Pultruded Fiberglass Structural Shapes		
Ultimate tensile strength in longitudinal direction	D 638	30,000 (207), minimum
Ultimate compressive strength in longitudinal direction	D 695	30,000 (207), minimum
Ultimate felexural strength in longitudinal direction	D 790	30,000 (207), minimum
Ultimate shear strength in longitudinal direction	D 3846	5,500 (38), minimum
Material Properties	**ASTM Test Method**	**Psi (MPa)**
Ultimate tensile strength in transverse direction	D 638	7,000 (48), minimum
Ultimate compressive strength in transverse direction	D 695	15,000 (103), minimum
Ultimate flexural strength in transverse direction	D 790	10,000 (69), minimum
Ultimate shear strengthen transverse direction	D 3846	5,500 (38), minimum
Density (lb/in.^{3} (kg/mm^3))	D 792	0.065 (0.00180), minimum
Water absorption (24-h immersion)	D 570	0.60 max, percent by weight
Material Properties	**ASTM Test Method**	**Psi (MPa)**
Pultruded Fiberglass Sheet		
Ultimate tensile strength in longitudinal direction	D 638	20,000 (138), minimum
Ultimate compressive strength in longitudinal direction	D 638	20,000 (138), minimum
Ultimate flexural strength in longitudinal direction	D 790	30,000 (207), minimum
Ultimate shear strength in longitudinal direction	D 3846	5,500 (38), minimum
Ultimate tensile strength in transverse direction	D 638	10,000 (69), minimum
Ultimate compressive strength in transverse direction	D 695	15,000 (103), minimum
Ultimate flexural strengthen transverse direction	D 790	13,000 (90), minimum
Ultimate shear strength in transverse direction	D 3846	5,500 (38), minimum
Material Properties	**ASTM Test Method**	**Psi (MPa)**
Water absorption (24-h) immersion)	D 570	0.50 max, percent by weight
Thermal		
Thermal Coefficient of Expansion	D 696	5 x 10^{-6} (inches with degree F)***
Thermal Conductivity		4 Btu per sq. ft./hour/ degree F/in.
Specific Heat		0.028 Btu/lb. degree F
Electrical		
Electric strength, short term in oil, 1/8 inch	D 149	200 vpm*
Electric strength, short term, in oil		35 kV per inch**
Dielectric constant, 60 Hertz	D 150	5.6
Dissipation factor, 60 Hertz	D 150*	0.03
Arc resistance	D 495	120 seconds***
Flame Retardant Properties		
Flame resistance	FTMS 402-2023	75/75 Ign. burn seconds
Intermittent flame test	HLT-15	100 rating
Flammability test	D 635	****
Surface burning characteristics	E 84	25 maximum
Flammability class	UL 94	V-0
Temperature index	UL 94	130

Notes to Table 1:
*Specimen tested perpendicular to laminate face.
**1-inch long specimen tested parallel to laminate face using 2-inch diameter electrodes.

***Indicates reported value measured in longitudinal direction.
****Average time of burning = 0.5 second, average extent of burning = 15 minutes

2.3.2 Fiberglass sheet or solid fiberglass bar shall be used to fabricate the internal connectors for the square tube. The internal connectors will be 1-1/2 by 1-1/2 inches (38.1 by 38.1 mm) with length and angularity variable to meet the requirements of each connection. Angular connections shall be fabricated from fiberglass sheet bonded together using a bisphenol A/epichlorohydrin epoxy resin with an amine-curing agent to give a minimum thickness of 1-1/2 inches. The angular connections will be fabricated to the proper dimension from the fiberglass sheets that have been bonded together.

2.3.2.1 Fiberglass sheet used for angular connections shall meet the properties specified in Table 1. Fiberglass solid bar, 1-1/2 by 1-1/2-inch, shall be used for the straight connections, and shall meet the properties specified in Table 1.

2.3.3 Bolts shall be a minimum 3/8 inch (9.5 mm) diameter, 316 stainless steel. FRP bolts or fasteners are not permitted.

2.3.4 Adhesive used to bond internal connectors to fiberglass pultruded square tube shall be a bisphenol A/epichlorohydrin epoxy resin with an amine-curing agent.

2.4 FRP GRATINGS AND FRAMES

2.4.1 Glass-fiber grating frames shall be fabricated from pultruded structural angles. No metallic fasteners shall be used.

2.4.2 All grating to have a non-slip finish.

2.4.3 Glass fiber gratings shall be standard square mesh type or pultruded bar type manufactured of continuous glass fibers completely wetted with polyester resin.

PART 3 - EXECUTION

3.1 PREPERATION

3.1.1 Coordinate and provide anchorages, setting Drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Site.

3.1.2 Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

3.2 INSTALLATION

3.2.1 Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous FRP fabrications to in-place construction. Include threaded fasteners for concrete inserts, toggle bolts, through-bolts, lag bolts, and other connectors as required.

3.2.2 Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installation of miscellaneous FRP fabrications. Set FRP fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

3.2.3 Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.

3.2.4 All cut edges and holes shall be sealed with a compatible resin system containing an UV inhibitor.

3.2.5 All connections shall be made using a one-piece solid internal connector bonded to the interior of the square tube using an epoxy adhesive and riveted. The following types of connections are defined:

3.2.5.1 All bolted connections shall have a one-piece solid internal connector bonded to the interior of the square tube through which connector holes will be drilled. A minimum 1 inch (26 mm) length of the solid internal connector will be on each side of the drilled hole.

3.2.6 Additional solid internal connector pieces can be bonded with epoxy adhesive to the interior of the square tube as desired.

3.3 INSTALLATION OF FRP GRATINGS

3.3.1 Install gratings to comply with recommendations of NAAMM grating standard referenced under Part 2 that apply to grating types and/or bar sizes indicated, including installation clearances and standard anchoring details.

3.3.2 All sections of FRP floor grating to be removable sections. Secure removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

END OF SECTION

SECTION 07 41 13.16

STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Standing-seam metal roof panels.

1.2.2 Related Sections:

1.2.2.1 Section 07 72 53 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.3 ACTION SUBMITTALS

1.3.1 Product Data: For each type of product.

1.3.1.1 Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

1.3.2 Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1.3.2.1 Include similar Samples of trim and accessories involving color selection.

1.3.3 Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1.3.3.1 Metal Panels: 12 inches long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

1.4.1 Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

1.5.1 Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

1.6.1 Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6.2 UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

1.7.2 Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

1.7.3 Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

1.7.4 Retain strippable protective covering on metal panels during installation.

1.7.5 Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.8 FIELD CONDITIONS

1.8.1 Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

1.9.1 Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9.2 Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

1.10.1 Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1.10.1.1 Failures include, but are not limited to, the following:

1.10.1.1.1 Structural failures including rupturing, cracking, or puncturing.
1.10.1.1.2 Deterioration of metals and other materials beyond normal weathering.

1.10.1.2 Warranty Period: Twenty years from date of Substantial Completion.

1.10.2 Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1.10.2.1 Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

1.10.2.1.1 Color fading more than 5 Delta E units when tested according to ASTM D2244.
1.10.2.1.2 Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
1.10.2.1.3 Cracking, checking, peeling, or failure of paint to adhere to bare metal.

1.10.2.2 Finish Warranty Period: 10 years from date of Substantial Completion.

1.10.3 Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1.10.3.1 Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Energy Performance: Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List" for steep-slope roof products.

2.1.2 Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:

2.1.2.1 Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than 0.75.
2.1.2.2 Three-year, aged Solar Reflectance Index of not less than 64 when calculated according to ASTM E1980.

2.1.3 Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

2.1.3.1 Wind Loads: As indicated on Drawings.
2.1.3.2 Other Design Loads: As indicated on Drawings.
2.1.3.3 Deflection Limits: For wind loads, no greater than 1/240 of the span.

2.1.4 Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:

2.1.4.1 Test-Pressure Difference: 2.86 lbf/sq. ft..

2.1.5 Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.

2.1.6 Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

2.1.6.1 Uplift Rating: UL 90.

2.1.7 Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

2.1.7.1 Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

2.2.1 Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

2.2.1.1 Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.
2.2.1.2 Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1637.

2.2.2 Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.

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

2.2.2.1.1 Advanced Architectural Products.
2.2.2.1.2 Advanced Building Products Inc.
2.2.2.1.3 AEP Span; A BlueScope Steel Company.
2.2.2.1.4 Architectural Building Components.
2.2.2.1.5 Architectural Metal Systems.
2.2.2.1.6 ATAS International, Inc.
2.2.2.1.7 Berridge Manufacturing Company.
2.2.2.1.8 CENTRIA Architectural Systems.
2.2.2.1.9 Dimensional Metals, Inc.
2.2.2.1.10 Drexel Metals.
2.2.2.1.11 Englert, Inc.
2.2.2.1.12 Fabral.
2.2.2.1.13 Firestone Building Products.
2.2.2.1.14 Firestone Metal Products, LLC.
2.2.2.1.15 Flexospan Steel Buildings, Inc.
2.2.2.1.16 Garland Company, Inc. (The).
2.2.2.1.17 IMETCO.
2.2.2.1.18 MBCI.
2.2.2.1.19 McElroy Metal, Inc.
2.2.2.1.20 Merchant and Evans.
2.2.2.1.21 Metal Sales Manufacturing Corporation.
2.2.2.1.22 Morin - A Kingspan Group Company.
2.2.2.1.23 PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company.
2.2.2.1.24 Ryerson Tull, Inc.
2.2.2.1.25 Ultra Seam Incorporated.
2.2.2.1.26 Union Corrugating Company.

2.2.2.2 Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.

2.2.2.2.1 Nominal Thickness: 0.034 inch.
2.2.2.2.2 Exterior Finish: Two-coat fluoropolymer / Three-coat fluoropolymer / Mica fluoropolymer / Metallic fluoropolymer / FEVE fluoropolymer / Siliconized polyester.
2.2.2.2.3 Color: As indicated by manufacturer's designations or As selected by Engineer of Record from manufacturer's full range.

2.2.2.3 Clips: Two-piece floating to accommodate thermal movement.

2.2.2.3.1 Material: 0.0625-inch- thick, stainless steel sheet.

2.2.2.4 Joint Type: Double folded As standard with manufacturer.
2.2.2.5 Panel Coverage: 12 inches.
2.2.2.6 Panel Height: 2.5 inches.

2.3 UNDERLAYMENT MATERIALS

2.3.1 Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.

2.3.1.1 Thermal Stability: Stable after testing at 240 deg F; ASTM D1970.
2.3.1.2 Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D1970.

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

2.3.1.3.1 Carlisle WIP Products; a brand of Carlisle Construction Materials.
2.3.1.3.2 GCP Applied Technologies Inc.
2.3.1.3.3 Henry Company.
2.3.1.3.4 Metal-Fab Manufacturing, a Drexel Metals Company.
2.3.1.3.5 Owens Corning.
2.3.1.3.6 Protecto Wrap Company.
2.3.1.3.7 SDP Advanced Polymer Products Inc.

2.3.2 Felt Underlayment: ASTM D226/D226M, Type II (No. 30), asphalt-saturated organic felts.

2.3.3 Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

2.4.2 Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

2.4.2.1 Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2.4.2.2 Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
2.4.2.3 Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

2.4.3 Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

2.4.4 Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch-long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels roof and fascia and rake trim.

2.4.5 Downspouts: Formed from same material as roof panels. Fabricate in 10-foot-long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.

2.4.6 Panel Fasteners: Self-tapping screws designed to withstand design loads.

2.4.7 Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

2.4.7.1 Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
2.4.7.2 Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
2.4.7.3 Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.5 FABRICATION

2.5.1 Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

2.5.2 On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

2.5.3 Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

2.5.4 Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

2.5.5 Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.5.5.1 Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

2.5.5.2 Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

2.5.5.3 Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

2.5.5.4 Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.

2.5.5.5 Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

2.5.5.6 Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

2.5.5.6.1 Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

2.6.1 Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.6.2 Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6.3 Steel Panels and Accessories:

2.6.3.1 Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2.6.3.2 Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

3.1.1.1 Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

3.1.1.2 Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

3.1.1.2.1 Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

3.1.2 Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

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

3.2 PREPARATION

3.2.1 Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.3 INSTALLATION OF STANDING SEAM METAL ROOF PANELS

3.3.1 Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

3.3.1.1 Shim or otherwise plumb substrates receiving metal panels.

3.3.1.2 Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.

3.3.1.3 Install screw fasteners in predrilled holes.

3.3.1.4 Locate and space fastenings in uniform vertical and horizontal alignment.

3.3.1.5 Install flashing and trim as metal panel work proceeds.

3.3.1.6 Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.

3.3.1.7 Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.

3.3.1.8 Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

3.3.2 Fasteners:

3.3.2.1 Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
3.3.2.2 Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
3.3.2.3 Copper Panels: Use copper, stainless steel, or hardware-bronze fasteners.
3.3.2.4 Stainless Steel Panels: Use stainless steel fasteners.

3.3.3 Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

3.3.4 Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

3.3.5 Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

3.3.5.1 Install clips to supports with self-tapping fasteners.
3.3.5.2 Install pressure plates at locations indicated in manufacturer's written installation instructions.
3.3.5.3 Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
3.3.5.4 Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
3.3.5.5 Watertight Installation:

3.3.5.5.1 Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
3.3.5.5.2 Provide sealant or tape between panels and protruding equipment, vents, and accessories.
3.3.5.5.3 At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

3.3.6 Clipless Metal Panel Installation: Fasten metal panels to supports with screw fasteners at each lapped joint at location and spacing recommended by manufacturer.

3.3.7 Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

3.3.7.1 Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

3.3.8 Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.3.8.1 Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.

3.3.8.2 Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.3.9 Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

3.3.10 Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

3.3.10.1 Provide elbows at base of downspouts to direct water away from building.
3.3.10.2 Connect downspouts to underground drainage system indicated.

3.4 ERECTION TOLERANCES

3.4.1 Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.5 FIELD QUALITY CONTROL

3.5.1 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

3.5.2 Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

3.5.3 Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

3.5.4 Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

3.6.1 Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

3.6.2 Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

1.1.1.1 Formed roof-drainage sheet metal fabrications.

1.2 RELATED SECTIONS

1.2.1 07 41 13.16 Standing-Seam Metal Roof Panels

1.3 ACTION SUBMITTALS

1.3.1 Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

1.4.1 Product certificates.

1.4.2 Product test reports.

1.4.3 Sample warranty.

1.5 CLOSEOUT SUBMITTALS

1.5.1 Maintenance data.

1.6 QUALITY ASSURANCE

1.6.1 Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1.6.1.1 For copings and roof edge flashings that are SPRI ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.

1.7 WARRANTY

1.7.1 Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1.7.1.1 Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

2.1.2 Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

2.1.3 Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

2.1.3.1 Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

2.2.1 General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

2.2.2 Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, dead soft, fully annealed; 2D (dull, cold rolled)]

2.3 MISCELLANEOUS MATERIALS

2.3.1 General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

2.3.2 Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

2.3.2.1 General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

2.3.2.1.1 Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.

2.3.2.1.2 Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.

2.3.2.1.3 Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2.3.2.2 Fasteners for Copper Sheet: Copper, hardware bronze or passivated Series 300 stainless steel.
2.3.2.3 Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.

2.3.3 Solder:

2.3.3.1 For Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.

2.3.4 Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

2.3.5 Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

2.3.6 Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

2.3.7 Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

2.3.8 Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.

2.3.9 Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.4 ACCESSORIES:

2.4.1 Mastic/sealant: Product standard of quality is York Manufacturing, Inc.; UniverSeal US100.

2.4.1.1 Flashing Drip Edge, Requirements: 22 GA (minimum) Stainless Steel, extend horizontally from outside face of wall to face of insulation.

2.4.1.2 Characteristics:

2.4.1.2.1 Type: One part 100% solids, solvent-free formulated silyl-terminated polyether (STPE), ASTM C920-11, Type S, Grade NS, Class 50.

2.4.2 Outside corner and inside corner material; manufacturer’s standard available units using:

2.4.2.1 Multi-Flash 500
2.4.2.2 Preformed stainless steel: 26 gauge stainless steel.

2.4.3 End dam: Product may be folded in line with the flashing material or utilize preformed end dams by manufacturer using:

2.4.3.1 Multi-Flash 500.
2.4.3.2 Preformed stainless steel: 26 gauge stainless steel

2.4.4 Splice material: Product standard of quality is York304 SS by York. Manufacturer's standard self-adhered metal material; material matching system material or use Multi-Flash 500 6" lap piece and polyether sealant as a splice.

2.4.5 Termination bar: Product standard of quality is York T-96 termination bar. Manufacturer's standard 1" composite material bar or a 1" 26 gauge stainless steel termination bar with sealant lip.

2.4.6 Weep vent protection: Product standard of quality is York's Weep Armor. Geotextile drainage fabric at least 12" in height.

2.4.7 Weep vents: Product standard of quality is York's Stainless Steel Weep Vent. Type 316 stainless steel wool weep vents.

2.4.7.1.1 Repair and other materials/accessories: Manufacturer's standard.

2.4.8 Fasteners: Domestic manufactured fastener types and sizes recommended by flashing manufacturer for intended use.

2.5 FABRICATION, GENERAL

2.5.1 General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

2.5.1.1 Obtain field measurements for accurate fit before shop fabrication.
2.5.1.2 Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
2.5.1.3 Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

2.5.2 Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

2.5.2.1 Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
2.5.2.2 Use lapped expansion joints only where indicated on Drawings.

2.5.3 Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

2.5.4 Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

2.5.5 Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

2.5.6 Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

2.5.7 Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

PART 3 - EXECUTION

3.1 UNDERLAYMENT INSTALLATION

3.1.1 Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller. Cover underlayment within 14 days.

3.2 INSTALLATION, GENERAL

3.2.1 General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

3.2.1.1 Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
3.2.1.2 Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3.2.1.3 Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
3.2.1.4 Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
3.2.1.5 Torch cutting of sheet metal flashing and trim is not permitted.

3.2.2 Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

3.2.2.1 Coat concealed side of uncoated-aluminum sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
3.2.2.2 Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

3.2.3 Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.

3.2.3.1 Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
3.2.3.2 Use lapped expansion joints only where indicated on Drawings.

3.2.4 Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

3.2.5 Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

3.2.6 Seal joints as required for watertight construction. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.2.7 Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work.

3.2.7.1 Do not solder metallic-coated steel and aluminum sheet.
3.2.7.2 Do not use torches for soldering.
3.2.7.3 Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
3.2.7.4 Copper Soldering: Tin edges of uncoated sheets, using solder for copper.

3.2.8 Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.3 ROOF FLASHING INSTALLATION

3.3.1 General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

3.3.2 Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate.

3.3.3 Copings: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated.

3.3.4 Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches over base flashing. Install stainless-steel draw band and tighten.

3.3.5 Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints minimum of 4 inches.

3.3.6 Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.4 CLEANING AND PROTECTION

3.4.1 Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

3.4.2 Clean and neutralize flux materials. Clean off excess solder.

3.4.3 Clean off excess sealants.

3.4.4 Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION

SECTION 07 72 53

SNOW GUARDS

PART 1 - GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

1.1.1.1 Rail-type, seam-mounted snow guards.

1.2 ACTION SUBMITTALS

1.2.1 Product Data: For each type of product.

1.2.2 Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

1.2.2.1 Include details of rail-type snow guards.

1.2.3 Samples:

1.2.3.1 Rail-Type Snow Guards: Bracket, 12-inch-long rail, and installation hardware.

1.2.3.1.1 For units with factory-applied finishes, submit manufacturer's standard color selections.

1.2.4 Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.

1.2.4.1 Include calculation of number and location of snow guards.

1.3 INFORMATIONAL SUBMITTALS

1.3.1 Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the jurisdiction / state in which the Project is located.

1.3.2 Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design snow guards, including attachment to roofing material and roof deck, applicable for attachment method, based on the following:

2.1.1.1 Roof snow load.
2.1.1.2 Snow drifting
2.1.1.3 Roof slope.
2.1.1.4 Roof type.
2.1.1.5 Roof dimensions.
2.1.1.6 Roofing substrate type and thickness.
2.1.1.7 Snow guard type.
2.1.1.8 Snow guard fastening method and strength.
2.1.1.9 Snow guard spacing.
2.1.1.10 Coefficient of Friction Between Snow and Roof Surface: 0.
2.1.1.11 Factor of Safety: 3.

2.1.2 Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2.1.2.1 Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.1.3 Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

2.1.3.1 Snow Loads: As indicated on Drawings.

2.2 RAIL-TYPE SNOW GUARDS

2.2.1 Rail-Type, Flat-Mounted Snow Guards:

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

2.2.1.1.1 Alpine SnowGuards, a division of Vermont Slate & Copper Services, Inc.
2.2.1.1.2 Berger Building Products, Inc.
2.2.1.1.3 IceBlox Inc.
2.2.1.1.4 Rocky Mountain Snow Guards, Inc.
2.2.1.1.5 S-5! Attachment Solutions; Metal Roof Innovations, Ltd.
2.2.1.1.6 Sieger Snow Guards Inc.
2.2.1.1.7 TRA Snow and Sun, Inc.

2.2.1.2 Description: Units fabricated from metal baseplate anchored to adjustable bracket and equipped with minimum two bar(s), rail(s), or pipe(s).
2.2.1.3 Brackets and Baseplate: ASTM B209 aluminum; mill finish.
2.2.1.4 Bars: ASTM A240/A240M, Type 304 stainless steel; mill finish.

2.2.1.4.1 Profile: Round or Square with integral track to accept color-matching inserts of material and finish used for metal roof.

2.2.1.5 Seam clamps: ASTM B221 aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

2.2.2 Rail-Type, Seam-Mounted Snow Guards:

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

2.2.2.1.1 Alpine SnowGuards, a division of Vermont Slate & Copper Services, Inc.
2.2.2.1.2 Berger Building Products, Inc.
2.2.2.1.3 IceBlox Inc.
2.2.2.1.4 LMCurbs.
2.2.2.1.5 PMC Industries, Ltd.
2.2.2.1.6 Rocky Mountain Snow Guards, Inc.
2.2.2.1.7 S-5! Attachment Solutions; Metal Roof Innovations, Ltd.
2.2.2.1.8 TRA Snow and Sun, Inc.

2.2.2.2 Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with one rail with integral track to accept color-matching inserts of material and finish used for metal roof.
2.2.2.3 Brackets and Baseplates: ASTM A240/A240M, Type 304 stainless steel; mill finish.
2.2.2.4 Bars: ASTM A240/A240M, Type 304 stainless steel; mill finish.

2.2.2.4.1 Profile: Round or Square with integral track to accept color-matching inserts of material and finish used for metal roof.

2.2.2.5 Seam clamps: ASTM B221 aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Install snow guards according to manufacturer's written instructions.

3.1.1.1 Space rows as indicated on Drawings.
3.1.1.2 Space rows as recommended by manufacturer.

3.1.2 Attachment for Standing-Seam Metal Roofing:

3.1.2.1 Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.
3.1.2.2 Pad-Type, Flat-Mounted Snow Guards:

3.1.2.2.1 Mechanically attach to metal roofing according to manufacturer's instructions.
3.1.2.2.2 Solder to copper roofing according to manufacturer's instructions.

3.1.2.3 Pad-Type, Seam-Mounted Snow Guards:

3.1.2.3.1 Install snow guards in straight rows.
3.1.2.3.2 Secure in place using stainless steel set screws, incorporating round nonpenetrating point.
3.1.2.3.3 Torque set screw according to manufacturer's instructions.

3.1.2.4 Rail-Type, Seam-Mounted Snow Guards:

3.1.2.4.1 Install brackets to vertical ribs in straight rows.
3.1.2.4.2 Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
3.1.2.4.3 Torque set screw according to manufacturer's instructions.
3.1.2.4.4 Install cross members to brackets.

END OF SECTION

SECTION 22 05 23.12

BALL VALVES FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Brass ball valves.
1.2.1.2 Bronze ball valves.

1.3 DEFINITIONS

1.3.1 CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of valve.

1.4.1.1 Certification that products comply with NSF 61and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Prepare valves for shipping as follows:

1.5.1.1 Protect internal parts against rust and corrosion.
1.5.1.2 Protect threads, flange faces, and soldered ends.
1.5.1.3 Set ball valves open to minimize exposure of functional surfaces.

1.5.2 Use the following precautions during storage:

1.5.2.1 Maintain valve end protection.
1.5.2.2 Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

1.5.3 Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

2.1.1 Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

2.1.2 ASME Compliance:

2.1.2.1 ASME B1.20.1 for threads for threaded end valves.
2.1.2.2 ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2.1.2.3 ASME B16.18 for solder-joint connections.
2.1.2.4 ASME B31.9 for building services piping valves.

2.1.3 NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

2.1.4 Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

2.1.5 Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

2.1.6 Valve Sizes: Same as upstream piping unless otherwise indicated.

2.1.7 Valve Actuator Types:

2.1.7.1 Gear Actuator: For quarter-turn valves NPS 4 and larger.
2.1.7.2 Handlever: For quarter-turn valves smaller than NPS 4.

2.1.8 Valves in Insulated Piping:

2.1.8.1 Include 2-inch stem extensions.
2.1.8.2 Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
2.1.8.3 Memory stops that are fully adjustable after insulation is applied.

2.2 BRASS BALL VALVES

2.2.1 Brass Ball Valves, Two-Piece with Full Port and Brass Trim:

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

2.2.1.1.1 Apollo Valves; Conbraco Industries, Inc.
2.2.1.1.2 Elkhart Products Corporation.
2.2.1.1.3 Jomar Valve.
2.2.1.1.4 KITZ Corporation.
2.2.1.1.5 Milwaukee Valve Company.
2.2.1.1.6 NIBCO INC.
2.2.1.1.7 Red White Valve Corp.
2.2.1.1.8 Watts; a Watts Water Technologies company.

2.2.1.2 Description:

2.2.1.2.1 Standard: MSS SP-110.
2.2.1.2.2 CWP Rating: 600 psig.
2.2.1.2.3 Body Design: Two piece.
2.2.1.2.4 Body Material: Forged brass.
2.2.1.2.5 Ends: Threaded and soldered.
2.2.1.2.6 Seats: PTFE.
2.2.1.2.7 Stem: Stainless Steel
2.2.1.2.8 Ball: Stainless Steel, vented.
2.2.1.2.9 Port: Full.

2.2.2 Brass Ball Valves, Two-Piece with Regular Port and Stainless-Steel Trim:

2.2.2.1 Manufacturers: Subject to compliance with requirements, provide products by the following:

2.2.2.1.1 Jamesbury; Metso.

2.2.2.2 Description:

2.2.2.2.1 Standard: MSS SP-110.
2.2.2.2.2 CWP Rating: 600 psig.
2.2.2.2.3 Body Design: Two piece.
2.2.2.2.4 Body Material: Brass or bronze.
2.2.2.2.5 Ends: Threaded and soldered.
2.2.2.2.6 Seats: PTFE.
2.2.2.2.7 Stem: Stainless steel.
2.2.2.2.8 Ball: Stainless steel, vented.
2.2.2.2.9 Port: Regular.

2.2.3 Brass Ball Valves, Three-Piece with Full Port and Stainless-Steel Trim:

2.2.3.1 Manufacturers: Subject to compliance with requirements, provide products by the following:

2.2.3.1.1 Marwin Valve; Richards Industries.

2.2.3.2 Description:

2.2.3.2.1 Standard: MSS SP-110.
2.2.3.2.2 CWP Rating: 600 psig.
2.2.3.2.3 Body Design: Three piece.
2.2.3.2.4 Body Material: Forged brass.
2.2.3.2.5 Ends: Threaded and soldered.
2.2.3.2.6 Seats: PTFE.
2.2.3.2.7 Stem: Stainless steel.
2.2.3.2.8 Ball: Stainless steel, vented.
2.2.3.2.9 Port: Full.

2.3 BRONZE BALL VALVES

2.3.1 Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

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

2.3.1.1.1 Apollo Valves; Conbraco Industries, Inc.
2.3.1.1.2 Crane; Crane Energy Flow Solutions.
2.3.1.1.3 Hammond Valve.
2.3.1.1.4 Milwaukee Valve Company.
2.3.1.1.5 NIBCO INC.
2.3.1.1.6 Watts; a Watts Water Technologies company.

2.3.1.2 Description:

2.3.1.2.1 Standard: MSS SP-110.
2.3.1.2.2 CWP Rating: 600 psig.
2.3.1.2.3 Body Design: Two piece.
2.3.1.2.4 Body Material: Bronze.
2.3.1.2.5 Ends: Threaded or soldered.
2.3.1.2.6 Seats: PTFE.
2.3.1.2.7 Stem: Stainless steel.
2.3.1.2.8 Ball: Stainless steel, vented.
2.3.1.2.9 Port: Full.

2.3.2 Bronze Ball Valves, Three-Piece with Full Port and Stainless-Steel Trim:

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

2.3.2.1.1 Apollo Valves; Conbraco Industries, Inc.
2.3.2.1.2 Hammond Valve.
2.3.2.1.3 Milwaukee Valve Company.
2.3.2.1.4 NIBCO INC.
2.3.2.1.5 Watts; a Watts Water Technologies company.

2.3.2.2 Description:

2.3.2.2.1 Standard: MSS SP-110.
2.3.2.2.2 CWP Rating: 600 psig.
2.3.2.2.3 Body Design: Three piece.
2.3.2.2.4 Body Material: Bronze.
2.3.2.2.5 Ends: Threaded.
2.3.2.2.6 Seats: PTFE.
2.3.2.2.7 Stem: Stainless steel.
2.3.2.2.8 Ball: Stainless steel, vented.
2.3.2.2.9 Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

3.1.2 Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

3.1.3 Examine threads on valve and mating pipe for form and cleanliness.

3.1.4 Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

3.1.5 Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

3.2.1 Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

3.2.2 Locate valves for easy access and provide separate support where necessary.

3.2.3 Install valves in horizontal piping with stem at or above center of pipe.

3.2.4 Install valves in position to allow full stem movement.

3.2.5 Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

3.3.1 If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

3.3.2 Select valves with the following end connections:

3.3.2.1 For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

3.4.1 Pipe NPS 2 and Smaller:

3.4.1.1 Brass ball valves, two-piece with full port and stainless steel trim. Provide with threaded solder or press connection-joint ends.
3.4.1.2 Bronze ball valves, two-piece with full port and stainless steel trim. Provide with threaded or solder-joint ends.
3.4.1.3 Brass ball valves, three-piece with full port and stainless steel trim.
3.4.1.4 Bronze ball valves, three-piece with full port and stainless steel trim.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

- 1.2.1.1 Metal pipe hangers and supports.
- 1.2.1.2 Trapeze pipe hangers.
- 1.2.1.3 Fiberglass pipe hangers.
- 1.2.1.4 Metal framing systems.
- 1.2.1.5 Fiberglass strut systems.
- 1.2.1.6 Fastener systems.
- 1.2.1.7 Pipe-positioning systems.
- 1.2.1.8 Equipment supports.

1.2.2 Related Requirements:

- 1.2.2.1 Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
- 1.2.2.2 Section 22 05 16 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.

1.3 ACTION SUBMITTALS

1.3.1 Shop Drawings: Show fabrication and installation details and include calculations for the following:

- 1.3.1.1 Trapeze pipe hangers.
- 1.3.1.2 Metal framing systems.
- 1.3.1.3 Fiberglass strut systems.
- 1.3.1.4 Pipe stands.
- 1.3.1.5 Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

1.4.1 Welding certificates.

1.5 QUALITY ASSURANCE

1.5.1 Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

1.5.2 Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

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

2.2 METAL PIPE HANGERS AND SUPPORTS

2.2.1 Carbon-Steel Pipe Hangers and Supports:

2.2.1.1 Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2.2.1.2 Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
2.2.1.3 Nonmetallic Coatings: Plastic coated or epoxy powder coated.
2.2.1.4 Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
2.2.1.5 Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2.2 Copper Pipe and Tube Hangers:

2.2.2.1 Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2.2.2.2 Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.3 TRAPEZE PIPE HANGERS

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

2.4 FIBERGLASS PIPE HANGERS

2.4.1 Clevis-Type, Fiberglass Pipe Hangers:

2.4.1.1 Description: Similar to MSS SP-58, Type 1 steel pipe hanger, except hanger is made of fiberglass or fiberglass-reinforced resin.

2.4.1.2 Hanger Rods: Continuous-thread rod, washer, and nuts made of fiberglass, polyurethane or stainless steel.
2.4.1.3 Flammability: ASTM D635, ASTM E84, UL 94.

2.4.2 Strap-Type, Fiberglass Pipe Hangers:

2.4.2.1 Description: Similar to MSS SP-58, Type 9 or Type 10 steel pipe hanger, except hanger is made of fiberglass-reinforced resin.

2.4.2.1.1 Flammability: ASTM D635, ASTM E84, UL 94.

2.4.2.2 Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.5 METAL FRAMING SYSTEMS

2.5.1 MFMA Manufacturer Metal Framing Systems:

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

2.5.1.1.1 B-line, an Eaton business.
2.5.1.1.2 Flex-Strut Inc.
2.5.1.1.3 G-Strut.
2.5.1.1.4 Haydon Corporation.
2.5.1.1.5 Thomas & Betts Corporation; A Member of the ABB Group.
2.5.1.1.6 Unistrut; Part of Atkore International.
2.5.1.1.7 Wesanco, Inc.

2.5.1.2 Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2.5.1.3 Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
2.5.1.4 Channels: Continuous slotted stainless-steel, Type 304 channel with inturned lips.
2.5.1.5 Channel Width: Selected for applicable load criteria.
2.5.1.6 Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
2.5.1.7 Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
2.5.1.8 Metallic Coating: No coating.

2.5.2 Non-MFMA Manufacturer Metal Framing Systems:

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

2.5.2.1.1 Anvil International.
2.5.2.1.2 CADDY; a brand of nVent.
2.5.2.1.3 Carpenter & Paterson, Inc.
2.5.2.1.4 Empire Industries, Inc.
2.5.2.1.5 FNW; Ferguson Enterprises, Inc.
2.5.2.1.6 Gripple Inc.
2.5.2.1.7 MIRO Industries.
2.5.2.1.8 PHD Manufacturing, Inc.
2.5.2.1.9 Sioux Chief Manufacturing Company, Inc.

2.5.2.2 Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.

2.5.2.3 Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
2.5.2.4 Channels: Continuous slotted carbon-steel channel with inturned lips.
2.5.2.5 Channel Width: Select for applicable load criteria.
2.5.2.6 Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
2.5.2.7 Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
2.5.2.8 Metallic Coating: No coating

2.6 FIBERGLASS STRUT SYSTEMS

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

2.6.1.1 Champion Fiberglass, Inc.
2.6.1.2 Fabco Plastics Wholesale Limited.
2.6.1.3 G-Strut.
2.6.1.4 Seasafe, Inc.; AMICO, a Gibraltar Industries Company.
2.6.1.5 Unistrut; Part of Atkore International.

2.6.2 Description: Structural-grade, factory-formed, glass-fiber-resin channels and angles for supporting multiple parallel pipes.

2.6.2.1 Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
2.6.2.2 Channels: Continuous slotted fiberglass-reinforced plastic channel with inturned lips.
2.6.2.3 Channel Width: Selected for applicable load criteria.
2.6.2.4 Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
2.6.2.5 Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
2.6.2.6 Rated Strength: Selected to suit applicable load criteria.
2.6.2.7 Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.7 FASTENER SYSTEMS

2.7.1 Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

2.7.1.1.1 Hilti, Inc.
2.7.1.1.2 ITW Ramset/Red Head; Illinois Tool Works, Inc.
2.7.1.1.3 MKT Fastening, LLC.
2.7.1.1.4 Simpson Strong-Tie Co., Inc.

2.7.2 Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

2.7.2.1.1 B-line, an Eaton business.
2.7.2.1.2 Empire Tool and Manufacturing Co., Inc.
2.7.2.1.3 Hilti, Inc.
2.7.2.1.4 ITW Ramset/Red Head; Illinois Tool Works, Inc.
2.7.2.1.5 MKT Fastening, LLC.

2.7.2.2 Indoor Applications: Zinc-coated steel.
2.7.2.3 Outdoor Applications: Stainless steel.

2.8 PIPE-POSITIONING SYSTEMS

2.8.1 Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.9 EQUIPMENT SUPPORTS

2.9.1 Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.10 MATERIALS

2.10.1 Aluminum: ASTM B221.

2.10.2 Carbon Steel: ASTM A1011/A1011M.

2.10.3 Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

2.10.4 Stainless Steel: ASTM A240/A240M.

2.10.5 Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

2.10.5.1 Properties: Nonstaining, noncorrosive, and nongaseous.
2.10.5.2 Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

3.1.1 Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

3.1.2 Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

3.2.1 Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

3.2.2 Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

3.2.2.1 Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
3.2.2.2 Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

3.2.3 Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

3.2.4 MetalFraming System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

3.2.5 Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

3.2.6 Fastener System Installation:

3.2.6.1 Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
3.2.6.2 Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

3.2.7 Pipe Stand Installation:

3.2.7.1 Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 "Roof Accessories" for curbs.

3.2.8 Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

3.2.9 Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

3.2.10 Equipment Support Installation: Fabricate from welded-structural-steel shapes.

3.2.11 Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

3.2.12 Install lateral bracing with pipe hangers and supports to prevent swaying.

3.2.13 Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.2.14 Insulated Piping:

3.2.14.1 Attach clamps and spacers to piping.

3.2.14.1.1 Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
3.2.14.1.2 Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
3.2.14.1.3 Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

3.2.14.2 Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

3.2.14.2.1 Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3.2.14.3 Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

3.2.14.3.1 Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3.2.14.4 Shield Dimensions for Pipe: Not less than the following:

3.2.14.4.1 NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
3.2.14.4.2 NPS 4: 12 inches long and 0.06 inch thick.
3.2.14.4.3 NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
3.2.14.4.4 NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
3.2.14.4.5 NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

3.2.14.5 Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
3.2.14.6 Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

3.3.1 Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

3.3.2 Grouting: Place grout under supports for equipment, and make bearing surface smooth.

3.3.3 Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

3.4.1 Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

3.4.2 Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

3.4.3 Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

3.4.3.1 Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
3.4.3.2 Obtain fusion without undercut or overlap.
3.4.3.3 Remove welding flux immediately.
3.4.3.4 Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

3.5.1 Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.5.2 Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

3.6.1 Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

3.6.1.1 Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

3.6.2 Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 09 91 13 "Exterior Painting." And Section 09 91 23 "Interior Painting."

3.6.3 Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

3.7.1 Specific hanger and support requirements are in Sections specifying piping systems and equipment.

3.7.2 Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

3.7.3 Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

3.7.4 Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

3.7.5 Use carbon-steel pipe hangers and supports metal framing systems and attachments for general service applications.

3.7.6 Use stainless-steel pipe hangers and fiberglass pipe hangers and attachments for hostile environment applications.

3.7.7 Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

3.7.8 Use padded hangers for piping that is subject to scratching.

3.7.9 Use thermal hanger-shield inserts for insulated piping and tubing.

3.7.10 Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

3.7.10.1 Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
3.7.10.2 Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
3.7.10.3 Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.

3.7.11 Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

3.7.11.1 Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
3.7.11.2 Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

3.7.12 Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

3.7.12.1 Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
3.7.12.2 Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3.7.12.3 Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
3.7.12.4 Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
3.7.12.5 Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

3.7.13 Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

3.7.13.1 Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
3.7.13.2 Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3.7.13.3 Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3.7.13.4 Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
3.7.13.5 Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
3.7.13.6 C-Clamps (MSS Type 23): For structural shapes.
3.7.13.7 Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
3.7.13.8 Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
3.7.13.9 Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
3.7.13.10 Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
3.7.13.11 Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
3.7.13.12 Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

3.7.13.12.1 Light (MSS Type 31): 750 lb.
3.7.13.12.2 Medium (MSS Type 32): 1500 lb.
3.7.13.12.3 Heavy (MSS Type 33): 3000 lb.

3.7.13.13 Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
3.7.13.14 Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
3.7.13.15 Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

3.7.14 Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

3.7.14.1 Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
3.7.14.2 Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3.7.14.3 Thermal Hanger-Shield Inserts: For supporting insulated pipe.

3.7.15 Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

3.7.16 Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

3.7.17 Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.7.18 Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Pipe labels.
1.2.1.2 Stencils.
1.2.1.3 Valve tags.
1.2.1.4 Warning tags.

1.3 ACTION SUBMITTALS

1.3.1 Product Data: For each type of product indicated.

1.3.2 Samples: For color, letter style, and graphic representation required for each identification material and device.

1.3.3 Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

1.3.4 Valve numbering scheme.

1.3.5 Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 PIPE LABELS

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

2.1.1.1 Brady Corporation.
2.1.1.2 Brimar Industries, Inc.
2.1.1.3 Carlton Industries, LP.
2.1.1.4 Champion America.
2.1.1.5 Craftmark Pipe Markers.
2.1.1.6 emedco.
2.1.1.7 Kolbi Pipe Marker Co.

2.1.1.8 LEM Products Inc.
2.1.1.9 Marking Sevices Inc.
2.1.1.10 Seton Identification Products.

2.1.2 General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

2.1.3 Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

2.1.4 Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

2.1.5 Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

2.1.5.1 Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2.1.5.2 Lettering Size: Size letters according to ASME A13.1 for piping.

2.2 STENCILS

2.2.1 Stencils for Piping:

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

2.2.1.1.1 Brimar Industries, Inc.
2.2.1.1.2 Carlton Industries, LP.
2.2.1.1.3 Champion America.
2.2.1.1.4 Craftmark Pipe Markers.
2.2.1.1.5 Kolbi Pipe Marker Co.
2.2.1.1.6 Marking Sevices Inc.

2.2.1.2 Lettering Size: Size letters according to ASME A13.1 for piping.
2.2.1.3 Stencil Material: Aluminum.
2.2.1.4 Stencil Paint: Exterior, gloss, alkyd enamel acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
2.2.1.5 Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

2.3 VALVE TAGS

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

2.3.1.1 Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2.3.1.2 Brady Corporation.
2.3.1.3 Brimar Industries, Inc.
2.3.1.4 Carlton Industries, LP.
2.3.1.5 Champion America.
2.3.1.6 Craftmark Pipe Markers.
2.3.1.7 emedco.

2.3.1.8 Kolbi Pipe Marker Co.
2.3.1.9 LEM Products Inc.
2.3.1.10 Marking Sevices Inc.
2.3.1.11 Seton Identification Products.

2.3.2 Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

2.3.2.1 Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2.3.2.2 Fasteners: Brass wire-link chain or S-hook.

2.3.3 Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

2.3.3.1 Valve-tag schedule shall be included in operation and maintenance data.

2.4 WARNING TAGS

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

2.4.1.1 Brady Corporation.
2.4.1.2 Brimar Industries, Inc.
2.4.1.3 Carlton Industries, LP.
2.4.1.4 Champion America.
2.4.1.5 Craftmark Pipe Markers.

2.4.2 Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

2.4.2.1 Size: 3 by 5-1/4 inches minimum.
2.4.2.2 Fasteners: Brass grommet and wire.
2.4.2.3 Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
2.4.2.4 Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

3.2.1 Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

3.2.2 Coordinate installation of identifying devices with locations of access panels and doors.

3.2.3 Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 PIPE LABEL INSTALLATION

3.3.1 Piping Color Coding: Painting of piping is specified in Section 09 91 23 "Interior Painting."

3.3.2 Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.

3.3.2.1 Identification Paint: Use for contrasting background.
3.3.2.2 Stencil Paint: Use for pipe marking.

3.3.3 Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

3.3.3.1 Near each valve and control device.
3.3.3.2 Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3.3.3.3 Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
3.3.3.4 At access doors, manholes, and similar access points that permit view of concealed piping.
3.3.3.5 Near major equipment items and other points of origination and termination.
3.3.3.6 Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
3.3.3.7 On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.3.4 Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

3.3.5 Pipe Label Color Schedule:

3.3.5.1 Domestic Water Piping

3.3.5.1.1 Background: Safety green.
3.3.5.1.2 Letter Colors: White.

3.3.5.2 Sanitary Waste Piping:

3.3.5.2.1 Background Color: Safety black.
3.3.5.2.2 Letter Color: White.

3.4 VALVE-TAG INSTALLATION

3.4.1 Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.4.2 Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

3.4.2.1 Valve-Tag Size and Shape:

3.4.2.1.1 Cold Water: 1-1/2 inches, round.
3.4.2.1.2 Hot Water: 1-1/2 inches, round.

3.4.2.2 Valve-Tag Colors:

3.4.2.2.1 Cold Water: Natural.
3.4.2.2.2 Hot Water: Natural.

3.4.2.3 Letter Colors:

3.4.2.3.1 Cold Water: White.
3.4.2.3.2 Hot Water: White.

3.5 WARNING-TAG INSTALLATION

3.5.1 Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement (PWS), including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section includes insulating the following plumbing piping services:

1.2.1.1 Domestic cold-water piping (Tepid Water)

1.2.2 Related Sections:

1.2.2.1 Section 22 07 16 "Plumbing Equipment Insulation" for equipment insulation.

1.3 ACTION SUBMITTALS

1.3.1 Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.3.2 Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1.3.2.1 Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
1.3.2.2 Detail attachment and covering of heat tracing inside insulation.
1.3.2.3 Detail insulation application at pipe expansion joints for each type of insulation.
1.3.2.4 Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
1.3.2.5 Detail removable insulation at piping specialties, equipment connections, and access panels.
1.3.2.6 Detail application of field-applied jackets.

1.4 INFORMATIONAL SUBMITTALS

1.4.1 Qualification Data: For qualified Installer.

1.4.2 Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.4.3 Field quality-control reports.

1.5 QUALITY ASSURANCE

1.5.1 Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

1.5.2 Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1.5.2.1 Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
1.5.2.2 Insulation Installed Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.

1.5.2.3 Piping Mockups:

1.5.2.3.1 One 10-foot section of NPS 2 straight pipe.
1.5.2.3.2 One each of a 90 degree threaded, welded, and flanged elbow.
1.5.2.3.3 One each of a threaded, welded, and flanged tee fitting.
1.5.2.3.4 One NPS 2 or smaller valve and one NPS 2-1/2 or larger valve.
1.5.2.3.5 Four support hangers, including hanger shield and insert.
1.5.2.3.6 One threaded strainer and one flanged strainer with removable portion of insulation.
1.5.2.3.7 One threaded reducer and one welded reducer.
1.5.2.3.8 One pressure temperature tap.
1.5.2.3.9 One mechanical coupling.
1.5.2.3.10 One union.

1.5.2.4 For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
1.5.2.5 Notify Engineer of Record (EOR) seven days in advance of dates and times when mockups will be constructed.
1.5.2.6 Obtain EOR approval of mockups before starting insulation application.
1.5.2.7 Approval of mockups does not constitute approval of deviations from the PWS Documents contained in mockups unless EOR specifically approves such deviations in writing.
1.5.2.8 Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
1.5.2.9 Demolish and remove mockups when directed.

1.5.3 Comply with the following applicable standards and other requirements specified for miscellaneous components:

1.5.3.1 Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

1.7.1 Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1.7.2 Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7.3 Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

1.8.1 Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

1.8.2 Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

2.1.1 Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

2.1.2 Products shall not contain asbestos, lead, mercury, or mercury compounds.

2.1.3 Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

2.1.4 Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

2.1.5 Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

2.1.6 Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

2.1.6.1 Manufacturers: Subject to compliance with requirements, provide products by the following:

2.1.6.1.1 Pittsburgh Corning Corporation.

2.1.6.2 Preformed Pipe Insulation: Type II, Class 1, without jacket.
2.1.6.3 Preformed Pipe Insulation: Type II, Class 2, with factory-applied ASJ-SSL jacket.
2.1.6.4 Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
2.1.6.5 Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.1.7 Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials.

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

2.1.7.1.1 Aeroflex USA, Inc.
2.1.7.1.2 Armacell LLC.
2.1.7.1.3 K-Flex USA.

2.1.8 Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

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

2.1.8.1.1 Johns Manville; a Berkshire Hathaway company.
2.1.8.1.2 Knauf Insulation.
2.1.8.1.3 Manson Insulation Inc.
2.1.8.1.4 Owens Corning.

2.1.8.2 Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ-SSL.
2.1.8.3 850 deg F.
2.1.8.4 Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
2.1.8.5 Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.1.9 Phenolic: Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126.

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

2.1.9.1.1 ITW Insulation Systems; Illinois Tool Works, Inc.
2.1.9.1.2 Resolco Inc.

2.1.9.2 Preformed Pipe Insulation: Type III, with factory-applied ASJ.
2.1.9.3 Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
2.1.9.4 Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.1.10 Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type I, Grade 1, for tubular materials.

2.1.10.1 Manufacturers: Subject to compliance with requirements, provide products by the following:

2.1.10.1.1 Armacell LLC.

2.2 INSULATING CEMENTS

2.2.1 Mineral-Fiber Insulating Cement: Comply with ASTM C195.

2.2.1.1 Manufacturers: Subject to compliance with requirements, provide products by the following:

2.2.1.1.1 Ramco Insulation, Inc.

2.2.2 Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

2.2.2.1 Manufacturers: Subject to compliance with requirements, provide products by the following:

2.2.2.1.1 Ramco Insulation, Inc.

2.2.3 Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.2.3.1 Manufacturers: Subject to compliance with requirements, provide products by the following:

2.2.3.1.1 Ramco Insulation, Inc.

2.3 ADHESIVES

2.3.1 Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

2.3.2 Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

2.3.2.1 Manufacturers: Subject to compliance with requirements, provide products by the following:

2.3.2.1.1 Foster Brand; H. B. Fuller Construction Products.

2.3.3 Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

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

2.3.3.1.1 Aeroflex USA, Inc.
2.3.3.1.2 Armacell LLC.
2.3.3.1.3 Foster Brand; H. B. Fuller Construction Products.
2.3.3.1.4 K-Flex USA.

2.3.3.2 Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
2.3.3.3 Wet Flash Point: Below 0 deg F.
2.3.3.4 Service Temperature Range: 40 to 200 deg F.
2.3.3.5 Color: Black.

2.3.4 Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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

2.3.4.1.1 Childers Brand; H. B. Fuller Construction Products.
2.3.4.1.2 Foster Brand; H. B. Fuller Construction Products.

2.3.5 Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

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

2.3.5.1.1 Childers Brand; H. B. Fuller Construction Products.
2.3.5.1.2 Foster Brand; H. B. Fuller Construction Products.

2.3.6 ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

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

2.3.6.1.1 Childers Brand; H. B. Fuller Construction Products.
2.3.6.1.2 Foster Brand; H. B. Fuller Construction Products.
2.3.6.1.3 Mon-Eco Industries, Inc.

2.3.7 PVC Jacket Adhesive: Compatible with PVC jacket.

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

2.3.7.1.1 Dow Consumer Solutions.
2.3.7.1.2 Johns Manville; a Berkshire Hathaway company.
2.3.7.1.3 P.I.C. Plastics, Inc.
2.3.7.1.4 Speedline Corporation.

2.4 MASTICS AND COATINGS

2.4.1 Materials shall be compatible with insulation materials, jackets, and substrates.

2.4.2 Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

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

2.4.2.1.1 Childers Brand; H. B. Fuller Construction Products.
2.4.2.1.2 Foster Brand; H. B. Fuller Construction Products.

2.4.2.2 Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
2.4.2.3 Service Temperature Range: Minus 50 to plus 220 deg F.
2.4.2.4 Color: White.

2.5 SEALANTS

2.5.1 Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

2.5.2 Joint Sealants:

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

2.5.2.1.1 Childers Brand; H. B. Fuller Construction Products.
2.5.2.1.2 Foster Brand; H. B. Fuller Construction Products.
2.5.2.1.3 Mon-Eco Industries, Inc.
2.5.2.1.4 Pittsburgh Corning Corporation.

2.5.2.2 Permanently flexible, elastomeric sealant.
2.5.2.3 Service Temperature Range: Minus 58 to plus 176 deg F.
2.5.2.4 Color: White or gray.

2.5.3 FSK and Metal Jacket Flashing Sealants:

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

2.5.3.1.1 Childers Brand; H. B. Fuller Construction Products.
2.5.3.1.2 Foster Brand; H. B. Fuller Construction Products.
2.5.3.1.3 Mon-Eco Industries, Inc.

2.5.3.2 Fire- and water-resistant, flexible, elastomeric sealant.
2.5.3.3 Service Temperature Range: Minus 40 to plus 250 deg F.
2.5.3.4 Color: Aluminum.

2.5.4 ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

2.5.4.1 Manufacturers: Subject to compliance with requirements, provide products by the following:

2.5.4.1.1 Childers Brand; H. B. Fuller Construction Products.

2.5.4.2 Fire- and water-resistant, flexible, elastomeric sealant.
2.5.4.3 Service Temperature Range: Minus 40 to plus 250 deg F.
2.5.4.4 Color: White.

2.6 FACTORY-APPLIED JACKETS

2.6.1 Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

2.6.1.1 ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2.6.1.2 FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.7 FIELD-APPLIED JACKETS

2.7.1 Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.

2.7.2 FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.7.3 PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

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

2.7.3.1.1 Johns Manville; a Berkshire Hathaway company.
2.7.3.1.2 P.I.C. Plastics, Inc.
2.7.3.1.3 Proto Corporation.
2.7.3.1.4 Speedline Corporation.

2.7.3.2 Adhesive: As recommended by jacket material manufacturer.
2.7.3.3 Color: White.
2.7.3.4 Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

2.7.3.4.1 Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.7.4 Metal Jacket:

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

2.7.4.1.1 ITW Insulation Systems; Illinois Tool Works, Inc.
2.7.4.1.2 RPR Products, Inc.

2.7.4.2 Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

2.7.4.2.1 Sheet and roll stock ready for shop or field sizing.
2.7.4.2.2 Finish and thickness are indicated in field-applied jacket schedules.
2.7.4.2.3 Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
2.7.4.2.4 Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
2.7.4.2.5 Factory-Fabricated Fitting Covers:

2.7.4.2.5.1 Same material, finish, and thickness as jacket.
2.7.4.2.5.2 Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
2.7.4.2.5.3 Tee covers.
2.7.4.2.5.4 Flange and union covers.
2.7.4.2.5.5 End caps.
2.7.4.2.5.6 Beveled collars.
2.7.4.2.5.7 Valve covers.
2.7.4.2.5.8 Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.7.4.3 Stainless-Steel Jacket: ASTM A240/A240M.

2.7.4.3.1 Sheet and roll stock ready for shop or field sizing.
2.7.4.3.2 Material, finish, and thickness are indicated in field-applied jacket schedules.
2.7.4.3.3 Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
2.7.4.3.4 Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
2.7.4.3.5 Factory-Fabricated Fitting Covers:

2.7.4.3.5.1 Same material, finish, and thickness as jacket.
2.7.4.3.5.2 Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
2.7.4.3.5.3 Tee covers.
2.7.4.3.5.4 Flange and union covers.
2.7.4.3.5.5 End caps.
2.7.4.3.5.6 Beveled collars.
2.7.4.3.5.7 Valve covers.
2.7.4.3.5.8 Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

2.8.1 ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

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

2.8.1.1.1 3M Industrial Adhesives and Tapes Division.
2.8.1.1.2 Avery Dennison Corporation, Specialty Tapes Division.
2.8.1.1.3 Ideal Tape Co., Inc., an American Biltrite Company.
2.8.1.1.4 Knauf Insulation.

2.8.1.2 Width: 3 inches.
2.8.1.3 Thickness: 11.5 mils.
2.8.1.4 Adhesion: 90 ounces force/inch in width.
2.8.1.5 Elongation: 2 percent.
2.8.1.6 Tensile Strength: 40 lbf/inch in width.
2.8.1.7 ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.8.2 FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

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

2.8.2.1.1 3M Industrial Adhesives and Tapes Division.
2.8.2.1.2 Avery Dennison Corporation, Specialty Tapes Division.
2.8.2.1.3 Ideal Tape Co., Inc., an American Biltrite Company.
2.8.2.1.4 Knauf Insulation.

2.8.2.2 Width: 3 inches.
2.8.2.3 Thickness: 6.5 mils.
2.8.2.4 Adhesion: 90 ounces force/inch in width.
2.8.2.5 Elongation: 2 percent.
2.8.2.6 Tensile Strength: 40 lbf/inch in width.
2.8.2.7 FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.8.3 PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

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

2.8.3.1.1 3M Industrial Adhesives and Tapes Division.
2.8.3.1.2 Ideal Tape Co., Inc., an American Biltrite Company.

2.8.3.2 Width: 2 inches.
2.8.3.3 Thickness: 6 mils.
2.8.3.4 Adhesion: 64 ounces force/inch in width.
2.8.3.5 Elongation: 500 percent.
2.8.3.6 Tensile Strength: 18 lbf/inch in width.

2.8.4 Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

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

2.8.4.1.1 3M Industrial Adhesives and Tapes Division.
2.8.4.1.2 Avery Dennison Corporation, Specialty Tapes Division.
2.8.4.1.3 Ideal Tape Co., Inc., an American Biltrite Company.
2.8.4.1.4 Knauf Insulation.

2.8.4.2 Width: 2 inches.
2.8.4.3 Thickness: 3.7 mils.
2.8.4.4 Adhesion: 100 ounces force/inch in width.
2.8.4.5 Elongation: 5 percent.
2.8.4.6 Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

2.9.1 Bands:

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

2.9.1.1.1 ITW Insulation Systems; Illinois Tool Works, Inc.
2.9.1.1.2 RPR Products, Inc.

2.9.1.2 Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
2.9.1.3 Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch / 3/4 inch wide with wing seal or closed seal.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

3.1.1.1 Verify that systems to be insulated have been tested and are free of defects.
3.1.1.2 Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

3.2.1 Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2.2 Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.2.3 Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

3.3.1 Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

3.3.2 Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

3.3.3 Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

3.3.4 Install insulation with longitudinal seams at top and bottom of horizontal runs.

3.3.5 Install multiple layers of insulation with longitudinal and end seams staggered.

3.3.6 Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

3.3.7 Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.

3.3.8 Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

3.3.9 Install insulation with least number of joints practical.

3.3.10 Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

- 3.3.10.1 Install insulation continuously through hangers and around anchor attachments.
- 3.3.10.2 For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
- 3.3.10.3 Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- 3.3.10.4 Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

3.3.11 Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

3.3.12 Install insulation with factory-applied jackets as follows:

3.3.12.1 Draw jacket tight and smooth.
3.3.12.2 Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3.3.12.3 Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.

3.3.12.3.1 For below-ambient services, apply vapor-barrier mastic over staples.

3.3.12.4 Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
3.3.12.5 Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

3.3.13 Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

3.3.14 Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

3.3.15 Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

3.3.16 For above-ambient services, do not install insulation to the following:

3.3.16.1 Vibration-control devices.
3.3.16.2 Testing agency labels and stamps.
3.3.16.3 Nameplates and data plates.
3.3.16.4 Cleanouts.

3.4 PENETRATIONS

3.4.1 Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

3.4.2 Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

3.4.2.1 Seal penetrations with flashing sealant.
3.4.2.2 For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3.4.2.3 Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
3.4.2.4 Seal jacket to wall flashing with flashing sealant.

3.4.3 Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.4.4 Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

3.4.4.1 Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.4.5 Insulation Installation at Floor Penetrations:

3.4.5.1 Pipe: Install insulation continuously through floor penetrations.
3.4.5.2 Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

3.5.1 Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

3.5.2 Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

3.5.2.1 Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
3.5.2.2 Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3.5.2.3 Insulate tee fittings with preformed fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
3.5.2.4 Insulate valves using preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
3.5.2.5 Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
3.5.2.6 Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
3.5.2.7 For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

3.5.3 Install removable insulation covers at locations indicated. Installation shall conform to the following:

3.5.3.1 Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
3.5.3.2 When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation

on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.

3.5.3.3 Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

3.5.3.4 When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.5.3.5 Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

3.6.1 Insulation Installation on Straight Pipes and Tubes:

3.6.1.1 Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.

3.6.1.2 Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3.6.1.3 For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.

3.6.1.4 For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

3.6.2 Insulation Installation on Pipe Fittings and Elbows:

3.6.2.1 Install preformed sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

3.6.2.2 When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

3.6.3 Insulation Installation on Valves and Pipe Specialties:

3.6.3.1 Install preformed sections of cellular-glass insulation to valve body.

3.6.3.2 Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3.6.3.3 Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

3.7.1 Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7.2 Insulation Installation on Pipe Flanges:

3.7.2.1 Install pipe insulation to outer diameter of pipe flange.

3.7.2.2 Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3.7.2.3 Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
3.7.2.4 Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7.3 Insulation Installation on Pipe Fittings and Elbows:

3.7.3.1 Install mitered sections of pipe insulation.
3.7.3.2 Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7.4 Insulation Installation on Valves and Pipe Specialties:

3.7.4.1 Install preformed valve covers manufactured of same material as that of pipe insulation when available.
3.7.4.2 When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3.7.4.3 Install insulation to flanges as specified for flange insulation application.
3.7.4.4 Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

3.8.1 Insulation Installation on Straight Pipes and Tubes:

3.8.1.1 Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
3.8.1.2 Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3.8.1.3 For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
3.8.1.4 For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

3.8.2 Insulation Installation on Pipe Fittings and Elbows:

3.8.2.1 Install preformed sections of same material as that of straight segments of pipe insulation when available.
3.8.2.2 When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

3.8.3 Insulation Installation on Valves and Pipe Specialties:

3.8.3.1 Install preformed sections of same material as that of straight segments of pipe insulation when available.
3.8.3.2 When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3.8.3.3 Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3.8.3.4 Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF PHENOLIC INSULATION

3.9.1 General Installation Requirements:

3.9.1.1 Secure single-layer insulation with stainless steel bands at 12-inch intervals, and tighten bands without deforming insulation materials.
3.9.1.2 Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.

3.9.2 Insulation Installation on Straight Pipes and Tubes:

3.9.2.1 Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
3.9.2.2 Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3.9.2.3 For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
3.9.2.4 For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

3.9.3 Insulation Installation on Pipe Fittings and Elbows:

3.9.3.1 Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

3.9.4 Insulation Installation on Valves and Pipe Specialties:

3.9.4.1 Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.
3.9.4.2 Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3.9.4.3 Install insulation to flanges as specified for flange insulation application.

3.10 FIELD-APPLIED JACKET INSTALLATION

3.10.1 Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

3.10.1.1 Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
3.10.1.2 Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3.10.1.3 Completely encapsulate insulation with coating, leaving no exposed insulation.

3.10.2 Where FSK jackets are indicated, install as follows:

3.10.2.1 Draw jacket material smooth and tight.
3.10.2.2 Install lap or joint strips with same material as jacket.
3.10.2.3 Secure jacket to insulation with manufacturer's recommended adhesive.

3.10.2.4 Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.

3.10.2.5 Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.10.3 Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

3.10.3.1 Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.10.4 Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.11 FINISHES

3.11.1 Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

3.11.1.1 Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

3.11.1.1.1 Finish Coat Material: Interior, flat, latex-emulsion size.

3.11.2 Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.11.3 Color: Final color as selected by EOR. Vary first and second coats to allow visual inspection of the completed Work.

3.11.4 Do not field paint aluminum or stainless steel jackets.

3.12 FIELD QUALITY CONTROL

3.12.1 Owner will engage a qualified testing agency to perform tests and inspections.

3.12.2 Engage a qualified testing agency to perform tests and inspections.

3.12.3 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.12.4 Perform tests and inspections.

3.12.5 Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by EOR, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to 1 locations of straight pipe.

3.12.6 All insulation applications will be considered defective if they do not pass tests and inspections.

3.12.7 Prepare test and inspection reports.

3.13 PIPING INSULATION SCHEDULE, GENERAL

3.13.1 Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.13.2 Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

3.13.2.1 Drainage piping located in crawl spaces.
3.13.2.2 Underground piping.
3.13.2.3 Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.14 INDOOR PIPING INSULATION SCHEDULE

3.14.1 Domestic Cold Water (Tepid):

3.14.1.1 NPS 1-1/4 and Larger: Insulation shall be one of the following:

3.14.1.1.1 Cellular Glass: 1-1/2 inches thick.
3.14.1.1.2 Flexible Elastomeric: 1 inch thick.
3.14.1.1.3 Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
3.14.1.1.4 Phenolic: 1 inch thick.
3.14.1.1.5 Polyolefin: 1 inch thick.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

3.15.1 Domestic Water Piping (Tepid):

3.15.1.1 All Pipe Sizes: Insulation shall be one of the following:

3.15.1.1.1 Cellular Glass: 2 inches thick.
3.15.1.1.2 Flexible Elastomeric: 2 inches thick.
3.15.1.1.3 Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
3.15.1.1.4 Phenolic: 2 inches thick.
3.15.1.1.5 Polyolefin: 2 inches thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

3.16.1 Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

3.16.2 If more than one material is listed, selection from materials listed is Contractor's option.

3.16.3 Piping, Exposed:

3.16.3.1 PVC: 20 mils thick.
3.16.3.2 Stainless Steel, Type 304 or Type 316,: 0.010 inch thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

3.17.1 Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

3.17.2 If more than one material is listed, selection from materials listed is Contractor's option.

3.17.3 Piping, Exposed:

3.17.3.1 Stainless Steel, Type 304 or Type 316,: 0.010 inch thick.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Copper tube and fittings.
1.2.1.2 Galvanized steel pipe and fittings.
1.2.1.3 Stainless-steel piping
1.2.1.4 PP pipe and fittings.
1.2.1.5 Piping joining materials.
1.2.1.6 Encasement for piping.
1.2.1.7 Transition fittings.
1.2.1.8 Dielectric fittings.

1.3 ACTION SUBMITTALS

1.3.1 Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

1.4.1 System purging and disinfecting activities report.

1.4.2 Field quality-control reports.

1.5 FIELD CONDITIONS

1.5.1 Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Navy or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1.5.1.1 Notify Engineer of Record / Navy no fewer than two days in advance of proposed interruption of water service.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

2.1.1 Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.1.2 Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.2 COPPER TUBE AND FITTINGS

2.2.1 Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.

2.2.2 Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

2.2.3 Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.2.4 Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

2.2.5 Copper Unions:

2.2.5.1 MSS SP-123.
2.2.5.2 Cast-copper-alloy, hexagonal-stock body.
2.2.5.3 Ball-and-socket, metal-to-metal seating surfaces.
2.2.5.4 Solder-joint or threaded ends.

2.2.6 Copper, Brass, or Bronze Pressure-Seal-Joint Fittings:

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

2.2.6.1.1 Apollo Flow Controls; Conbraco Industries, Inc.
2.2.6.1.2 Elkhart Products Corporation.
2.2.6.1.3 Mueller Industries, Inc.
2.2.6.1.4 NIBCO INC.
2.2.6.1.5 Viega LLC.

2.2.6.2 Fittings: Cast-brass, cast-bronze or wrought-copper with EPDM O-ring seal in each end. Sizes NPS 2-1/2 and larger with stainless steel grip ring and EPDM O-ring seal.
2.2.6.3 Minimum 200-psig working-pressure rating at 250 deg F.

2.2.7 Copper-Tube, Extruded-Tee Connections:

2.2.7.1 Manufacturers: Subject to compliance with requirements, provide products by the following:

2.2.7.1.1 T-DRILL Industries Inc.

2.2.7.2 Description: Tee formed in copper tube according to ASTM F 2014.

2.3 GALVANIZED-STEEL PIPE AND FITTINGS

2.3.1 Galvanized-Steel Pipe:

2.3.1.1 ASTM A 53/A 53M,, Grade B, Standard Weight.
2.3.1.2 Include ends matching joining method.

2.3.2 Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.

2.3.3 Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

2.3.4 Malleable-Iron Unions:

2.3.4.1 ASME B16.39, Class 150.
2.3.4.2 Hexagonal-stock body.
2.3.4.3 Ball-and-socket, metal-to-metal, bronze seating surface.
2.3.4.4 Threaded ends.

2.3.5 Flanges: ASME B16.1, Class 125, cast iron.

2.4 CPVC PIPING

2.4.1 CPVC Pipe: ASTM F 441/F 441M, Schedule 40.

2.4.1.1 CPVC Socket Fittings: ASTM F 438 for Schedule 40.
2.4.1.2 CPVC Threaded Fittings: ASTM F 437, Schedule 80.

2.4.2 CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.

2.4.3 CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

2.5 PP PIPE AND FITTINGS

2.5.1 PP Pipe: ASTM F 2389, SDR 7.4.

2.5.2 PVC Socket Fittings: ASTM F 2389.

2.6 PIPING JOINING MATERIALS

2.6.1 Pipe-Flange Gasket Materials:

2.6.1.1 AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2.6.1.2 Full-face or ring type unless otherwise indicated.

2.6.2 Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.6.3 Solder Filler Metals: ASTM B 32, lead-free alloys.

2.6.4 Flux: ASTM B 813, water flushable.

2.6.5 Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.6.6 Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

2.7 TRANSITION FITTINGS

2.7.1 General Requirements:

2.7.1.1 Same size as pipes to be joined.
2.7.1.2 Pressure rating at least equal to pipes to be joined.
2.7.1.3 End connections compatible with pipes to be joined.

2.7.2 Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.7.3 Plastic-to-Metal Transition Fittings:

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

2.7.3.1.1 Charlotte Pipe and Foundry Company.
2.7.3.1.2 Harvel Plastics, Inc.
2.7.3.1.3 Sioux Chief Manufacturing Company, Inc.
2.7.3.1.4 Spears Manufacturing Company.
2.7.3.1.5 Uponor.

2.7.3.2 Description:

2.7.3.2.1 CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
2.7.3.2.2 One end with threaded brass insert and one solvent-cement-socket or threaded end.

2.7.4 Plastic-to-Metal Transition Unions:

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

2.7.4.1.1 Colonial Engineering, Inc.
2.7.4.1.2 NIBCO INC.
2.7.4.1.3 Spears Manufacturing Company.

2.7.4.2 Description:

2.7.4.2.1 CPVC four-part union.
2.7.4.2.2 Brass or stainless-steel threaded end.
2.7.4.2.3 Solvent-cement-joint or threaded plastic end.
2.7.4.2.4 Rubber O-ring.
2.7.4.2.5 Union nut.

2.8 DIELECTRIC FITTINGS

2.8.1 General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2.8.2 Dielectric Unions:

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

2.8.2.1.1 A.Y. McDonald Mfg. Co.
2.8.2.1.2 Capitol Manufacturing Company.
2.8.2.1.3 Central Plastics Company.
2.8.2.1.4 HART Industrial Unions, LLC.
2.8.2.1.5 Jomar Valve.
2.8.2.1.6 Matco-Norca.
2.8.2.1.7 WATTS.
2.8.2.1.8 Wilkins.
2.8.2.1.9 Zurn Industries, LLC.

2.8.2.2 Standard: ASSE 1079.
2.8.2.3 Pressure Rating: 150 psig.
2.8.2.4 End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 EARTHWORK

3.1.1 Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

3.2.1 Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

3.2.2 Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

3.2.3 Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 22 11 19 "Domestic Water Piping Specialties."

3.2.4 Install shutoff valve immediately upstream of each dielectric fitting.

3.2.5 Install domestic water piping level without pitch and plumb.

3.2.6 Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

3.2.7 Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

3.2.8 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

3.2.9 Install piping to permit valve servicing.

3.2.10 Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

3.2.11 Install piping free of sags and bends.

3.2.12 Install fittings for changes in direction and branch connections.

3.2.13 Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.2.14 Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

3.2.15 Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

3.2.16 Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

3.3.1 Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

3.3.2 Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

3.3.3 Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

3.3.3.1 Apply appropriate tape or thread compound to external pipe threads.
3.3.3.2 Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

3.3.4 Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

3.3.5 Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

3.3.6 Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.

3.3.7 Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

3.3.8 Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

3.3.9 Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

3.3.10 Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Square cut / Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping

3.3.11 Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

3.3.11.1 Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
3.3.11.2 CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3.3.12 Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

3.4.1 Install transition couplings at joints of dissimilar piping.

3.4.2 Transition Fittings in Underground Domestic Water Piping:

3.4.2.1 Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
3.4.2.2 Fittings for NPS 2 and Larger: Sleeve-type coupling.

3.4.3 Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

3.5.1 Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.5.2 Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

3.6.1 Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3.6.2 Comply with requirements for hangers, supports, and anchor devices in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

3.6.2.1 Vertical Piping: MSS Type 8 or 42, clamps.
3.6.2.2 Individual, Straight, Horizontal Piping Runs:

3.6.2.2.1 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
3.6.2.2.2 Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
3.6.2.2.3 Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3.6.2.3 Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
3.6.2.4 Base of Vertical Piping: MSS Type 52, spring hangers.

3.6.3 Install hangers for copper ductile iron, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6.4 Install vinyl-coated hangers for CPVC and PP piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6.5 Support horizontal piping within 12 inches of each fitting.

3.6.6 Support vertical runs of copper piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6.7 Support vertical runs of CPVC and PP piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

3.7.1 Drawings indicate general arrangement of piping, fittings, and specialties.

3.7.2 When installing piping adjacent to equipment and machines, allow space for service and maintenance.

3.7.3 Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

3.7.4 Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

3.7.4.1 Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3.7.4.2 Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

3.8.1 Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.8.2 Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

3.9.1 Perform the following tests and inspections:

3.9.1.1 Piping Inspections:

3.9.1.1.1 Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

3.9.1.1.2 During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

3.9.1.1.2.1 Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

3.9.1.1.2.2 Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

3.9.1.1.3 Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

3.9.1.1.4 Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

3.9.1.2 Piping Tests:

3.9.1.2.1 Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

3.9.1.2.2 Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

3.9.1.2.3 Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3.9.1.2.4 Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3.9.1.2.5 Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

3.9.1.2.6 Prepare reports for tests and for corrective action required.

3.9.2 Domestic water piping will be considered defective if it does not pass tests and inspections.

3.9.3 Prepare test and inspection reports.

3.10 ADJUSTING

3.10.1 Perform the following adjustments before operation:

3.10.1.1 Close drain valves, hydrants, and hose bibbs.
3.10.1.2 Open shutoff valves to fully open position.
3.10.1.3 Open throttling valves to proper setting.
3.10.1.4 Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

3.10.1.4.1 Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
3.10.1.4.2 Adjust calibrated balancing valves to flows indicated.

3.10.1.5 Remove plugs used during testing of piping and for temporary sealing of piping during installation.
3.10.1.6 Remove and clean strainer screens. Close drain valves and replace drain plugs.
3.10.1.7 Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
3.10.1.8 Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

3.11.1 Clean and disinfect potable domestic water piping as follows:

3.11.1.1 Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
3.11.1.2 Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

3.11.1.2.1 Flush piping system with clean, potable water until dirty water does not appear at outlets.
3.11.1.2.2 Fill and isolate system according to either of the following:

3.11.1.2.2.1 Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
3.11.1.2.2.2 Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

3.11.1.2.3 Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
3.11.1.2.4 Repeat procedures if biological examination shows contamination.
3.11.1.2.5 Submit water samples in sterile bottles to authorities having jurisdiction.

3.11.2 Clean non-potable domestic water piping as follows:

3.11.2.1 Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
3.11.2.2 Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

3.11.2.2.1 Flush piping system with clean, potable water until dirty water does not appear at outlets.
3.11.2.2.2 Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

3.11.3 Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

3.11.4 Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

3.12.1 Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

3.12.2 Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

3.12.3 Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

3.12.4 Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:

3.12.4.1 Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed copper pressure-seal-joint fittings; and pressure-sealed joints.
3.12.4.2 PP, SDR 11 socket fittings; and fusion-welded joints.

3.12.5 Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

3.12.5.1 Hard copper tube, ASTM B 88, Type L ASTM B 88, Type M; cast- or wrought-copper, solder-joint fittings; and brazed soldered joints.
3.12.5.2 Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure-seal-joint fittings; and pressure-sealed joints.
3.12.5.3 CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
3.12.5.4 CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
3.12.5.5 PP, SDR 11 socket fittings; and fusion-welded joints.

3.13 VALVE SCHEDULE

3.13.1 Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

3.13.1.1 Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
3.13.1.2 Drain Duty: Hose-end drain valves.

3.13.2 Use check valves to maintain correct direction of domestic water flow to and from equipment.

3.13.3 Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

SECTION 22 45 00

EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:
1.2.1.1 Combination units.

1.3 DEFINITIONS

1.3.1 Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

1.3.2 Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

1.3.3 Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

1.3.4 Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

1.4.2 Shop Drawings:
1.4.2.1 Include plans, elevations, sections, and mounting details.
1.4.2.2 Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1.4.2.3 Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
1.4.2.4 Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.

1.5.2 Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

1.6.1 Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

1.7.1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7.1.1 Flushing-Fluid Solution: Separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.1.2 ISEA Standard: Comply with ISEA Z358.1.

2.1.3 NSF Standard: Comply with NSF 61 and NSF 372, for fixture materials that will be in contact with potable water.

2.1.4 Regulatory Requirements: Comply with requirements in ICC A117.1,; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

2.2 COMBINATION UNITS

2.2.1 Standard, Plumbed Emergency Shower with Eyewash Combination Units, P-1:

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

2.2.1.1.1 Acorn Safety.
2.2.1.1.2 Bradley Corporation.
2.2.1.1.3 Encon Safety Products.
2.2.1.1.4 Guardian Equipment Co.
2.2.1.1.5 Haws Corporation.
2.2.1.1.6 Sellstrom Manufacturing Company.
2.2.1.1.7 Speakman Company.
2.2.1.1.8 WaterSaver Faucet Co.

2.2.1.2 Piping:

2.2.1.2.1 Material: Galvanized steel or stainless steel.
2.2.1.2.2 Unit Supply: NPS 1-1/4 minimum.
2.2.1.2.3 Unit Drain: Outlet at back or side near bottom.

2.2.1.3 Shower:

2.2.1.3.1 Capacity: Not less than 20 gpm for at least 15 minutes.
2.2.1.3.2 Supply Piping: NPS 1 with flow regulator and stay-open control valve.
2.2.1.3.3 Control-Valve Actuator: Pull rod.
2.2.1.3.4 Shower Head: 8-inch-minimum diameter, stainless steel or plastic.
2.2.1.3.5 Mounting: Pedestal.

2.2.1.4 Eye/Face Wash Unit:
2.2.1.4.1 Capacity: Not less than 3.0 gpm for at least 15 minutes.
2.2.1.4.2 Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
2.2.1.4.3 Control-Valve Actuator: Paddle.
2.2.1.4.4 Spray-Head Assembly: Two or four receptor-mounted spray heads.
2.2.1.4.5 Receptor: stainless-steel or Plastic bowl.
2.2.1.4.6 Mounting: Attached shower pedestal.
2.2.1.4.7 Drench-Hose Option: May be provided instead of eye/face wash unit.
2.2.1.4.7.1 Capacity: Not less than 3.0 gpm for at least 15 minutes.
2.2.1.4.7.2 Drench Hose: Hand-held spray head with squeeze-handle actuator and hose.
2.2.1.4.7.3 Mounting: Bracket on shower pedestal.

2.2.2 Freeze-Protected, Plumbed Emergency Shower with Eyewash Combination Units, P-2:
2.2.2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2.2.2.1.1 B-L-S Industries, Inc.
2.2.2.1.2 Bradley Corporation.
2.2.2.1.3 Encon Safety Products.
2.2.2.1.4 Guardian Equipment Co.
2.2.2.1.5 Haws Corporation.
2.2.2.1.6 Speakman Company.
2.2.2.2 Piping: Galvanized steel.
2.2.2.2.1 Unit Supply: NPS 1-1/4 minimum from bottom.
2.2.2.3 Heating System: Electric, 120 V ac; insulation enclosed in a protective jacket with thermometer.
2.2.2.3.1 Heating Capacity: 10 deg F minimum above ambient temperature.
2.2.2.4 Shower:
2.2.2.4.1 Shower Capacity: Not less than 20 gpm for at least 15 minutes.
2.2.2.4.2 Supply Piping: NPS 1 with flow regulator and stay-open control valve.
2.2.2.4.3 Control-Valve Actuator: Pull rod.
2.2.2.4.4 Shower Head: 8-inch-minimum diameter, stainless steel or plastic.
2.2.2.4.5 Mounting: Pedestal.
2.2.2.5 Eye/Face Wash Unit:
2.2.2.5.1 Capacity: Not less than 3 gpm for at least 15 minutes.
2.2.2.5.2 Control-Valve Actuator: Paddle.

2.1 WATER-TEMPERING EQUIPMENT

2.1.1 Hot- and Cold-Water, Water-Tempering Equipment:
2.1.1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2.1.1.1.1 Acorn Safety.
2.1.1.1.2 Armstrong International, Inc.
2.1.1.1.3 Bradley Corporation.
2.1.1.1.4 Encon Safety Products.
2.1.1.1.5 Guardian Equipment Co.
2.1.1.1.6 Haws Corporation.
2.1.1.1.7 Lawler Manufacturing Company, Inc.
2.1.1.1.8 Leonard Valve Company.
2.1.1.1.9 POWERS; A WATTS Brand.
2.1.1.1.10 Speakman Company.
2.1.1.1.11 Stingray Systems LLC.
2.1.1.1.12 WATTS.
2.1.1.2 Description: Factory-fabricated equipment with thermostatic mixing valve.

2.1.1.2.1 Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.

2.1.1.2.2 Supply Connections: For hot and cold water.

2.1.2 Electric Water-Tempering Equipment

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

2.1.2.1.1 Chronomite Laboratories, Inc; a division of Morris Group International.

2.1.2.1.2 Haws Corporation.

2.1.2.1.3 Stingray Systems, LLC.

2.1.2.2 Description: Factory-fabricated equipment with electric heating.

2.1.2.2.1 Heating System: Electric, designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, heating coils, high-temperature-limit device, metal piping, and corrosion-resistant enclosure.

2.1.2.2.1.1 Electrical Characteristics: 120 V ac, 20 A, single phase, 60 Hz.

2.2 SOURCE QUALITY CONTROL

2.2.1 Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

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

3.2 INSTALLATION OF EMERGENCY PLUMBING FIXTURE INSTALLATION

3.2.1 Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

3.2.2 Install fixtures level and plumb.

3.2.3 Fasten fixtures to substrate.

3.2.4 Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of the equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping" and Section 22 05 23.15 "Gate Valves for Plumbing Piping."

3.2.4.1 Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.

3.2.4.2 Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

3.2.5 Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 22 11 16 "Domestic Water Piping."

3.2.6 Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.2.7 Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system. Comply with requirements for waste piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.3 CONNECTIONS

3.3.1 Connect cold-water-supply piping to plumbed emergency plumbing fixtures having water-tempering equipment (Tepid Water Supply). Comply with requirements for cold-water piping specified in Section 22 11 16 "Domestic Water Piping."

3.3.2 Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.3.3 Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste.

3.3.4 Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

3.4.1 Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

3.5.1 Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

3.5.2 Tests and Inspections:

3.5.2.1 Perform each visual and mechanical inspection.

3.5.2.2 Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3.5.2.3 Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.

3.5.2.4 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5.3 Emergency plumbing fixtures will be considered defective if they do not pass tests and inspections.

3.5.4 Prepare test and inspection reports.

3.6 ADJUSTING

3.6.1 Adjust or replace fixture flow regulators for proper flow.

3.6.2 Adjust equipment temperature settings.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General Conditions and Division 01 Specification Sections, apply to this Section and to all of Divisions 26.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 General requirements applicable to components and systems included in Electric Performance Work Statement (PWS).

1.2.2 Products Installed but Not Furnished Under This Section

1.2.2.1 Make electrical connections to equipment shown on Drawings and furnished by other Contractors. Obtain approved wiring diagrams and location drawings for roughing in and final connections from Contractor furnishing equipment.

1.2.2.2 Contractor shall be responsible for coordination with PSEG, Long Island, NY (PSEG) in providing materials and utility power related services. See latest edition of PSEG's RED Book (it is available on web site) and/or PSEG's Specification for Customers & Electrical Contractors, Revised in July 2014 for Three Phase Pad Mount Transformer. The later can be seen as an attachment "A" to this section.

Electrical work is mostly to upgrade Utility Service Transformer size from 500KVA to 1,000KVA. This includes extension of 13.2KV overhead line to a new overhead pole, which would be located near the new 1000KVA Transformer as cited above. In addition to new Pad Mounted Transformer, the following items are required to be added: (a). a new Power Service Meter; (b). two service Disconnects - one to feed existing Motor Control Center (MCC-1) and second Disconnect to serve a new 400A, 277/480V, 3Phase Power Panel (P). The later panelboard "P" shall be feeding most of the additional incoming electrical load in this improvement work. The feeder to the 400A amp panelboard "P" shall be provided with private networkable Electric Power Meter.

The existing service including the existing Utility Transformer, meter shall be demolished after the new service shall be installed & commissioned.

1.3 REFERENCES

1.3.1 AIA American Institute of Architects
1.3.2 ADA Americans with Disabilities Act
1.3.3 AISC American Institute of Steel Construction
1.3.4 ANSI American National Standards Institute
1.3.5 ASTM ASTM International
1.3.6 IBC International Building Code

1.3.7 IEEE Institute of Electrical and Electronics Engineers, Inc. (The)
1.3.8 IES Illuminating Engineering Society of North America
1.3.9 NEC National Electrical Code
1.3.10 NEMA National Electrical Manufacturers' Association
1.3.11 NETA International Electrical Testing Association
1.3.12 NFPA National Fire Protection Association
1.3.13 UL Underwriters' Laboratories, Inc.

1.4 DEFINITIONS

1.4.1 “Existing”: Equipment depicted on Drawings with an “E” designation denotes existing equipment to remain.

1.4.2 “Modify”: Disconnect equipment, remove circuitry to a point beyond demolition and tag for reuse, store equipment for reuse and reinstall as specified in PWS Documents. Modify/extend circuitry to new equipment locations and reconnect with necessary control/monitoring wiring (in Conduit) as required. The Contractor is responsible for protecting equipment from damage during removal, storage and reinstallation.

1.4.3 “Replace”: Existing equipment to replace. Refer to relevant Drawing Project Manual Specification for additional information and requirements.

1.5 SYSTEM DESCRIPTIONS

1.5.1 Inspection of Existing Systems: Inspect each existing system scheduled for modification in presence of Authorized Navy’s Representative and issue a deficiency report to Navy and Architect listing conditions found prior to any removals, relocations, procurement, or additions. Modified systems include (but are not limited to):

1.5.1.1 Motor Control Center with NO/NC Contacts as required.
1.5.1.2 PLC System.
1.5.1.3 Conduit: Wiring to reconnect existing to remaining Pump Motors.

1.5.2 Design Requirements - Provide complete systems, properly tested, balanced, and ready for operation including necessary details, items and accessories although not expressly shown or specified, including (but not limited to):

1.5.2.1 Wiring and raceway for work specified in Project Manual and/or shown on Drawings.

1.5.2.2 Electrical devices and equipment for work specified in Project Manual and/or shown on Drawings.

1.5.2.3 Systems included, but not limited to:

1.5.2.3.1 Modifications of MCC buckets to fit fused switches to feed new external mounted VFDs (to be provided and tested by electrical contractor). Provide conduit and wiring from VFD to MCC 8 PLC Cabinet.
1.5.2.3.2 Electrical connections including providing local disconnecting switches for the equipment to be served.
1.5.2.3.3 Control system- providing connecting conduit-wiring to respective VFDs for Pump Motor systems and signals to existing PLC/SCADA. Provide signal to building automation network (BACNET) system providing new conduit-wiring.
1.5.2.3.4 Computer network system.

1.5.2.3.5 Security system.
1.5.2.3.6 Emergency lighting.

1.5.3 Electric Layouts: Arrange MCC panels; disconnect switches, equipment, raceways, and similar components neatly, orderly and symmetrically. Provide 3/4-inch fire treated, gray painted plywood backboards for surface mounted panels, disconnect switches, enclosed breakers, and similar equipment. Arrangements shown on Drawings are diagrammatic only; provide and adjust raceways, wiring, and other components as required.

1.5.4 Power Interruptions and Scheduled Outages: Coordinate scheduling of all power interruptions and outages with Navy. Confirm with Navy and/or Utility Company prior to interruption of power, which building systems are considered critical and must remain operational during the interruption. If a scheduled power outage is to extend beyond one standard workday, provide temporary power to operate critical building systems (including, but not limited to fire alarm system, security system, building access control system, and building energy management control system).

1.6 SUBMITTALS

1.6.1 General Division 26 submittal requirements:

1.6.1.1 Comply with requirements of SECTION 01 33 00 – SUBMITTAL PROCEDURES and as modified below.

1.6.1.2 Product Data: Submit product data for items listed in individual technical section. Clearly identify manufacturer, pertinent design, function, materials, construction and performance data specifically addressing specification description and PWS Document requirements of item. Strike out products that are not applicable to item being submitted, where more than one product is indicated on manufacturer product literature.

1.6.1.2.1 Cover Sheet: Attach cover sheet, identified in Section 01 33 00, to Product Data of each item submitted. Provide cover sheet for only one type of item with related accessories, equipment with related components. Do not combine unrelated items under the same cover sheet.

1.6.1.2.2 Specified Equivalent Product Data: Submit manufacturer’s product information including product literature, technical specifications and descriptions, performance data and, and similar items to demonstrate compatibility with Basis-of-Design Equipment as specified.

1.6.1.3 Shop Drawings: Submit detailed drawings for electrical equipment layouts, showing exact sizes and locations for approval before beginning work.

1.6.1.3.1 Do not proceed with installation of systems in each area until agreement is reached with all concerned on exact arrangements for each room or area, unless otherwise directed by Engineer of Record (EOR). If Contractor proceeds prior to resolving conflicts, Contractor shall modify installed Work as required to permit other systems to proceed with a coordinated installation.

1.6.1.3.2 Specified Equivalent Drawings: Submit detailed drawings of proposed Specified Equivalents, indicating proposed installation of equipment and showing maintenance clearances, required service removal space other pertinent revisions to arrangement and configuration shown in PWS Documents.

1.6.1.4 Samples: On all submittals, indicate standard factory color and factory finish surfaces. Where more than one color is available, selection will be made by EOR from manufacturer's full range of colors. Electronically transmitted color samples are not acceptable.

1.7 ACTION SUBMITTALS

1.7.1 Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sleeves and sleeve seals. Include rated capacities, and furnished specialties and accessories.

1.7.1.1 Penetration firestopping materials.
1.7.1.2 Penetration firestopping assembly drawings.

1.8 QUALITY ASSURANCE

1.8.1 Regulatory Requirements:

1.8.1.1 Codes and Standards: Comply with applicable Federal, State and local building and electrical codes, laws, ordinances, and regulations, and comply with applicable NFPA, National Electrical Code and utility company requirements and regulations. Provide Underwriters Laboratories Seal on all materials.

1.8.1.2 Permits and Inspections: Obtain approvals, tests, and inspections required by Engineer of Record, local electrical inspector, agent or agency specified in Project Manual, or National, State, or local codes and ordinances.

1.8.1.2.1 Schedule electrical inspection by an agency acceptable to the local authority having jurisdiction and submit final inspection certificate to EOR.
1.8.1.2.2 Furnish materials and labor necessary for tests and pay costs associated with tests and inspections.
1.8.1.2.3 Conduct tests under load for load balancing and where required by codes, regulations, ordinances, or technical Specification.

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

1.9 DELIVERY, STORAGE AND HANDLING

1.9.1 Storage and Protection:

1.9.1.1 Take precautions to store materials and products to protect finishes and not permit dust and dirt to penetrate equipment.
1.9.1.2 Replace equipment damaged beyond reasonable repair as required by EOR.
1.9.1.3 Refinish any equipment with marks, stains, scratches, dents, and other aesthetic damage that doesn't impede operation of equipment as required by EOR.

1.10 COORDINATION OF WORK

1.10.1 New Construction:

1.10.1.1 Openings, Chases, Recesses, Sleeves, Lintels and Bucks (required for admission of Electric PWS systems and components): Coordinate requirements with General PWS or for inclusion in General PWS. Furnish necessary information (e.g. locations and sizes) to General Contractor in ample time for installation of systems and components included in Electric PWS.

1.10.1.2 Anchor Bolts: Deliver to Contractor responsible for General Work anchor bolts required for Electric PWS construction that are to be installed in construction included in General PWS.

1.10.1.3 Locate settings, check locations as installation in General PWS progresses, and provide templates or holding fixtures as required to maintain proper accuracy.

1.10.2 Existing Construction:

1.10.2.1 Unless otherwise specified, employ Contractor responsible for General Work for all cutting, patching, repairing and replacing of general work required for installation of systems and components included in Electric Work. Secure approval from EOR's representative before cutting.

1.10.2.2 Anchor Bolts: Deliver to Contractor responsible for General Work anchor bolts required for Electric Work construction that are to be installed in construction included in General PWS. Provide templates or holding fixtures as required to maintain proper accuracy.

1.10.2.3 Access Doors: Provide access doors shown on Drawings, or as required for access to pull boxes, junction boxes, relays and other electrical devices requiring periodic inspection, adjustment or maintenance, where located above or within inaccessible walls or ceilings, and including cutting and patching of adjacent walls and ceilings to match existing materials and finishes.

1.11 ALTERATION PROCEDURES

1.11.1 In locations where existing devices are indicated to be disconnected and removed and existing power circuit or communications cable is not scheduled to be reused:

1.11.1.1 Remove circuit conductors back to source.

1.11.1.2 Modify panel directory for that circuit.

1.11.1.3 Remove all existing exposed and unexposed accessible raceway.

1.11.1.4 Provide blank cover plates or wall infill as described below:

1.11.1.4.1 For single gang and multi-gang switch boxes in public or occupied spaces; stainless steel cover plates.

1.11.1.4.2 For single gang and multi-gang boxes in un-occupied spaces; stainless steel, galvanized steel or coverplates.

1.11.1.4.3 For boxes larger than standard boxes in public or occupied spaces and provide wall infill, matching sub-surface and finished surface conditions. Paint wall to match surrounding finishes.

1.11.1.4.4 For boxes larger than standard boxes in un-occupied spaces; 18 gage galvanized sheet metal coverplate with machined edges. Prime and paint to match surrounding finish conditions.

1.11.1.5 Patch and paint walls where disturbed by the electrical work.

1.11.2 In locations where existing devices are to remain in place, ensure circuits feeding such devices remain operational. Modify existing circuits as required to allow new construction to occur and to maintain necessary circuitry to existing devices for complete and proper operation.

1.11.3 In locations where entire existing system is being removed or modified:

1.11.3.1 Refer to individual system specification sections for documentation and inspection requirements prior to any alteration work on any system.
1.11.3.2 Take all necessary measures to ensure that down time will not compromise safety.
1.11.3.3 Notify Navy, Engineer of Record, Utility Company and other Contractors not less than 2 weeks prior to interruptions in service.
1.11.3.4 Coordinate work schedule to minimize duration of system outage during hours when building is occupied.

PART 2 - PRODUCTS

2.1 SLEEVE AND SLEEVE SEALS

2.1.1 Comply with requirements for sealants in fire rated penetrations specified in Section 26 05 44; “Sleeve and Sleeve Seals for Electrical Systems.”

2.1.2 Submit Manufacturers Product Data Sheets for each type of product selected. Certify that Firestop Material is free of asbestos and lead paint, and complies with local regulations.

2.1.2.1 Certification by firestopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.

2.1.3 Submit system design listings, including illustrations from qualified testing and inspection agency that is applicable to each firestop configuration.

2.1.4 Submit a project specific Penetration Firestopping Schedule indicating where each firestop configuration will be used.

2.2 GROUT

2.2.1 Description: ASTM C 1107, Grade B, non-shrink, non-metallic, high strength grout, suitable for interior and exterior, above and below grade applications.

2.2.1.1 Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2.2.1.2 Design Mix: 5000-psi, 28-day compressive strength.

2.2.1.3 Packaging: Premixed and factory packaged.

2.3 SEALANTS

2.3.1 Comply with requirements for sealants in non-fire rated penetrations specified in Section 07 92 00 "Joint Sealants."

2.3.2 Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

2.3.2.1 Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following::

2.3.2.1.1 BASF Building Systems; Omniplus.
2.3.2.1.2 Dow Corning Corporation; 786 Mildew Resistant.
2.3.2.1.3 GE Advanced Materials - Silicones; Sanitary SCS1700.

2.4 ACCESS DOORS

2.4.1 Provide Access Panels and Doors for Electrical Items that are behind the finished surfaces or otherwise concealed. Access Doors and Frames shall be located in coordination with Work of other trades and/or Project EOR.

2.5 PAINT AND FINISHES

2.5.1 Provide painting and finishing of MCC’s Panel Switches per manufacturer’s recommendations.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

3.1.1 Do not cut waterproofed floors or walls for admission of any equipment or materials and do not pierce any structural members without written permission from EOR.

3.1.2 Furnish and install sleeves, inserts, panels, raceways, boxes, and similar infrastructure, ahead of general construction work and maintain Contractor personnel at Site during installation of general construction work to be responsible for and to maintain these items in position.

3.1.3 Unless otherwise noted elsewhere in PWS Documents, bear expense of cutting, patching, repairing or replacing of work of other trades made necessary by any fault, error or tardiness on part of Electrical PWS or damage done by Electric PWS. Employ and pay Contractor whose work is involved.

3.2 DEMONSTRATION OF COMPLETE ELECTRICAL SYSTEMS

3.2.1 Thoroughly demonstrate and instruct Navy's designated representative in care and operation of electrical systems and equipment furnished and installed in Electric PWS.

3.2.1.1 System Operator: Maintain competent operator at building for at least 2 days in 2 consecutive weeks after Navy takes occupancy of major parts of building to operate systems and equipment in presence of Navy's representative.

3.2.1.2 Factory Representative: In addition to demonstration and instruction specified above, provide technically qualified factory representatives from manufacturers of major equipment, to train Navy's representatives in care and operation of applicable products as specified in applicable technical sections of Division 26.

3.2.1.3 Coordinate and schedule time and place of all training through the EOR at the Navy’s convenience.

3.2.1.4 Submit letters attesting to satisfactory completion of instructions, including date of completion of instruction, names of persons in attendance, and signature of Navy's authorized representative.

3.2.1.5 EOR's representative must be present when Navy's representatives participate in instruction.

3.2.1.6 The following equipment and systems are included:

3.2.1.6.1 New ATC control system including local & remote startups of all HVAC Systems.
3.2.1.6.2 Lighting system.
3.2.1.6.3 Clock and program system.
3.2.1.6.4 Computer network systems.
3.2.1.6.5 Telephone system.
3.2.1.6.6 Security system.
3.2.1.6.7 Lightning protection system.

3.3 GROUTING

3.3.1 Mix and install grout for electrical equipment base bearing surfaces, other equipment base plates, and anchors.

3.3.2 Clean surfaces that will come into contact with grout.

3.3.3 Provide forms as required for placement of grout.

3.3.4 Avoid air entrapment during placement of grout.

3.3.5 Place grout, completely filling equipment bases.

3.3.6 Place grout on concrete bases and provide smooth bearing surface for equipment.

3.3.7 Place grout around anchors.

3.3.8 Cure placed grout.

3.4 SEALANTS

3.4.1 Install sealants according to the requirements of Manufacturer's Instructions of Joint Sealant Materials to be used.

3.5 FIRESTOPPING

3.5.1 Install firestopping according to the requirements of Manufacturer's Instructions of Penetration Firestopping to be used.

3.5.2 Applied Fireproofing:

3.5.2.1 Coordinate the installation of hangers, supports and accessories from the structural steel with the fireproofing installation. Install all hangers and supports prior to installation of fireproofing.

3.5.2.2 Repair or replace existing fireproofing removed as a part of Electrical Work installation.

3.5.2.2.1 Employ the services of an approved fireproofing contractor to repair or replace the fireproofing by patching any areas that have been removed or damaged due to the installation of work after the completion of the fireproofing.

3.5.3 Repaired or replacement fireproofing shall match the fireproofing adjacent to the repaired area. All warranties shall be maintained.

END OF SECTION

PSEG LI

PSEG Long Island LLC.

Three Phase Padmounted Transformer Specifications for Customers & Electrical Contractors

Revised July 2014

Distribution Design
T&D Engineering

THREE PHASE PADMOUNTED TRANSFORMER SPECIFICATIONS

TABLE OF CONTENTS

ILLUSTRATIONS AND CONSTRUCTION STANDARDS (CS)

THREE PHASE PADMOUNTED TRANSFORMER SPECIFICATIONS

Section 1: Introduction

1. This specification covers the material and design requirements of PSEG Long Island (PSEG LI) for “Dead-Front”, three phase padmounted transformers ranging in size from 75 kVA to 1,500 kVA.

2. Three phase secondary service supplied from 4kV primary circuits or 13,200GrdY/7,620V primary through padmounted transformers shall not exceed 4,000 amperes at 208Y/120 volts or 2,500 amperes at 480Y/277 volts.

3. The applicant or customer shall consult Distribution Design Department before plans are finalized, equipment or material purchased or construction commenced on facilities to be connected to PSEG Long Island’s (PSEG LI) electric distribution system.

4. All installations shall conform to the requirements of the National Electric Code (NEC), National Electric Safety Code (NESC), and the City of New York Electrical Code (where applicable), latest editions.

5. All installations shall conform to LIPA’s “Specifications and Requirements for Electric Installations” (Red Book). Specific job details will be outlined in a specification letter provided to the customer’s representative/contractor by the Customer Planning Representative.

6. The customer’s electrical contractor or consultant shall furnish all information requested by PSEG LI including but not limited to size of present load and expected future load in kW, equipment specifications, and any unusual requirements.

7. The customer or applicant shall be advised of the available service voltage and applicable fees and rates by the Customer Planning Representative.

8. Summary of General Responsibilities:

    a) The customer/contractor is responsible for the procurement and installation of the concrete footing, foundation, and pad as specified in Section II.

    b) In non-CIPUD areas the customer/contractor shall procure and install the primary cable according to the requirements in Section III.

c) PSEG LI shall deliver the transformer and set it onto the concrete pad. The appropriate number of bushings, loadbreak elbow terminators and surge arresters shall be provided as specified in Section IV.

d) The customer/contractor is responsible for the primary and secondary connections to the transformer as specified in Sections IV and V.

Section II: Concrete Footing, Foundation and Pad Installation

1. The customer shall furnish, install, own and maintain the concrete footing, foundation, pad, ground rods and all wiring.

   Reference: Illustration #1 - page 4.

2. Precast footing, foundation and pad shall be obtained only from PSEG LI approved suppliers listed below and shall be manufactured according to Specification, PT14-07-004, "Concrete Pads & Foundations." These specifications are issued to the suppliers below and are available to customers and contractors upon request.

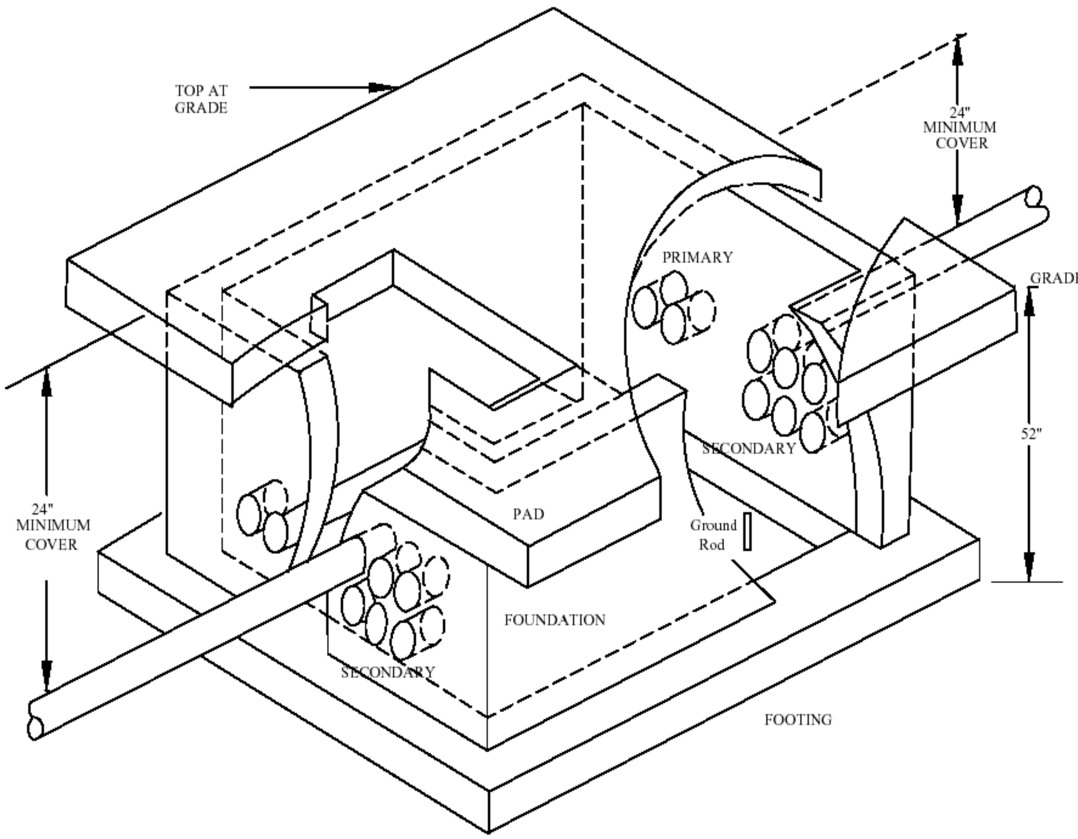
John Potente & Sons
114 Woodbury Road
Hicksville, NY 11801
(516) 935-8585

Roman Stone Construction Co.
85 South 4th Street
Bayshore, NY 11706
(631) 667-0566

AFCO Precast Corp.
114 Rocky Point Road
Middle Island, NY 11953
(631) 924-7400

Coastal Pipeline
55 Twomey Avenue
Calverton, N.Y. 11933
(631) 369-4000

Long Island Precast
20 Stiriz Road
Brookhaven, NY 11719
(631) 286-0240



NOT TO SCALE

Illustration #1
Isometric View of Footing, Foundation and Pad Top

Preparation of sub-grade for footing and foundation.

1. Remove 52” of soil to reach undisturbed earth.

2. Install precast footing and foundation.

3. Install conduits and grout entrances.

4. Install plugs or caps on all unused duct entrances.

5. Backfill outside foundation with clean fill, mechanically compacted every 12”.
   <u>DO</u> <u>NOT</u> backfill inside the foundation.

6. Install two (2)-1/2” x 8’ copperweld groundrods driven flush with the top of the footing (6 feet apart).

3. CONCRETE PAD INSTALLATION CLEARANCES:

   Reference: CS 5362, CS 5369, CS 5370

   a) A clear working space of 10 feet minimum shall be maintained in front of the padmounted transformer doors. The doors shall be kept clear of obstructions and shall face away from all buildings and structures. See above CS’s for details.

   b) A minimum of 5 feet shall be maintained between padmounted transformer and adjacent structures. See CS 5370 for details.

Section III: Primary Wiring

1. PRIMARY CABLE SPECIFICATION:

2/C (two conductor) - #2 or #1/0 aluminum or copper concentric or compressed round stranded with copper concentric neutrals. #2 conductor shall have 10 - #14 neutral strands and #1/0 conductor shall have 16 - #14 neutral strands.

INSULATION SYSTEM:

Conductor shield: The center conductor shall be covered with a uniform layer of extruded semi-conducting material that is compatible with the conductor and easily removable with conventional stripping tools. The conductor shield minimum thickness shall be 12 mils.

Insulation: 15kV tree-retardant cross linked polyethylene (TR-XLPE) insulation for aluminum conductor or ethylene propylene rubber (EPR) insulation for copper conductor. Insulation thickness shall be 220 mils.

Insulation shield: Extruded over the insulation, there shall be a UV stabilized, weather resistant layer of black semi-conducting material compatible with the insulation and copper neutral strand. The insulation shield shall be easily removable with conventional stripping tools. The insulation shield minimum thickness shall be 30 mils.

Jacket: The cable shall have a 50 mil thick black linear low density polyethylene jacket extruded to fill over the concentric neutrals, yet shall be free stripping from the insulation shielding.

NOTE: Only semi-conducting jacket material may be direct buried with the other facilities (such as communications cables); cables with insulating jacket material must be installed in conduit on public highways and in the presence of direct buried communications facilities.

CABLE IDENTIFICATION:

1. Cable identification shall meet the requirements of ICEA S-94-649.

2. Jacket shall have identification markings along the entire length as follows:

- Three (225 mils wide by 6 mils thick) durable extruded red identification stripes that run longitudinally 120 degrees apart for the entire length of each conductor jacket.

- Permanent printed information markings at maximum intervals of 24 inches apart that state the following:
    - Name of manufacturer.
    - Year of manufacturer.
    - Conductor size and material.
    - Type and thickness of insulation.
    - Type of jacket.
    - Cable voltage rating.
    - NESC "Lightning Bolt" before and after the words "Electric Cable".

2. PSEG LI's Customer Planning Representative may request from the customer or contractor a three foot sample of the cable for inspection.

3. a) Primary cable may be direct buried or installed in schedule 40 PVC conduit from the transformer pad to the base of the pole or termination. Direct buried cable must be a minimum of 30 inches below final grade on private property and 42 inches below final grade in the public right-of-way. Cable installed in schedule 40 conduit must be a minimum of 24 inches below final grade.

   b) A schedule 40 PVC insulating sleeve shall be installed on each primary cable opening in the concrete foundation wall. The sleeve shall be flush with the foundation wall and concreted in place.

Section IV: Padmount Transformer and Associated Equipment

Reference: Illustration #2 – p. 10, CS 3722, CS 3727, CS 4028, CS 5362

1. The padmount transformer is delivered and set onto the concrete pad by PSEG LI. The customer's contractor will be supplied with the appropriate number of bushings, load break elbow terminators and elbow surge arresters.

2. The customer's contractor shall install loadbreak elbow terminators onto the cable according to CS 3722 and in conjunction with the elbow manufacturer's cutback length instructions as explained in step 6 on page 2 of 8 of CS 3722. *For crimping instructions and tool/die requirements, see crimp chart on CS 3722, sheet 8 of 8.*

3. The bushings shall be individually bonded with a #14 AWG bare copper conductor that is attached to the "bonding eye" on the bushing and bonded to the transformer ground lug that is installed by the contractor.

4. The customer's contractor shall install elbow surge arresters onto the transformer as shown on CS 4028. PSEG LI will supply three #2 copper lugs (one per arrester) and one copper hot line clamp. The arresters shall be individually bonded using a #10 AWG bare copper conductor that is attached to the "bonding eye" on the arrester housing, wrapped around itself and secured to the ground stud.

5. Primary and secondary cables shall have a minimum of 5 feet of slack inside the foundation. Maintain as much physical separation between primary and secondary cables as possible inside foundation.

Section V: Services

Reference: Illustration #2 – page 10 and Illustration #3 – page 11.

1. All secondary conductor installations governed by the City of New York Electrical Code – latest edition, regardless of voltage characteristics, must obtain approval from PSEG LI prior to the commencement of work.

2. A maximum of 8 conductors are permitted, per phase, for the connection to 75 – 1,500 kVA padmount transformers.

3. All connections to the transformer secondary terminals shall be made with a 2-hole NEMA terminal lug. See illustration #3 – page 11.

4. Service conductors supplying 480Y/277 volts shall conform to the following specifications:

   a) Radial services shall be limited to supplying one meter or one main disconnect switch.

   b) Conductors shall be of type USE – 2, XHHW – 2, or RHW – 2.

   c) Isolated phase service run shall not exceed 50 feet.

   d) Services *up to 800 amperes* can be installed in metallic or non-metallic conduit in an integrated phase configuration.

   e) For services *above 800 amperes*, all secondary conductor runs between the transformer enclosure and the customer's meter or main disconnect switch shall be run in an isolated phase configuration in non-metallic conduit.

   f) Ground Fault Protection:

      - Services supplying multiple separately metered customers require a single main switch with ground fault protection as per NEC article 230-95.

      - Ground fault protection shall coordinate with PSEG LI's protection scheme and be approved by the Customer Planning Representative.

      - Services with switches sized at 1000 amperes or more shall have ground fault protection on those switches per NEC.

5. Service conductors supplying 208Y/120 volts shall conform to the following specifications:

   a) With the exception of Secondary Network Areas, only the following types of cable will be approved when properly installed in conduit, no exceptions will be allowed.

      - ♦ USE - 2, THW - 2, THWN - 2, XHHW - 2, and RHW - 2.

   b) For integrated phase configuration:

      - ♦ Metallic or non-metallic conduit may be utilized.
      - ♦ There is no limitation on the length of service run. It shall be determined by the customer/contractor with respect to the maximum allowable voltage drop.

   c) For isolated phase configuration:

      - ♦ Non-metallic conduit shall be used.
      - ♦ The service run shall not exceed 30 feet.

THREE PHASE PADMOUNTED TRANSFORMER SPECIFICATIONS

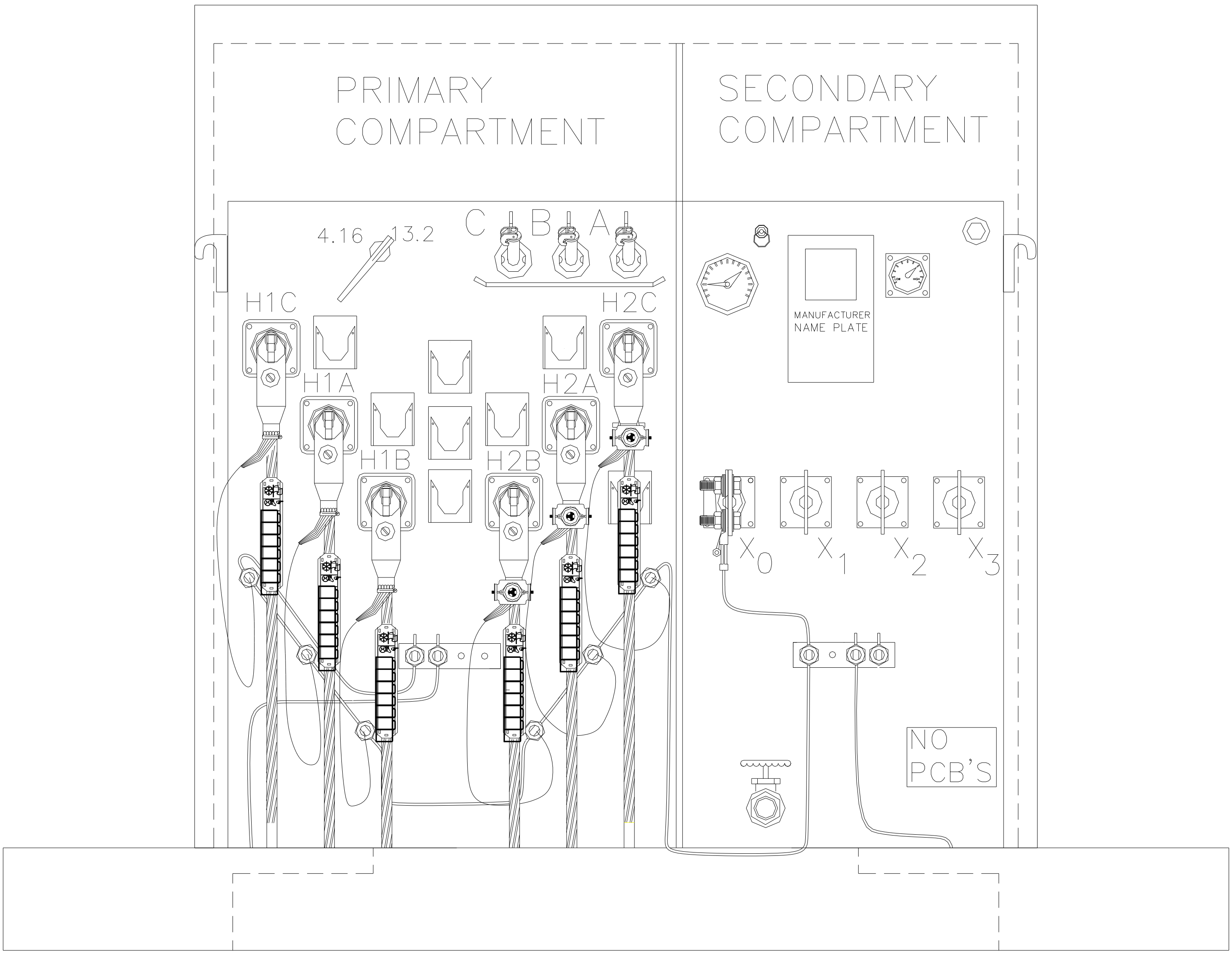


Illustration #2: Primary & Secondary Transformer Compartments

SECONDARY SPADE CONNECTION:

Description: Terminal Lug

1. Terminal Lug – Compression Connector – Tinned Aluminum or Copper. For up to 750 MCM compressed or concentric copper or aluminum secondary cable. NEMA 2-hole pad for ½ inch diameter bolts (stud size). Aluminum lug's bore shall be coated with oxide inhibiting compound and plugged. Connector shall be marked with manufacturer's name, cable size, type of conductor stranding and die index number. Connector barrel shall not have an inspection hole. Connector shall meet or exceed EEI-NEMA Standard TDJ-162, Class A-3.

   Follow manufacturer's compression tool and die recommendations for installing terminal connectors. For aluminum to copper connection, an additional bellville spring washer must be installed on the bolt side of the lug.

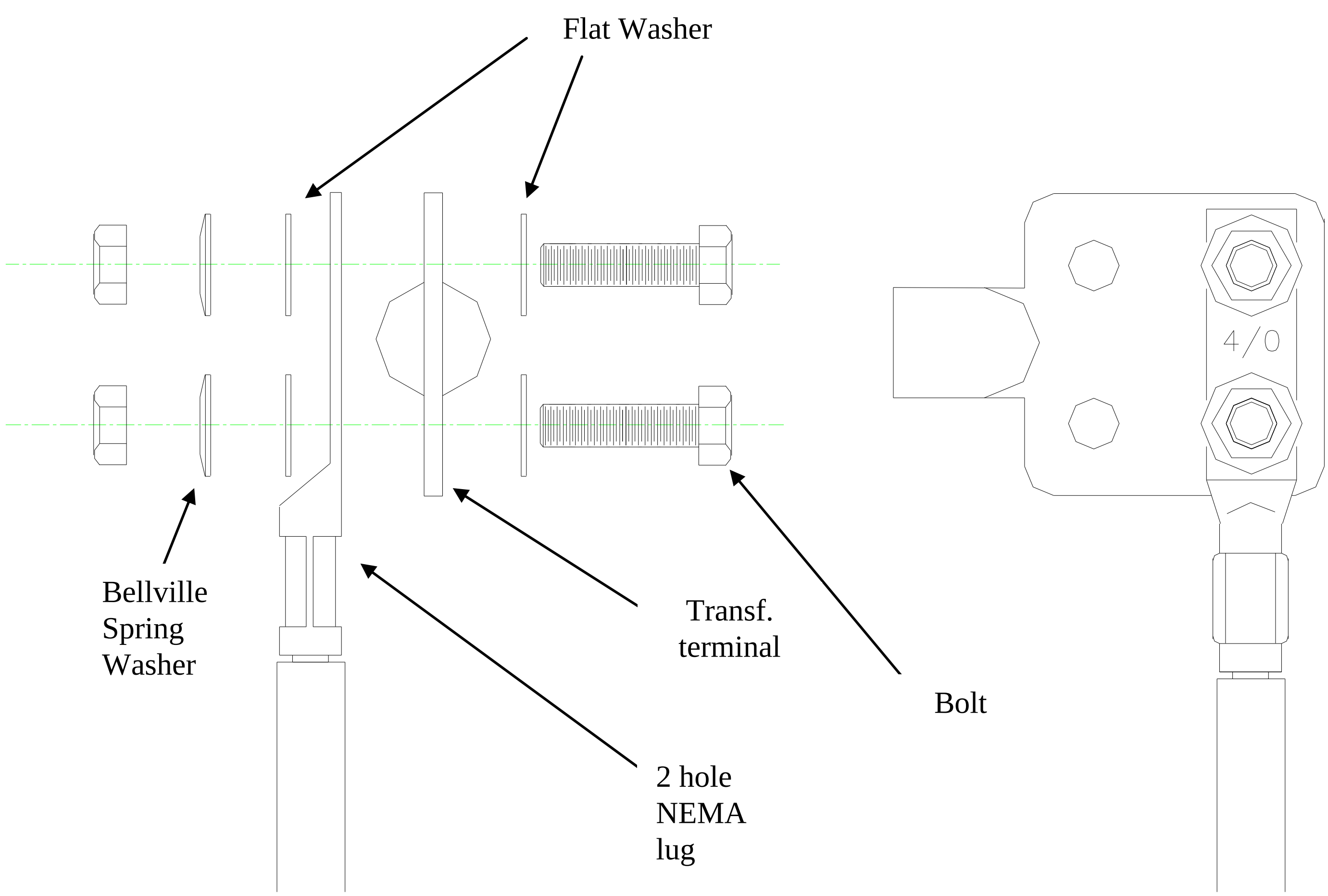


Illustration #3 – Secondary Spade Connection Detail

2. Lug to spade connection shall conform to the following:

   a) All copper components shall be tin or alloy plated.

   b) Wire brush aluminum conductor and apply oxide inhibitor compound to aluminum lug pad prior to connection to transformer spade. All excess compound must be removed after lug is secured. (Not required for tinned copper lugs.)

   c) Connect lug to transformer stud utilizing tinned or cadium plated silicon bronze or stainless steel hardware. Place concave side of bellville washer toward transformer stud. Recommended torque value for bolts: 480 in-lbs. for silicone bronze and 517 in-lbs. for stainless steel.

THREE PHASE PADMOUNTED TRANSFORMER SPECIFICATIONS

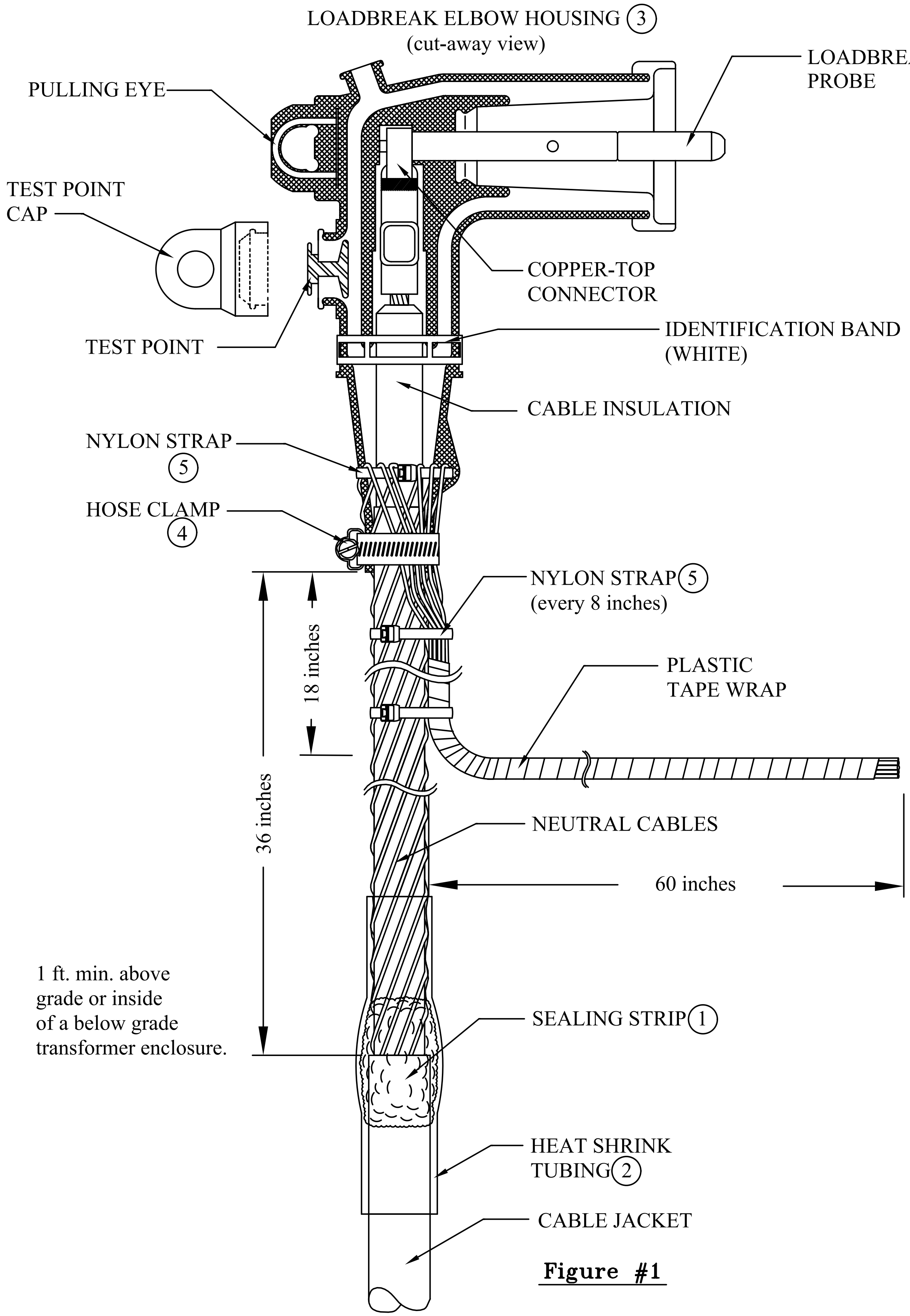


Figure #1

PSEG LONG ISLAND	REVISION	TERMINALS CABLE: PRIMARY	CONSTRUCTION STANDARD
APPROVED BY / DATE	17. 06/14: REVISED TITLE BLOCK	INSTALLATION AND OPERATING INSTRUCTION 15kV 200 AMP LOADBREAK ELBOW TERMINATION FOR XLPE or EPR INSULATED Cu. OR AL. CABLE	DRAWN BY AH
[signature] 7/22/14		DO NOT REVISE PRINT BY ANY OTHER METHOD THAN AUTO-CAD PREPARED BY: PSEG LONG ISLAND T&D ENGINEERING	NUMBER 3722 / SHEET No 1 of 8 / REV 17

INSTALLATION INSTRUCTIONS

1. Train the cable to the final assembled position. Six feet of cable should be extended beyond the bushing to provide sufficient system neutral to attach to the system neutral bus. A short length of #2 Cu cable, EPR insulated with a neoprene jacket (ITEM ID. 199428) may be hylinked to the neutral in place of four feet of additional neutral required above. There should also be sufficient cable slack to provide adequate clearance for lifting and placing elbows on operating accessories such as standoffs and feed -thru devices.

2. Slide a 6 inch length of heat shrinkable tubing over the cable.

3. Strip the cable jacket to provide flexibility for elbow operation. In most situations approximately 3 feet of jacket back from the elbow can be removed. The jacket must be retained on all primary cable in contact with soil and for a minimum of 1 foot above finished grade.

4. Install a self locking nylon strap (ITEM ID. 101003) over the neutrals 13 inches below the center of the bushing and fasten securely. Using self locking nylon straps, clamp the neutrals firmly against the insulation shield approximately every 8 inches. Carefully unwind and bend the neutrals back. Do not twist.

5. Cut the cable off 13 inches above the nylon strap.

6. Make the cable cutbacks in accordance with the manufacturers installation instruction sheet included with each kit. See manufacturers instructions for the exact cutback lengths. A brief summary is as follows:

   a. Remove the insulation shield (semiconductor) by making a circumferential cut part way through the shield. Exercise extreme caution to avoid nicking the insulation beneath. Make several longitudinal cuts part way through the shield from the circumferential cut to the end. Again exercise care not to nick the insulation.

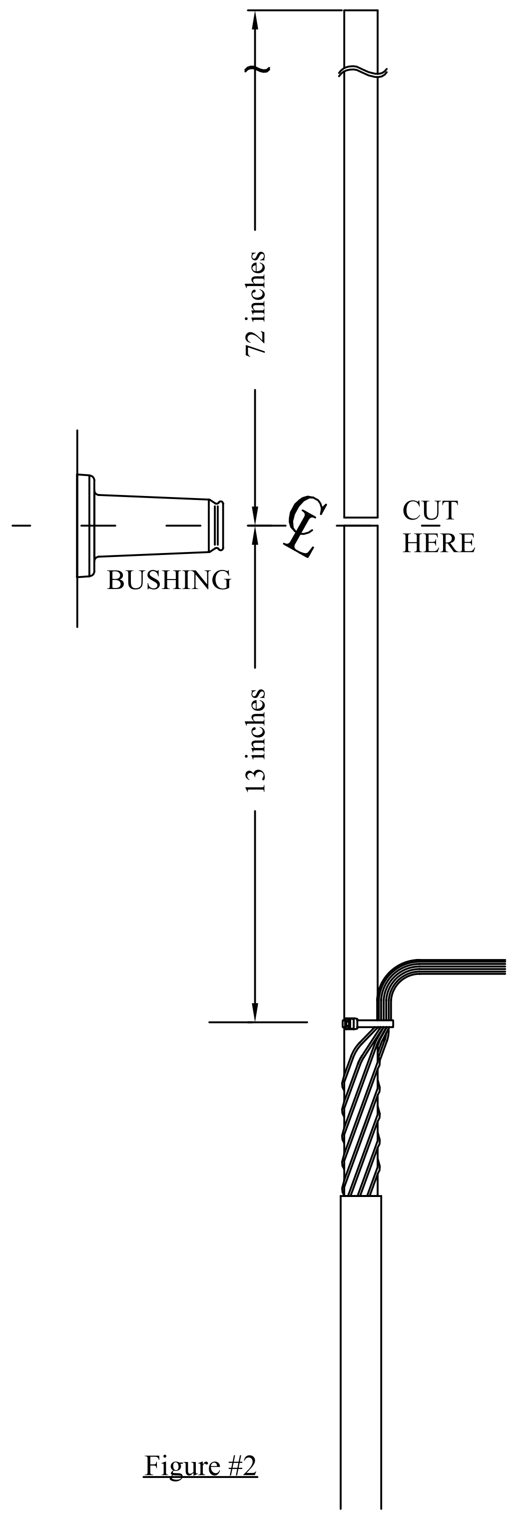


Figure #2

REVISION	17.06/14: REVISED TITLE BLOCK	TERMINALS CABLE: PRIMARY	CONSTRUCTION STANDARD DRAWN BY AH		
		INSTALLATION AND OPERATING INSTRUCTION 15kV 200 AMP LOADBREAK ELBOW TERMINATION FOR XLPE or EPR INSULATED Cu. OR AL. CABLE	NUMBER	SHEET No	REV
prepared by PSEG LONG ISLAND T&D ENGINEERING			3722	2 of 8	17

b. Prepare the cable end to accept the coppertop connector. Remove the insulation and conductor shield (semiconductor) from the end of the cable. Cut squarely being careful not to nick the conductor. Do not pencil. Apply a 1/8 inch Bevel to the end of the insulation. Fit the coppertop connector over the conductor. Check to make sure there is a 1/8 inch gap between the connector bottom and the insulation. This space is needed for expansion of the connector when it is crimped. Remove the connector and wipe the inhibitor grease off the conductor.

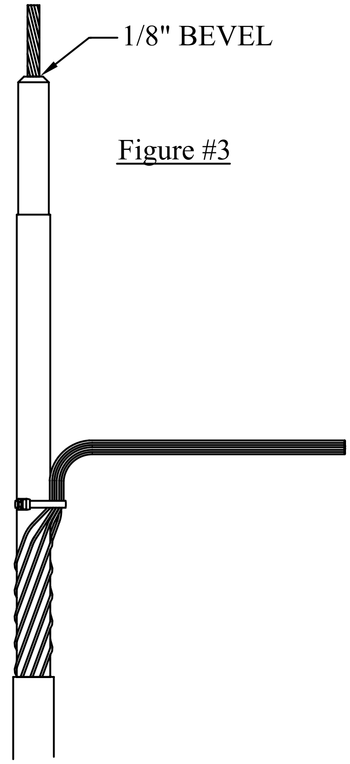


Figure #3

7. Wire brush (ITEM ID. 519030) the bare aluminum conductors. Immediately place the coppertop connector containing inhibitor grease on the conductor. Make sure the threaded hole in the coppertop connector faces the bushing. Crimp the connector in place using a tool and die combination listed in Table 1. Place one crimp centered between the connector knurl and connector bottom.

8. Clean the excess inhibitor grease from the coppertop connector. Wipe toward the threaded eye with a lint free cloth saturated with safety solvent (ITEM ID. 101374). Inhibitor residue can result in insulation damage and ultimate terminator failure.

Clean the exposed insulation surface with abrasive paper from the cleaning kits. (Item ID 101337) to remove all traces of semiconducting shielding and other foreign matter. Do Not Use Emery Cloth which contains conductive grit. Then wipe all exposed insulation surfaces clean with a lint free cloth saturated with safety solvent. Wipe towards the black semiconductor material without touching it. Be careful not to drag the black semiconductor material onto the clean insulation. In addition, clean the inside of the elbow housing, the cable entrance and the loadbreak bushing. [The solvent must be completely dry before applying any silicon grease.]

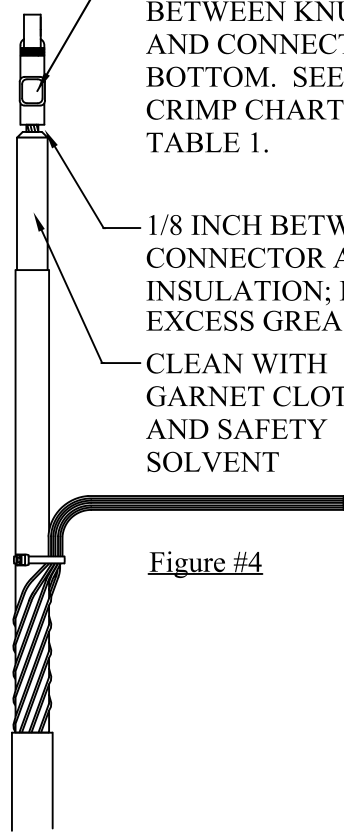


Figure #4

REVISION	TERMINALS CABLE: PRIMARY	CONSTRUCTION STANDARD DRAWN BY AH		
17.06/14: REVISED TITLE BLOCK	INSTALLATION AND OPERATING INSTRUCTION 15kV 200 AMP LOADBREAK ELBOW TERMINATION FOR XLPE or EPR INSULATED Cu. OR AL. CABLE	NUMBER	SHEET No	REV
prepared by PSEG LONG ISLAND T&D ENGINEERING		3722	3 of 8	17

9. Apply a thin coat of silicone grease supplied with the elbow kit to the exposed cable insulation, the elbow housing, the elbow cable entrance and the loadbreak bushing. Place the elbow onto the cable. With a twisting motion, push the elbow onto the cable until the threaded eye of the coppertop connector is visible through the elbow housing.

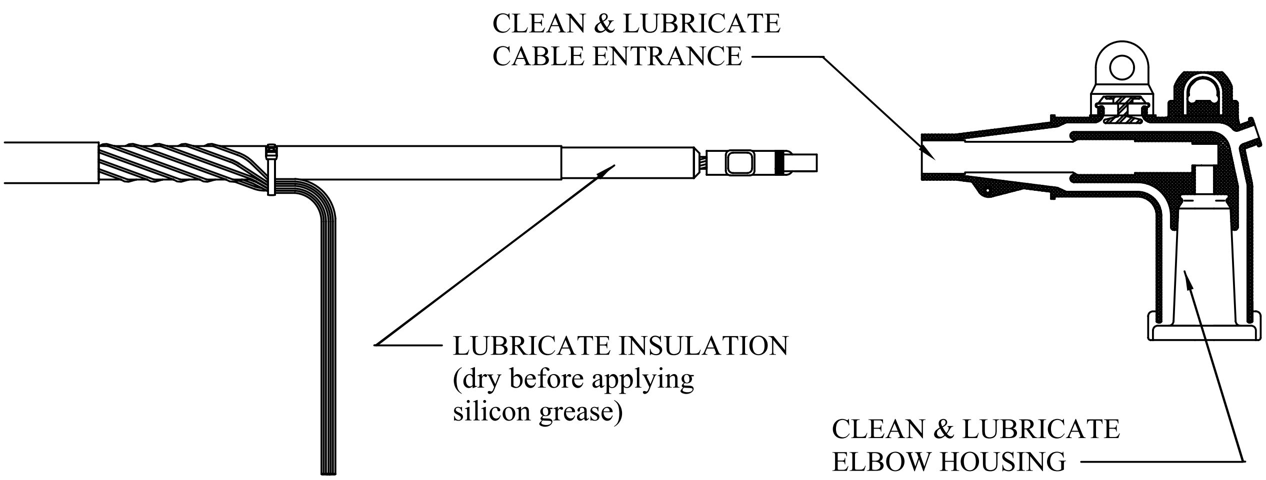
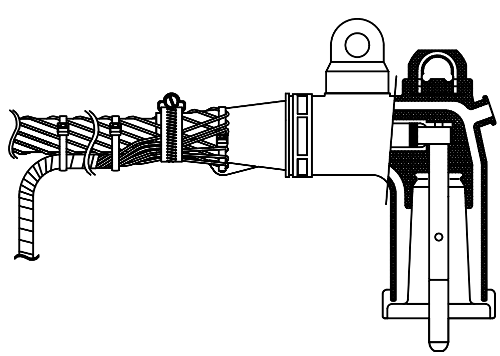


Figure #5

10. Insert the threaded end of the loadbreak probe into the elbow housing being careful not to contaminate the probe with silicone grease. By hand, thread the loadbreak probe into the threaded eye of the coppertop connector. Tighten the loadbreak probe with the torque applicator tool supplied with the elbow kit. Proper torque is applied when the torque applicator bends 180 degrees from its original shape. Discard the torque applicator. Do not reuse. As an alternative, one can use 15/25 kV probe installation tool made by Speed Systems (LPW 1525).

Probe installation tool may also be used to tighten the probe. After threading the probe into the threaded eye by hand, attach the installation tool to the probe and tighten until the tool click once.



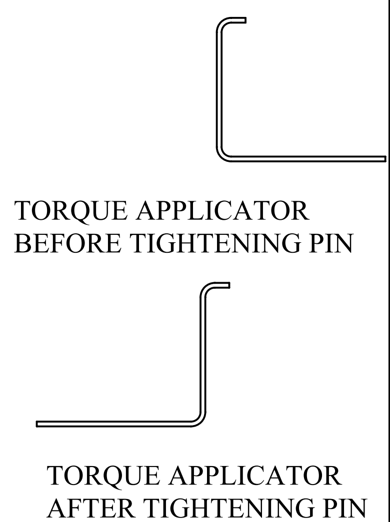


Figure #6

11. Bring the neutrals onto the elbow cable entrance. SEE FIGURE 1. Install a locking nylon strap over the neutrals and through the round eyelet at the base of the elbow. Bend the neutrals back over the nylon strap and install a hose clamp (ITEM ID. 121189) over both layers of neutral and the cable entrance. Tighten the hose clamp slowly until it is snug against the neutrals. Do Not Over Tighten. Gather the loose ends of the individual strands and form them into a parallel bundle of wires. Do Not Twist them tightly together; the individual strands will remain more flexible if not twisted together. Apply one half-lap layer of plastic tape to the last five feet of bundled neutral wire strands. Then, connect them to the neutral bus.

12. Apply (2) wraps of the sealing strip (ITEM ID. 185003) over the neutral wires at the point were the neutral wires come out from under the cable jacket.

13. Center the heat shrink tube over the sealing strip. Apply heat to the heat shrink tube evenly until it has fully contracted.

OPERATING INSTRUCTIONS

Before Loadmake or Loadbreak Operation:

Area must be clear of obstructions or contaminants that would interfere with the operation of the loadbreak elbow. This position should allow the operator to establish firm footing and enable the operator to grasp the shotgun stick securely, maintaining positive control over the movement of the loadbreak elbow before, during and directly after the operating sequence. Do not connect two different phases of a multi-phase system. Before closing any RUD loop, use an approved phasing tool to make sure both ends are the same phase. Do not operate a loadbreak elbow on a bushing insert by hand.

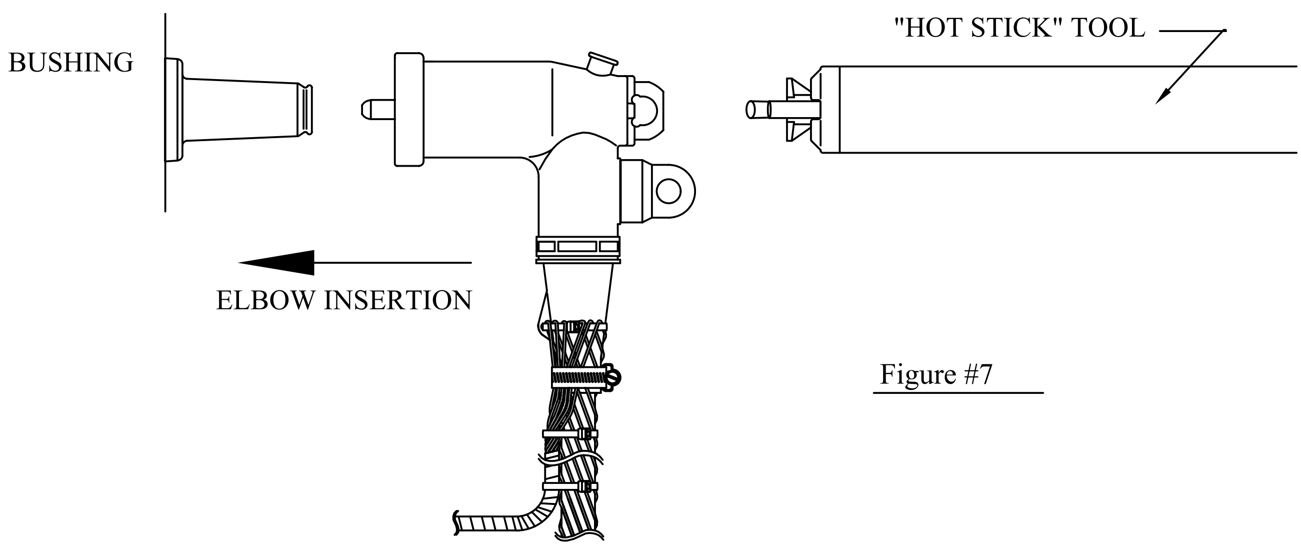


Figure #7

REVISION		TERMINALS CABLE: PRIMARY	CONSTRUCTION STANDARD DRAWN BY AH		
	17.06/14: REVISED TITLE BLOCK	INSTALLATION AND OPERATING INSTRUCTION 15kV 200 AMP LOADBREAK ELBOW TERMINATION FOR XLPE or EPR INSULATED Cu. OR AL. CABLE	NUMBER	SHEET No	REV
prepared by PSEG LONG ISLAND T&D ENGINEERING			3722	5 of 8	17

Loadmake Operation

1. Area must be clear of obstructions or contaminants that would interfere with the operation of the loadbreak elbow.
2. Securely fasten a shotgun stick to the pulling eye.
3. Place the loadbreak elbow over the bushing, inserting the load break probe into the bushing until the first slight resistance is felt. Resistance is felt when the arc follower portion of the loadbreak probe first meets the female contact of the bushing.
4. Immediately thrust the elbow onto the bushing with a fast, firm, straight motion, with sufficient force to latch the elbow to the bushing.

Fault Close

1. Do not operate the elbow on known faults.

Loadbreak Operation

1. Securely fasten a shotgun stick to the pulling eye.
2. To break surface friction between the elbow and the bushing, without exerting any pulling force, slightly rotate the loadbreak elbow clockwise while watching the bushing base. (Caution: If the base moves freely, do not turn the loadbreak elbow counterclockwise. The bushing may not be tightly seated.)
3. Withdraw the loadbreak elbow from the bushing with a fast, firm, straight motion, being careful not to place the elbow near a ground plane.
4. Place the loadbreak elbow on an appropriate accessory device.

NOTES:

1. New Construction
The loadbreak elbow and bushing insert must be installed as a matched set from the same manufacturer.

2. Maintenance
In existing installations, where routine (non-fault condition / non-loadbreak elbow failure) jobs are in progress, any loadbreak elbow found to be in good condition may be left in service. The existing elbow may be reinstalled into a new loadbreak bushing with no elbow replacement.

For field conditions where a loadbreak elbow experiences a fault or obvious failure, the elbow and bushing must be replaced with new components.

Additional situations where loadbreak elbow connector replacement is recommended:

a. when a faulted elbow is found to have an aluminum compression lug, replace all three phases.

b. when an elbow in an enclosure is found to be damaged, deformed or swollen.

c. when an elbow is not imprinted with the 8.3 / 14.4 kV rating and is not accordingly marked with the white and black bands around the cable entrance portion of the elbow.

2. Refer to CS 3727 for the loadbreak bushing insert installation instructions.

3. DIFFICULT REMOVAL SITUATIONS:
When difficulty may be expected in the removal of a loadbreak elbow, a twisting movement in conjunction with greater than normal pulling force is often required to break the elbow free. It is imperative that in these removal situations an elbow "clam-shell tool" (ITEM ID. 551308) be used to insure positive leverage on the entire upper elbow body.

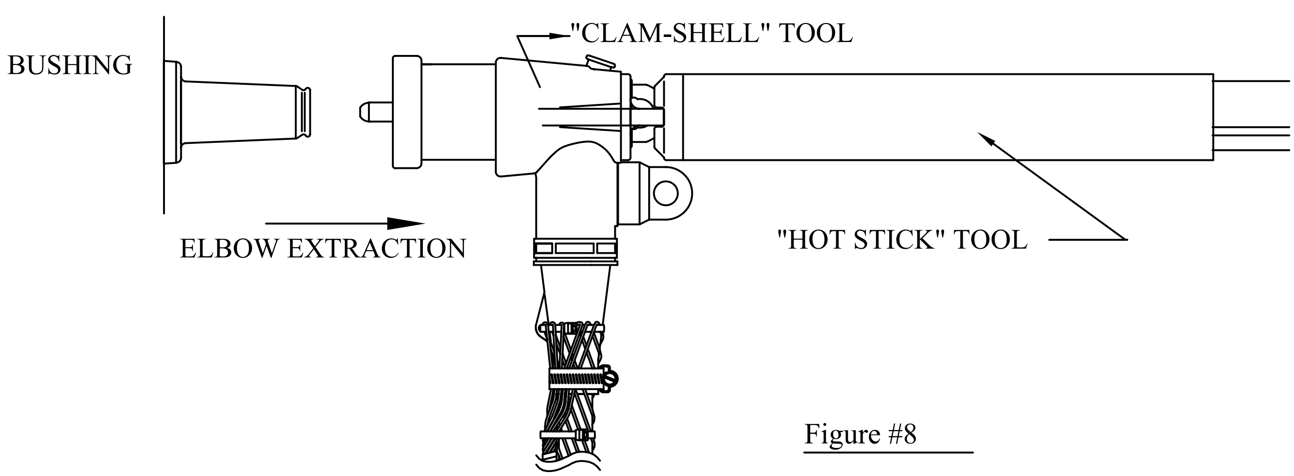


Figure #8

REVISION	17.06/14: REVISED TITLE BLOCK	TERMINALS CABLE: PRIMARY INSTALLATION AND OPERATING INSTRUCTION 15kV 200 AMP LOADBREAK ELBOW TERMINATION FOR XLPE or EPR INSULATED Cu. OR AL. CABLE	CONSTRUCTION STANDARD DRAWN BY AH	
			NUMBER: 3722	SHEET No: 7 of 8 — REV: 17

prepared by PSEG LONG ISLAND T&D ENGINEERING

	BILL OF MATERIAL		
ITEM	DESCRIPTION	QTY.	ITEM ID.
1	SEALANT STRIP	+	185003
2	TUBING, HEAT SHRINKABLE, 1.5 - 0.7" RECOVERED I.D.	+	197304
3	TERMINATOR L/B ELBOW # 2 AWG W/BUSHING INSERT	+	160112
	TERMINATOR L/B ELBOW # 1/0 AWG W/BUSHING INSERT	+	160114
	TERMINATOR L/B ELBOW # 3/0 AWG W/BUSHING INSERT	+	160115
4	HOSE CLAMP, STAINLESS STEEL	+	121189
5	NYLON STRAP, SELF LOCKING	+	101003

TABLE 1
CRIMP CHART

Conductor Size	Insulation Diameter (In.) Min. - Max **	Conn. O.D.	Elbow Term. With Bush. Insert	Tool	Die	No. of Crimps
# 2 Cu. or Alum.	0.755 - 0.815	5/8"	Item I. D. 160112	Y34A Y35 Y46*	A243 U243 U243	1
# 1/0 Cu. or Alum.	0.830 - 0.890	5/8"	Item I. D. 160114	Y34A Y35 Y46*	A243 U243 U243	1
# 3/0 Cu. or Alum.	0.925 - 0.985	5/8"	Item I. D. 160115	Y34A Y35 Y46*	A27AR U27ART U27ART	1

* Use with P - UADP Adapter

** Compressed Conductor with 220 Mil. Insulation

+ AS REQUIRED
* MISSING DIGITS BY TYPE OR SIZE

REVISION

Loadbreak Bushing Insert Installation Instructions

Precautions

1) All apparatus must be de-energized during the installation of the loadbreak bushing insert. Inspect the loadbreak bushing insert and bushing well for damage.

2) Read and follow all manufacturers instructions supplied with the loadbreak bushing inserts.

Replacement Requirements

3) For field conditions where a loadbreak elbow experiences a fault or obvious failure, the elbow and bushing must be replaced with new components from the same manufacturer. Bushing inserts and loadbreak elbows are stocked as a set from the same manufacturer.

In existing installations, where routine (non-fault condition / non-Loadbreak elbow failure) jobs are in progress, any loadbreak elbow found to be in good condition may be left in service. The existing elbow may be reinstalled into a new loadbreak bushing with no elbow replacement.

Additional situations where loadbreak elbow connector replacement is recommended:

a. when a faulted elbow is found to have an aluminum compression connector (non-coppertop), replace all three phases.

b. when an elbow in an enclosure is found to be damaged, deformed or swollen.

c. when elbow is not imprinted with the 8.3 / 14.4 kV rating and is not accordingly marked with the white and black bands around the cable entrance portion of the elbow.

d. When the temperature of the elbow terminator is more than 20°C above the ambient temperature of the adjacent cable.

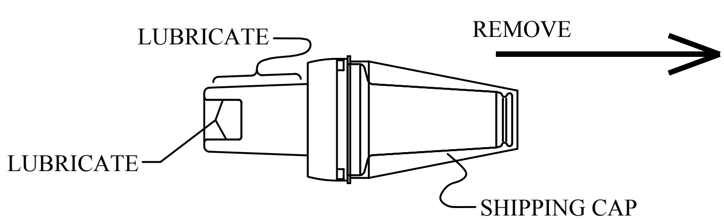
Refer to CS-3722 for the loadbreak elbow installation instructions.

Installation Instructions

Clean and Lubricate

4) Inspect the apparatus bushing well to be sure it is dry and free from all contaminants. Contamination will cause electrical failure.

5) Remove the protective shipping cap from the bushing insert. Lubricate the Bushing well interface area of the bushing insert with the supplied lubricant or using (ITEM ID.101045). Do not use any other greases or silicone products as a substitute.

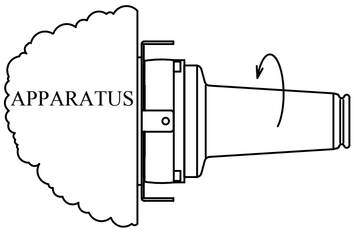


PSEG LONG ISLAND		REVISION	CABLE JOINTS: PRIMARY	CONSTRUCTION STANDARD
APPROVED BY	DATE	6. 06/14: UPDATE NOTES & REVISED TITLE BLOCK	INSTALLATION INSTRUCTIONS 15 kV, 200 AMP LOADBREAK BUSHING INSERT	DRAWN BY AH
[signature]	7/22/14			NUMBER 3727 · SHEET No 1 of 5 · REV 6

DO NOT REVISE PRINT BY ANY OTHER METHOD THAN AUTO-CAD
PREPARED BY: PSEG LONG ISLAND T&D ENGINEERING

Installing Existing Older Loadbreak Bushing Insert Without an Internal Hex Broach

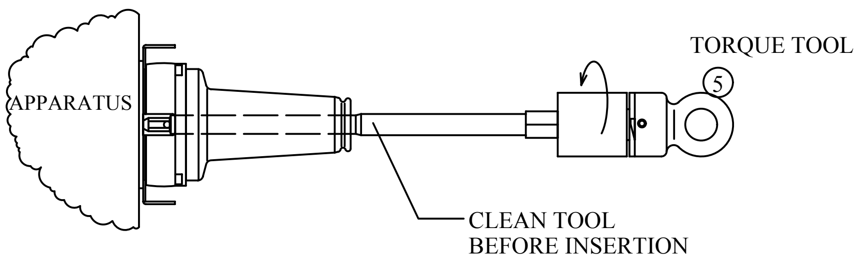
6a) Place the threaded end of the bushing insert in the apparatus bushing well.
Hand tighten the bushing insert in a clockwise direction until it bottoms.
Do not over tighten. This may cause the bushing well stud to snap off.



NOTE:
De-energized cleaning and lubricating instructions apply to existing bushings as well as newly installed bushing devices. On existing equipment the reuse of 15 kV bushings implies that the bushings be free of contaminants and properly lubricated with silicone grease.

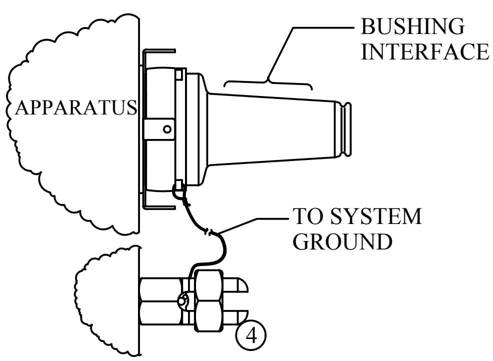
Alternate Method for Installing Newer Style Loadbreak Bushing Insert with an Internal Hex Broach Compatible with the 200 AMP Insert Torque Tool - ITEM ID. 160105

6b) Place the threaded end of the bushing insert into the apparatus bushing well. Insert the torque tool in the bore of the bushing insert. Turn the tool slightly to engage the hex broach. Insert a suitable rod through the eye of the tool and turn in a clockwise direction until the tool begins to ratchet and makes an audible click. Remove the torque tool from the bushing insert. The torque tool tightens the bushing to approximately 10 to 15 FT-LBS.



Connect Drain Wire Between Bushing Body and System Ground

7) Push a length of neutral strand (or a 14 AWG copper wire) through one of the grounding eyes on the bushing insert. Make a small loop and twist tight taking care not to damage the grounding eye. Connect the free end of the grounding wire to the ground pad lug (ITEM ID. 124138) of the apparatus. The grounding wire should be installed in such a manner so as not to contact the bushing interface or adjacent bushing interfaces or interfere with the placement of accessories on nearby parking stands.



REVISION	CABLE JOINTS: PRIMARY	CONSTRUCTION STANDARD DRAWN BY AH		
6. 06/14: UPDATE NOTES & REVISED BLOCK	INSTALLATION INSTRUCTIONS 15 kV, 200 AMP LOADBREAK BUSHING INSERT	NUMBER	SHEET No	REV
prepared by PSEG LONG ISLAND T&D ENGINEERING		3727	2 of 5	6

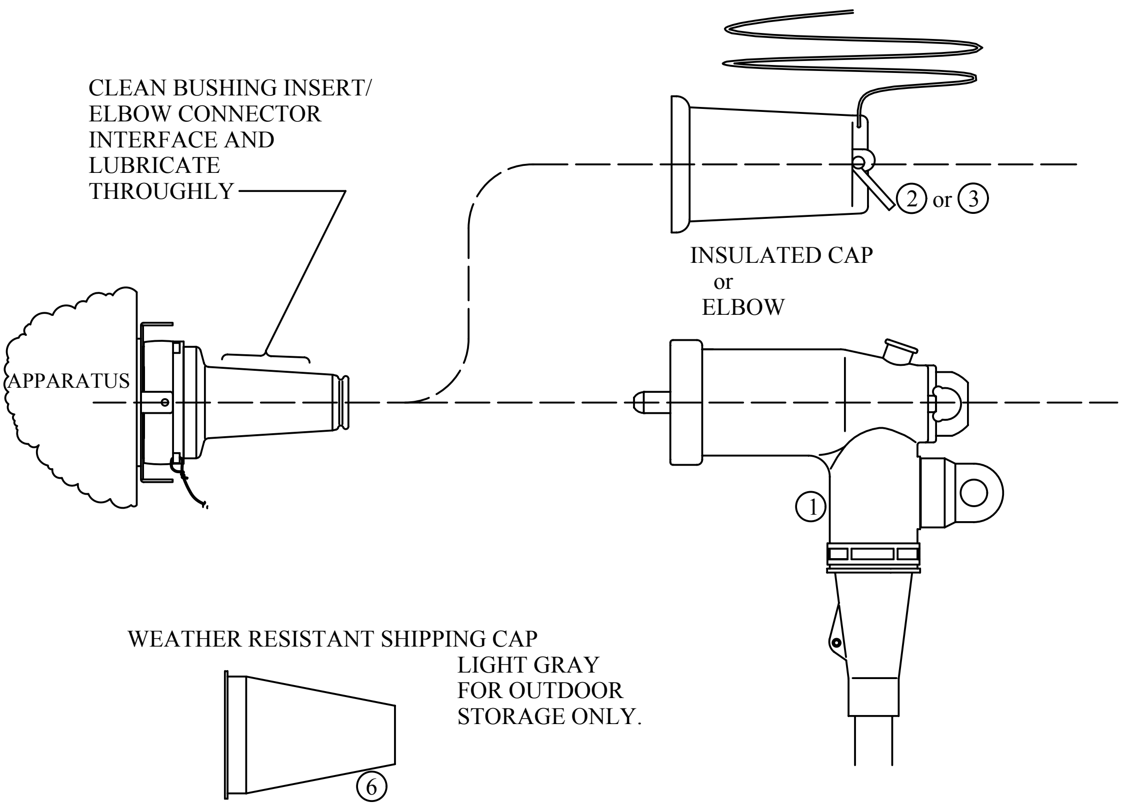
Cover Loadbreak Bushing Insert

8) Do not leave the bushing interface exposed. Cover with the appropriate mating product as follows:

Using a clean cloth, thoroughly wipe the bushing interface clean of contaminants and lubricate with the supplied lubricant. Do not apply lubricant to the arc quenching material inside the bushing insert. Install load break elbow or insulated cap on all bushing inserts left energized. Refer to CS-3722 for the loadbreak elbow installation instructions, loadmake and loadbreak operating instructions. If the bushing insert is not energized and is to be stored outdoors, install a new light gray weather resistant shipping cap ITEM ID 160024. Do not energize or submerge the apparatus with the shipping cap on the bushing insert. This is a protective cap which is not insulated or water tight and only intended to keep the bushing surfaces clean during storage, handling and installation.

Attention: Some newer style load break bushing inserts may be equipped with a latch indicator ring that serves as a visual indicator to verify the mating component is properly seated on the bushing insert. Once the mating component has been properly installed on the bushing insert, the yellow or white ring should be completely covered. If any yellow or white is visible, the load break elbow or protective cap must be completely installed or "latched" before energizing to assure a proper connection.

Also, some new bushing interfaces are red in color. This is to indicate it is a 15KV rated bushing and to distinguish it from bushings rated for higher voltages.



CAUTION: NEVER ENERGIZE WITH SHIPPING CAP INSTALLED !

REVISION	6. 06/14: UPDATE NOTES & REVISED BLOCK	CABLE JOINTS: PRIMARY INSTALLATION INSTRUCTIONS 15 kV, 200 AMP LOADBREAK BUSHING INSERT	CONSTRUCTION STANDARD DRAWN BY AH
prepared by PSEG LONG ISLAND T&D ENGINEERING			NUMBER 3727 / SHEET No 3 of 5 / REV 6

Bushing Insert Removal

9) De-energize apparatus, verify apparatus is de-energized and install grounds

10) Remove mating product and place in a stand-off device or in a clean, dry location.

11) Remove ground wire.

12) Use a 5/16" inch hex drive tool, torque tool or a strap wrench to remove.

   a. If a hex drive tool or torque tool is used, insert the drive into the bushing insert. Turn the tool slightly to engage the hex broach. Turn counter-clockwise to remove.

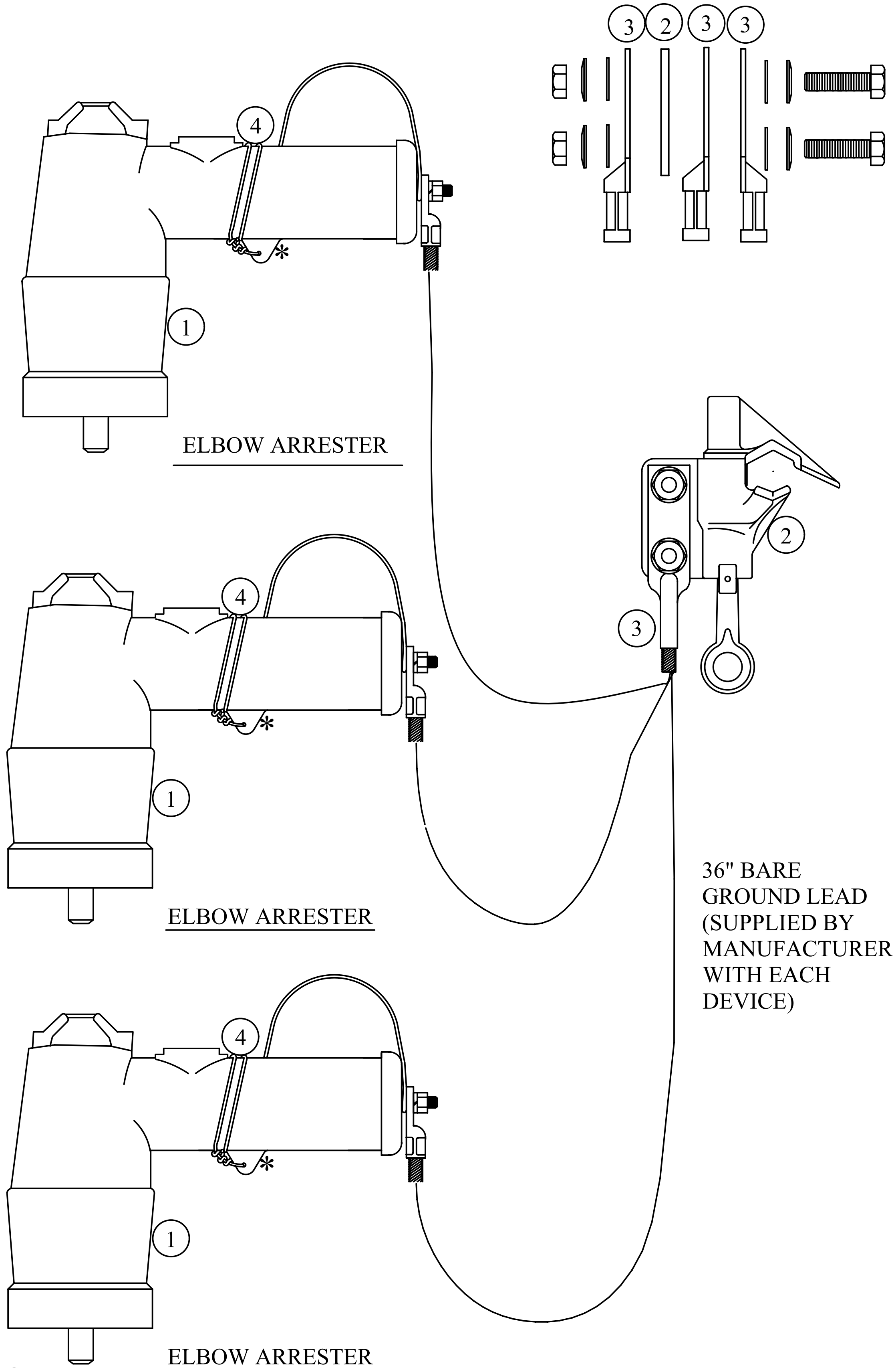
   b. If a strap wrench is used, wrap around the collar of the bushing insert. Turn counter-clockwise to remove. Take care not to damage the bushing insert interface during this procedure.

BILL OF MATERIAL			
ITEM	DESCRIPTION	QTY.	ITEM ID.
1	BUSHING INSERT 200A WITH LOAD BREAK ELBOW #2 AWG	+	160112*
	#1/0 AWG	+	160114*
	#3/0 AWG	+	160115*
2	INSULATING CAP WITHOUT BUSHING INSERT	+	160020
3	INSULATING CAP WITH BUSHING INSERT	+	160023
4	GROUND PAD LUG	+	124138
5	TORQUE TOOL LOADBREAK BUSHING INSERT INSTALLATION (200 AMP)	+	160105
6	SHIPPING CAP, WEATHER RESISTANT, LIGHT GRAY	+	160024

* BUSHING & ELBOW ARE PACKAGED AS ONE KIT

+ AS REQUIRED
* MISSING DIGITS BY TYPE OR SIZE

REVISION



* DRAINWIRE EYEHOLE

SEE SHEET 2 FOR BILL OF MATERIAL

nationalgrid	LIPA Long Island Power Authority	REVISION	TRANSFORMER AND EQUIPMENT: GENERAL	CONSTRUCTION STANDARD DRAWN BY AH		
APPROVED BY / DATE	APPROVED BY / DATE	3. 08/12: REVISED TITLE BLOCK	SURGE PROTECTION 3 PHASE RADIAL ONLY	NUMBER	SHEET No	REV
[signature] 09/14/12	[signature] 10/12/12	DO NOT REVISE PRINT BY ANY OTHER METHOD THAN AUTO-CAD PREPARED BY: National Grid Engineering & Survey, Inc.		4028	1 of 5	3

BILL OF MATERIAL

ITEM	DESCRIPTION	QTY.	ITEM ID.
1	Elbow Arrester with Ground Lead (with bushing*)	3	105214
2	Hot Line Clamp, Copper, (Includes Hardware)	1	121096
3	Lug, #2 Copper (2 Hole) (One Lug for Each Ground Lead)	3	143070
4	Wire, #10 Bare Solid Copper (See DM&S Bulletin 07-05 for Exceptions)	60"	199010

* Use of elbow arrester without bushing (Item ID 105213) implies that arrester will be inserted into an elbow bushing on the transformer.

+ AS REQUIRED
* MISSING DIGITS BY TYPE OR SIZE

REVISION

PREPARATION OF DEVICES

A. Triple surge arrester elbows, preparation for open point application.
(See Sheet 1)

1. Remove elbow arresters from packages.
   Each item is packed with 36" length of bare #4 extra-fine stranded copper ground lead. (Equivalent to a #2 19 strand copper wire)

2. Using the 20" lengths of #10 bare solid copper wire secure it to the drain wire eyehole on the body of the surge arrester upper body and secure them by interlocking the last wrap around itself (looping it under and around itself). Leave a short slack section as shown in the diagram on page one. Finally, attach the free end to the surge arrester ground stud together with the ground lead lug. Tighten the ground stud nut to 4 to 8 foot pounds torque.

3. Repeat step 2 for the second and third elbow arrester devices.

4. Hypress the free ends of the 36" lenght(s) of bare #4 extra-fine stranded ground lead to each of the #2 two hole lug(s).

5. Lubricate bushing interface of arrester with lubricant supplied.

6. See DM&S 07-05 or exceptions.

IMPORTANT NOTES FOR RADIAL APPLICATION:

NOTE 1. Use Item ID 105213 single elbow surge arresters without bushing for energized installations, where bushings already exist on the transformer.
Discard existing dead-end caps.

NOTE 2. Use only Item ID 105214 single elbow surge arresters with bushings for new radial installations, where new bushings are required to install surge arresters onto transformer.

INSTALLATION OF DEVICES

A. Elbow Arrester Installation On Energized Radial Feed Transformer (Endpoint).

NOTE: UTILIZE APPROPRIATE ENERGIZED/HOT STICK PROCEDURES FOR ALL INSTALLATION AND REMOVAL OPERATIONS.

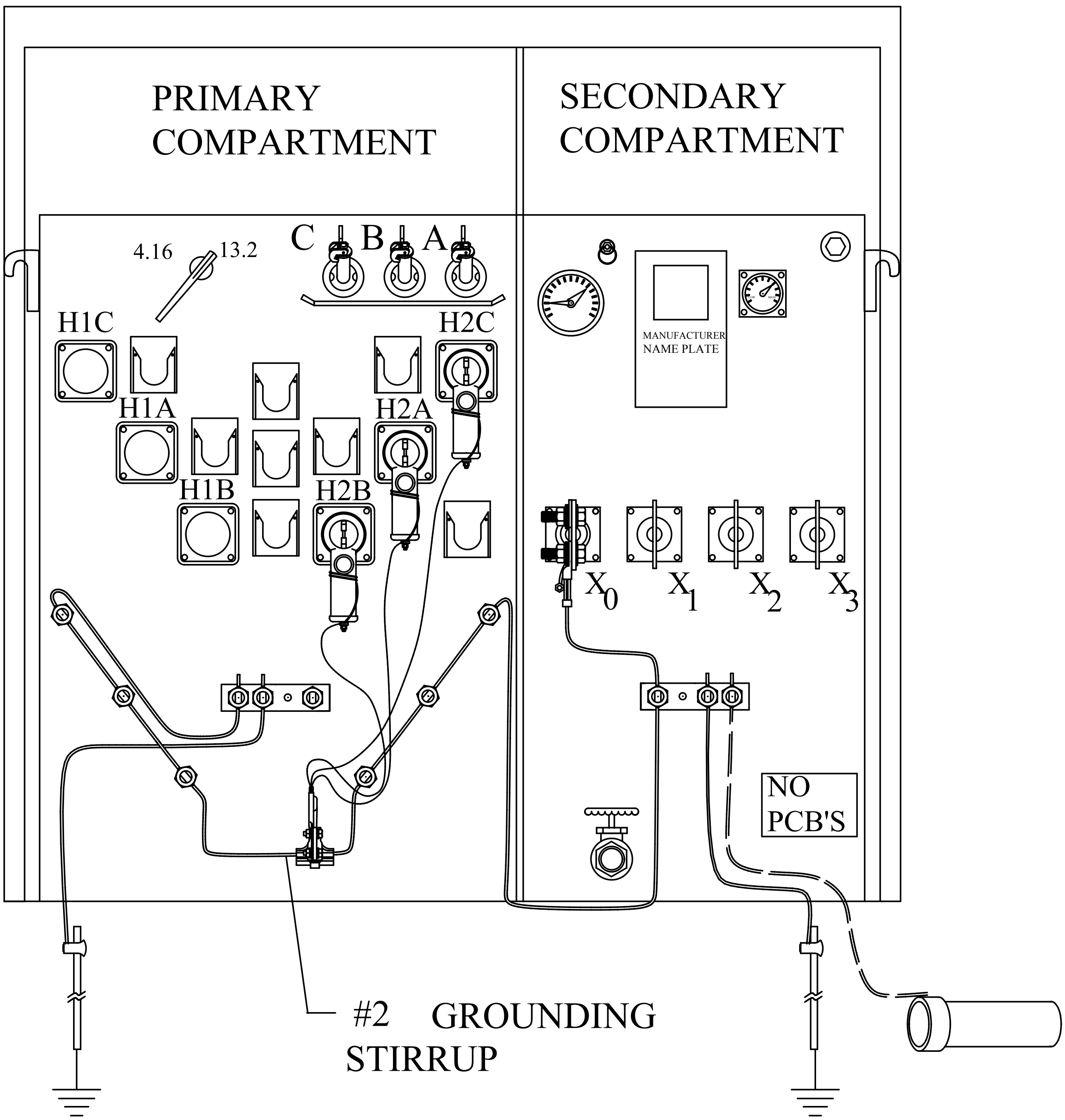
1. Open the transformer enclosure and identify visually the location of the transformer enclosure grounding point.

2. Using hot stick tool, install the elbow arrester's hotline clamp at the grounding point.

3. Remove the dead end caps from the transformer bushings. The dead end caps are no longer required.

4. Install the elbow arrester device onto the open bushing.

5. Close and lock the transformer enclosure.

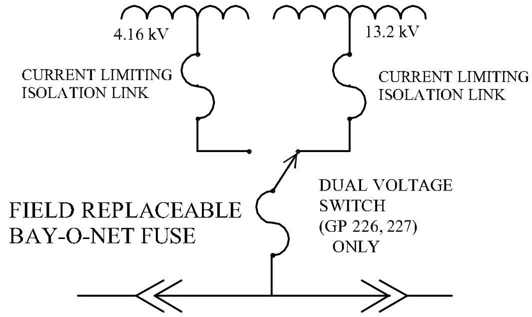


GROUNDING DETAILS

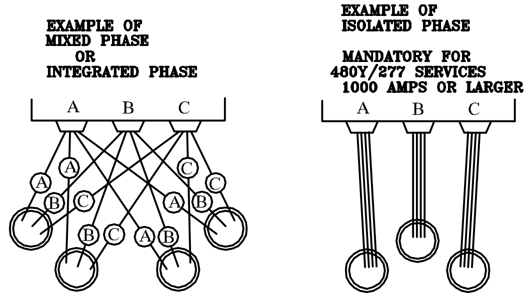
RADIAL FEED TRANSFORMER (END POINT)

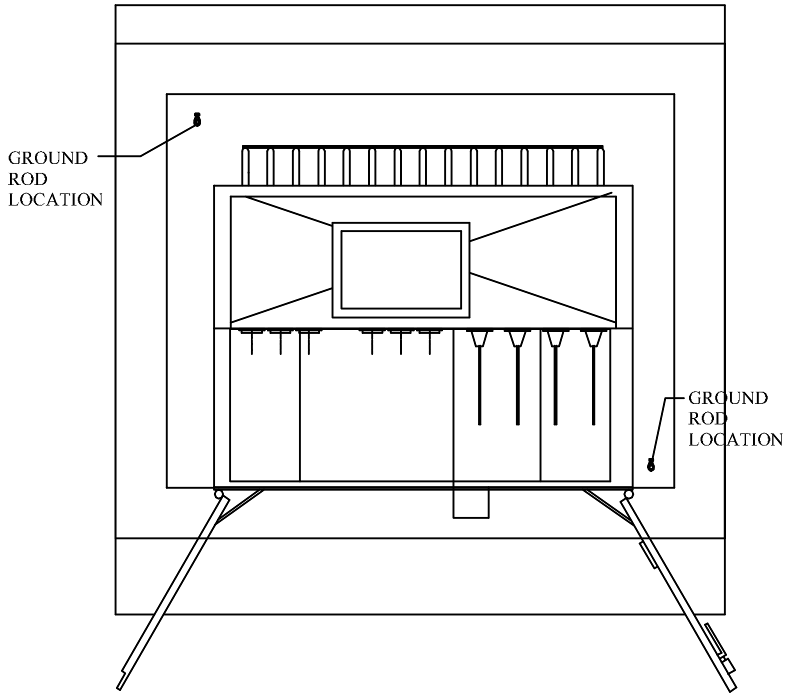
REVISION	3. 08/12: REVISED TITLE BLOCK	TRANSFORMER AND EQUIPMENT: GENERAL	CONSTRUCTION STANDARD DRAWN BY AH		
LONG ISLAND POWER AUTHORITY		SURGE PROTECTION 3 PHASE RADIAL ONLY	NUMBER	SHEET No	REV
prepared by National Grid Engineering & Survey, Inc.			4028	5 of 5	3

ONE LINE DIAGRAM

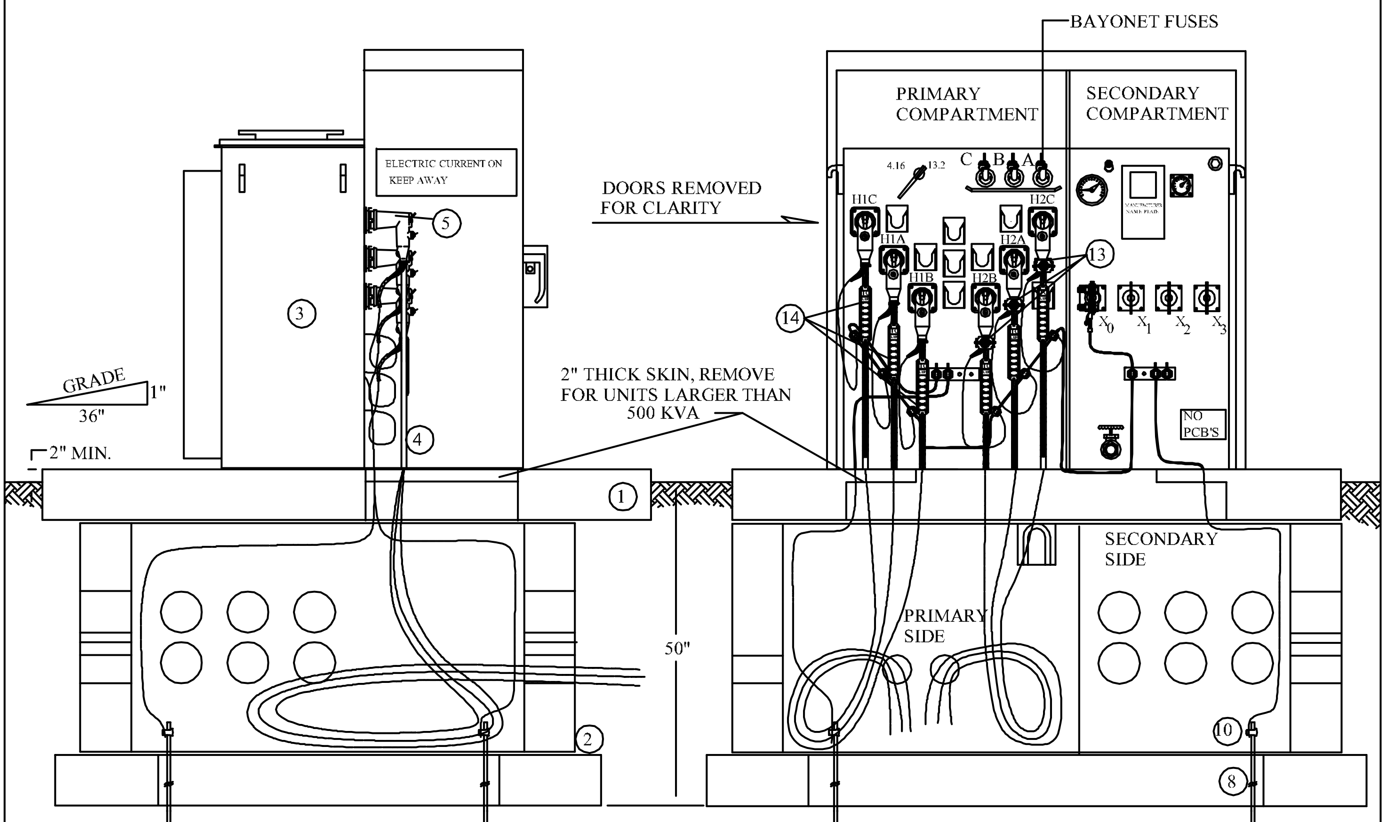


SECONDARY CABLE INSTALLATION





SEE SHEET 5 FOR GROUNDING DETAILS



nationalgrid	LIPA Long Island Power Authority	REVISION	TRANSFORMER INSTALLATION AND HOUSING CONSTRUCTION: PAD AND ENCLOSURE HOUSED
APPROVED BY DATE 08/10/11	APPROVED BY DATE 08/18/11	11/08/11: ADDED ITEM ID	3 PHASE 4kV OR 13kV "DEAD FRONT" METAL CLAD TRANSFORMER 75-1500KVA FOR PRIMARY DISTRIBUTION
			DO NOT REVISE PRINT BY ANY OTHER METHOD THAN AUTO-CAD
			PREPARED BY: National Grid Engineering & Survey, Inc.

CONSTRUCTION STANDARD
DRAWN BY AH

NUMBER	SHEET No	REV
5362	1 of 6	11

BILL OF MATERIAL			
ITEM	DESCRIPTION	QTY.	ITEM ID.
1	CONCRETE PAD, RE-ENFORCED, PRE-CAST (8' X 8' X 8")	1	131117
2	FOUNDATION AND FOOTING, RE-ENFORCED CONCRETE, PRECAST	1	131116
3	TRANSFORMER, THREE PHASE - PAD MOUNTED (SEE DA-50005)	1	922***
4	PRIMARY CABLE, 15kV, 3-2/C 1/0 AL. {LIPA INSTALLATION}	+	199984
5	PRIMARY TERMINATIONS / SURGE PROTECTION " "		
	TERMINATOR, LOADBREAK 1/0 W/BUSHING " "	6	160114
	LOOP INSTALLATIONS WITH FEED-THRU TRANSF. " "		
	TERMINATOR, LOADBREAK 1/0 W/BUSHING " "	6	160114
	STAND OFF BUSHING " "	3	160090
	DEAD END CAPS (WITHOUT BUSHING) " "	3	160020
	OR		
	RADIAL INSTALLATION: {CUSTOMER INSTALLATION}		
	TERMINATOR, LOADBREAK #2 W/BUSHING " "	3	160112
	ELBOW SURGE ARRESTER W/BUSHING (SEE CS-4028) "	3	105214
6	SECONDARY CABLE, COPPER, 600 V EPR:	+	199***
	NOTE: FOR ALL 480 VOLT SECONDARY SERVICES CABLE INSULATION MUST BE TYPE "USE-2" OR "XHHW-2", RHW-2, THWN-2		
7	TERMINAL CONNECTOR, 2-HOLE NEMA:		
	4/0 AWG STRANDED	+	143087
	500 KCM STRANDED	+	143098
8	GROUND ROD, 1/2" X 8'	2	173007
9	TERMINAL LUG, #4 AWG STR., #2 AWG SOL., 2-HOLE NEMA	1	143066
10	CONNECTOR, GROUND ROD	2	121065
11	WIRE SOLID #2 AWG, COPPER TINNED *	30'	199265
12	CONNECTOR, GROUND, THREAD. LUG (#2 TO 2/0 AWG STR.)	10	124138
13	FAULT INDICATOR, 400 AMP, 3 AMP RESET (LOOP FEED ONLY)	+	101400
14	IDENTIFICATION TAGS FOR PRIMARY CABLE (SEE CS-2030)	+	155***
15	NUT, JAM EVERDUR HEX, 1/2" X 13"	10	110198
16	WIRE SOLID #6 AWG, COPPER TINNED	+	199444
	* #2 AWG BARE MAY BE SUBSTITUTED ON RADIAL INSTALLATIONS.		

+ AS REQUIRED
* MISSING DIGITS BY TYPE OR SIZE

REVISION

CS # 5362 REV. 11
SHEET # 2 of 6

NOTES:

PRIMARY CABLE :

1. CABLES SHOULD HAVE 5 FT. OF SLACK INSIDE FOUNDATION. AS MUCH PHYSICAL SEPARATION AS POSSIBLE SHOULD BE GIVEN BETWEEN THE PRIMARY AND SECONDARY CABLES WITHIN THE FOUNDATION. PRIMARY CABLES SHALL ENTER FOUNDATION UNDER PRIMARY SIDE OF TRANSFORMER. SECONDARY CABLES SHALL ENTER UNDER SECONDARY SIDE OF TRANSFORMER ONLY.

2. INSTALL CURRENT RESET FAULT INDICATORS (ITEM ID 101400) ON OUTGOING CABLES IN LOOP INSTALLATIONS.

3. WHEN TERMINATING CABLE, SIX FEET OF CABLE SHOULD BE EXTENDED BEYOND THE THE BUSHING TO PROVIDE SUFFICIENT SYSTEM NEUTRAL TO ATTACH TO THE SYSTEM NEUTRAL BUS. A SHORT LENGTH OF #2 AWG COPPER CABLE EPR INSULATED WITH A NEOPRENE JACKET (ITEM ID 199428) MAY BE HYLINKED TO THE NEUTRAL IN PLACE OF FOUR FEET OF ADDITIONAL NEUTRAL REQUIRED ABOVE. THERE SHOULD ALSO BE SUFFICIENT CABLE SLACK TO PROVIDE ADEQUATE CLEARANCE FOR LIFTING AND PLACING ELBOWS ON OPERATING ACCESSORIES.

SECONDARY CABLE

4. ISOLATED PHASE CONSTRUCTION SHALL BE USED FOR ALL 480Y/277 VOLT SERVICES LARGER THAN 800 AMPS. FOR 800 AMPS SERVICES AND LESS, EITHER INTEGRATED OR ISOLATED PHASE IS ACCEPTABLE.

5. ISOLATED PHASE CONSTRUCTION SHALL NOT EXCEED 50 FT. FOR 480Y/277. FAILURE TO COMPLY WITH THIS REQUIREMENT WILL RESULT IN LOW VOLTAGE, PARTICULARLY UNDER HIGH LOADS, AND INDUCTIVE HEATING OF NEARBY METALLIC EQUIPMENT.

6. ALL ISOLATED PHASE INSTALLATIONS SHALL BE INSTALLED USING NON-METALLIC CONDUIT.

7. INTEGRATED PHASE CONSTRUCTION IS LIMITED TO ONE SET OF CABLES PER DUCT. (IE. ONLY ONE CABLE PER PHASE IN EACH DUCT)

8. ALL 480Y/277 VOLT SERVICES SHALL BE INSTALLED USING "USE-2", "XHHW-2", RHW-2, THWN-2 TYPE CABLE ONLY.

9. THREE PHASE 208Y/120 VOLT SERVICES SHALL BE INSTALLED USING INTEGRATED PHASE CONSTRUCTION, ONLY. IF ISOLATED PHASE CONSTRUCTION IS UNAVOIDABLE, CABLES MUST NOT EXCEED 30 FEET IN LENGTH AS A MAXIMUM DISTANCE.

BONDING/GROUNDING: (SEE PAGE 5)

11. WITH #2AWG BARE TINNED COPPER WIRE, CONNECT EACH GROUND LUG LOCATED BELOW EACH PRIMARY BUSHING. CONTINUE THE #2 COPPER TO THE GROUND PAD. SEE GROUNDING DIAGRAM.

12. USING #2 AWG, BTN COPPER WIRE CONNECT THE SECONDARY NEUTRAL BUSHING TO THE RIGHT GROUND PAD, CONNECT THE TWO GROUND PADS TO ONE ANOTHER. SEE GROUNDING DIAGRAM.

13. INSTALL TWO GROUND RODS AND CONNECT ONE TO EACH GROUND PAD USING A MINIMUM OF #6 BARE COPPER WIRE. A #2 BARE COPPER MAY BE SUBSTITUTED FOR THE #6 AWG BARE COPPER WIRE IN SITUATIONS WHERE #6 AWG BARE COPPER WIRE IS NOT READILY AVAILABLE.

14. ATTACH THE CONCENTRIC NEUTRALS OF THE PRIMARY CABLES TO THE #2 AWG BTN COPPER WIRE (GROUND BUS) USING SPLIT BOLT CONNECTORS.

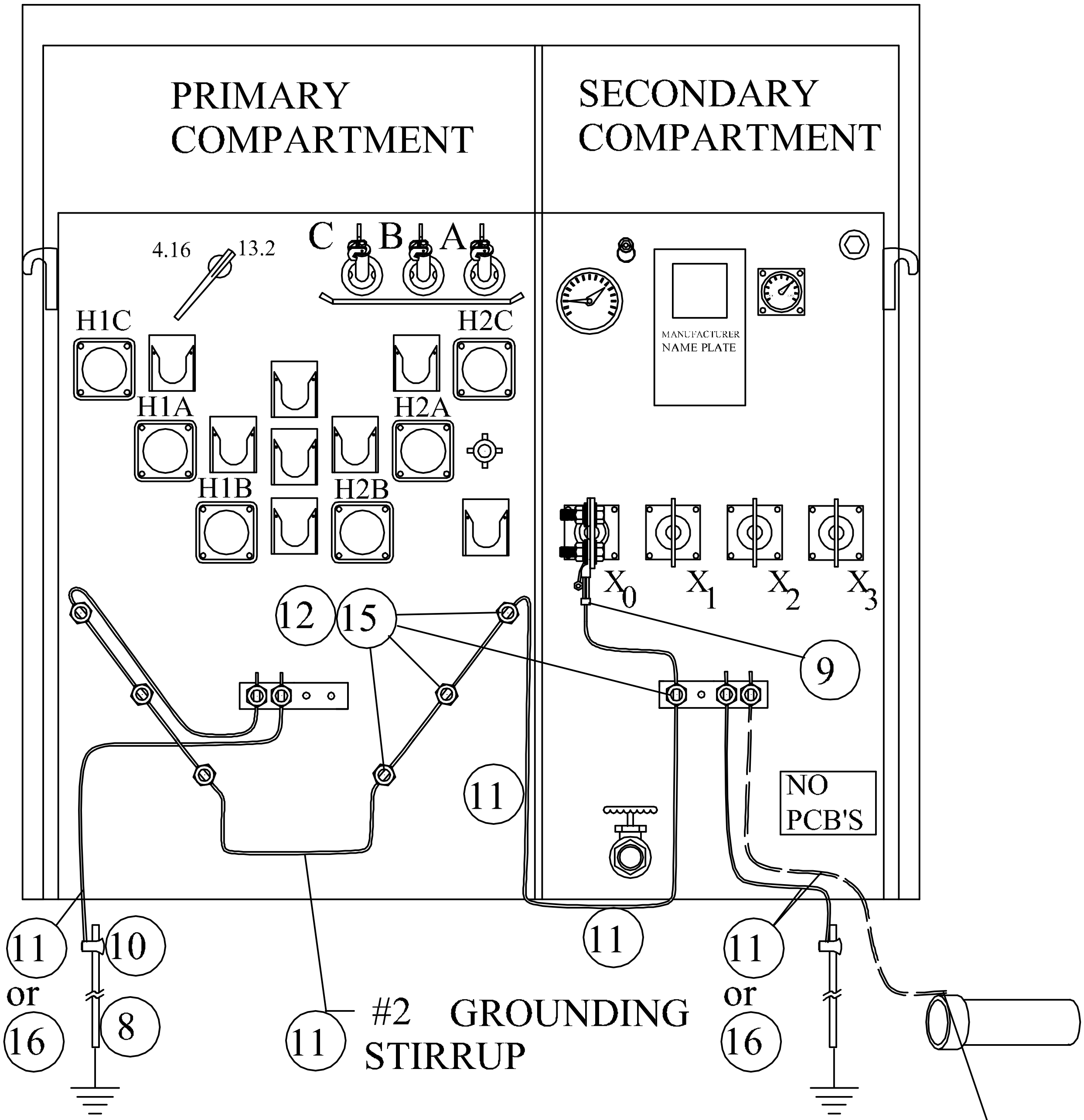
15. GROUND LEADS ASSOCIATED WITH SURGE PROTECTORS SHALL BE BONDED TO THE #2 AWG BTN COPPER WIRE (GROUND BUS) WITH HOT LINE CLAMPS AND LUGS (ITEM ID 121096 AND ITEM ID 143070).

16. BOND ALL METALLIC DUCT TO GROUND PAD.

17. PAD LOCATION SHALL BE IN ACCORDANCE WITH CS-5370 AND CS-5369.

REFERENCE STANDARDS:

D14-07-004	DISTRIBUTION EQUIPMENT DESCRIPTION; CONCRETE PADS & FOUNDATIONS.
CS 2030	UNDERGROUND CABLE TERMINATION IDENTIFICATION
CS 3722	LOADBREAK ELBOW TERMINATOR
CS 3727	INSTALLATION OF LOADBREAK BUSHING INSERT
CS 4020	3-PHASE TRANSFORMER FUSE REPLACEMENT GUIDE
CS 4028	SURGE PROTECTION, THREE PHASE RADIAL
CS 5369	PROTECTION FOR PAD MOUNT EQUIPMENT
CS 5370	TRANSFORMER PAD LOCATION ADJACENT TO BUILDINGS



GROUNDING DETAILS

BOND WIRE
FOR METALLIC
CONDUIT ONLY

REVISION	11.08/11: ADDED ITEM ID	TRANSFORMER INSTALLATION AND HOUSING CONSTRUCTION: PAD AND ENCLOSURE HOUSED 3 PHASE 4kV OR 13kV "DEAD FRONT" METAL CLAD TRANSFORMER 75-1500KVA FOR PRIMARY DISTRIBUTION	CONSTRUCTION STANDARD DRAWN BY AH NUMBER 5362 / SHEET No 5 of 6 / REV 11
LONG ISLAND POWER AUTHORITY prepared by National Grid Engineering & Survey, Inc.			

THREE PHASE PADMOUNTED TRANSFORMER SPECIFICATIONS

SECONDARY SPADE CONNECTION:

Description: Terminal Lug

1. Terminal Lug - compression Connector - Tinned Aluminum or Copper. For up to 750 MCM compressed or concentric copper or aluminum secondary cable. NEMA 2 - hole pad for 1/2 inch diameter bolts (stud size). Aluminum lug's bore shall be coated with oxide inhibiting compound and plugged. Connector shall be marked with manufacturer's name, cable size, type of conductor stranding and die index number. Connector barrel shall not have an inspection hole. Connector shall meet or exceed EEI-NEMA Standard TDJ-162, Class A-3.

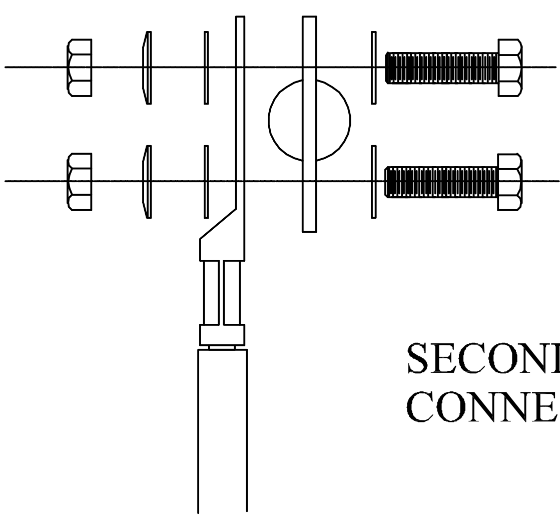
   Follow manufacturer's compression tool and die recommendations for installing terminal connectors. For an aluminum to copper connection, an additional bellville spring washer must be installed on the bolt side of the lug.

2. Lug to spade connection shall conform to the following:

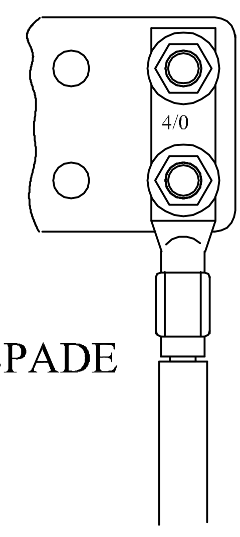
   a) All copper components shall be tin or alloy plated.

   b) Wire brush aluminum conductor and apply oxide inhibitor compound to aluminum lug pad prior to connection to transformer spade. All excess compound must be removed after lug is secured. (Not required for tinned copper lugs).

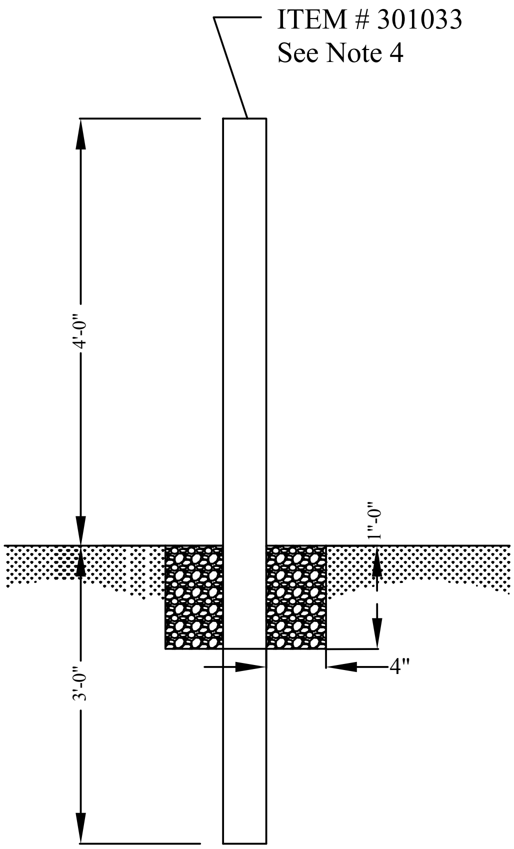
   c) Connect lug to transformer stud utilizing tinned or cadium plated silicon bronze or stainless steel hardware. Place concave side of bellville washer toward transformer stud. Recommended torque value for bolts: 480 in-lbs. for silicone bronze and 517 in-lbs. for stainless steel.



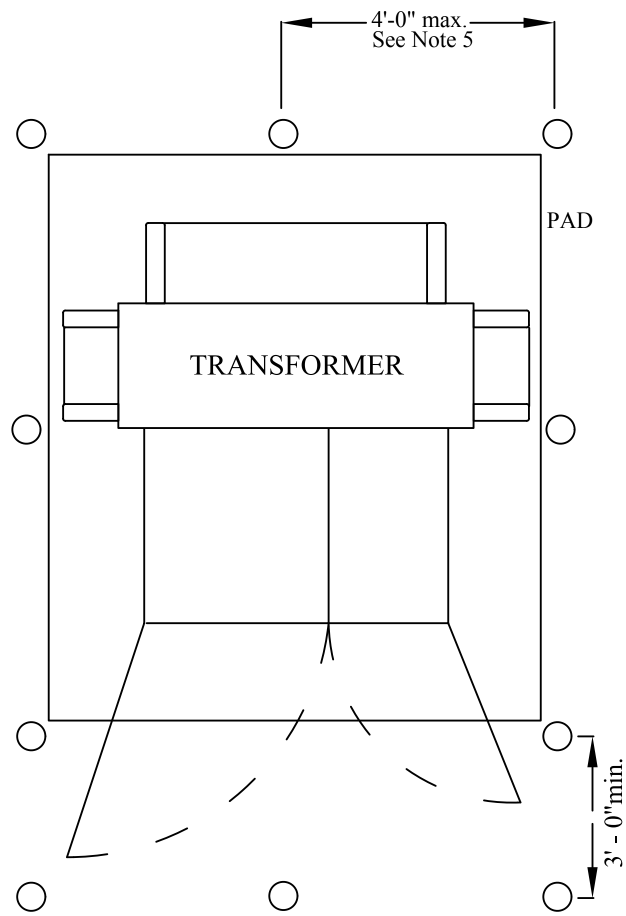
SECONDARY SPADE CONNECTION



REVISION	11.08/11: ADDED ITEM ID	TRANSFORMER INSTALLATION AND HOUSING CONSTRUCTION: PAD AND ENCLOSURE HOUSED	CONSTRUCTION STANDARD DRAWN BY AH		
LONG ISLAND POWER AUTHORITY prepared by National Grid Engineering & Survey, Inc.		3 PHASE 4kV OR 13kV "DEAD FRONT" METAL CLAD TRANSFORMER 75-1500KVA FOR PRIMARY DISTRIBUTION	NUMBER	SHEET No	REV
			5362	6 of 6	11



DETAIL "A"



Reference Drawings

CS-5362 Dead Front Transformers

NOTES:

1. This standard provides recommended barrier protection for pad mounted equipment subject to vehicular traffic.

2. Posts may be omitted on side (s) not subject to vehicular traffic.

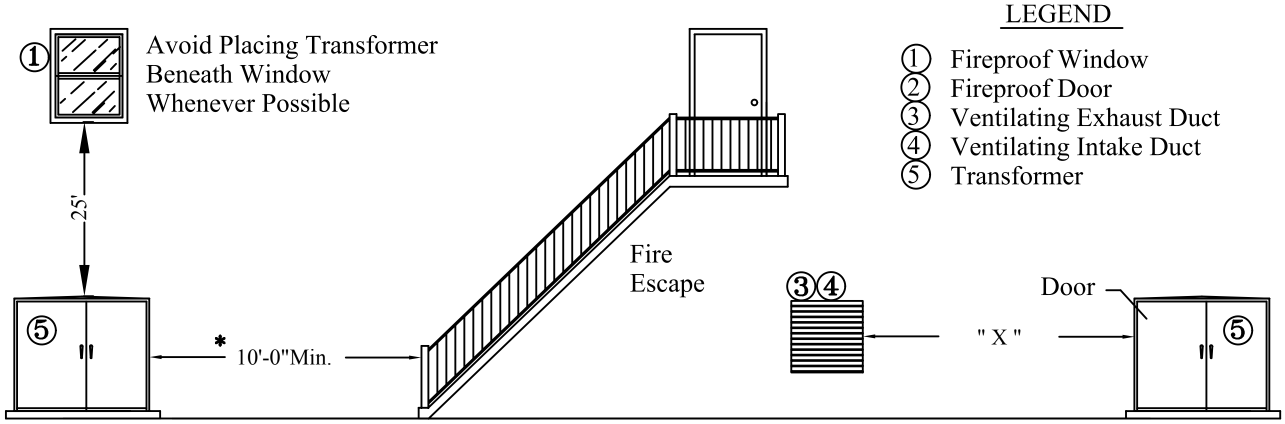
3. Barriers must not interfere with the operation of pad mount equipment by PSEG Long Island personnel.

4. A 3-1/2" heavy wall steel, concrete filled lally column purchased from local lumber yards is acceptable. Bearing plates must be removed. Set posts in concrete (see detail "A").

5. Install additional posts on sides or back as required to maintain maximum 48" spacing.

PSEG LONG ISLAND		REVISION	TRANSFORMER INSTALLATION AND HOUSING CONSTRUCTION PAD AND ENCLOSURE HOUSED	CONSTRUCTION STANDARD DRAWN BY AH		
APPROVED BY	DATE	7.04/14: CHANGED LIPA TO PSEG Long Island	PROTECTION FOR PAD MOUNT TRANSFORMER SUBJECT TO VEHICULAR TRAFFIC	NUMBER	SHEET No	REV
Richard Zambatti	5/15/14		DO NOT REVISE PRINT BY ANY OTHER METHOD THAN AUTO-CAD PREPARED BY: PSEG LONG ISLAND T&D ENGINEERING	5369	1 of 1	7

FIG 1



LEGEND

1. Fireproof Window
2. Fireproof Door
3. Ventilating Exhaust Duct
4. Ventilating Intake Duct
5. Transformer

FIG 2

* If This Is An Exit of A Public Building Such As An Auditorium, Change to 25 Feet.

If This Is A Combustible Door or Building Wall Change To 25 Feet.

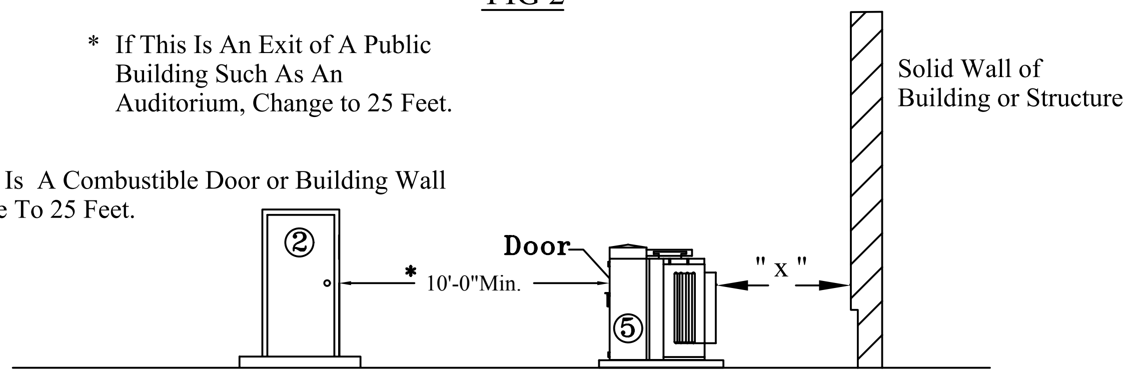


FIG 1 AND 2 SHOW MINIMUM CLEARANCES BETWEEN THE TRANSFORMER PAD AND WINDOWS, DOORS, FIRE ESCAPES, ENTRANCES AND VENTILATING DUCTS.

TABLE 1

Separation Distance	Horizontal Distance		Vertical Distance
	Fire Resistant or Non-Combustible Construction	Combustible Construction	All
x	5'	25'	25'

If the separation distances shown in table 1 cannot be maintained, a fire barrier must be provided to protect the building from exposure to any fire in the transformer. Fabricated barriers must be installed between the transformer and the building a minimum of 1 foot from the transformer pad. Barriers should be constructed of concrete block or reinforced concrete construction with a 2 hr fire rating (as specified by the building architect).

The barriers must extend at least one foot above the height of the transformer. The barrier should break the line of sight from the hightest point on the transformer to any point on the adjacent building (Fig. 3) closer than the distance in table 1.

Likewise, barriers must extend a minimum of 2 feet horizontally beyond the transformer, but be far enough to break the line of sight from the edge of the transformer to any point on the adjacent building (Fig. 4) closer than the distance in table 1.

PSEG LONG ISLAND	REVISION	TRANSFORMER INSTALLATION AND HOUSING CONSTRUCTION: PAD AND ENCLOSURE HOUSED	CONSTRUCTION STANDARD DRAWN BY AH		
APPROVED BY / DATE	11.02/14: UPDATE TITLE BLOCK & CHANGE REF. CS NUMBER	TRANSFORMER PAD LOCATION ADJACENT TO BUILDINGS	NUMBER	SHEET No	REV
[signature] 3/19/14		DO NOT REVISE PRINT BY ANY OTHER METHOD THAN AUTO-CAD PREPARED BY: PSEG LONG ISLAND T&D ENGINEERING	5370	1 of 2	11

FIG 3

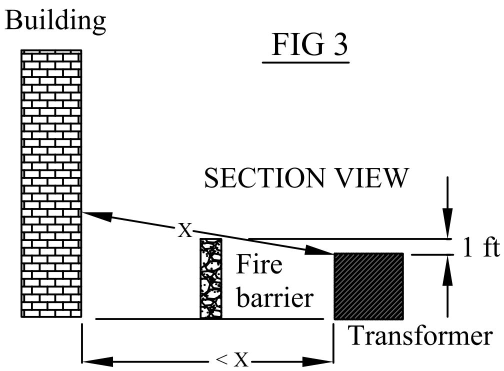
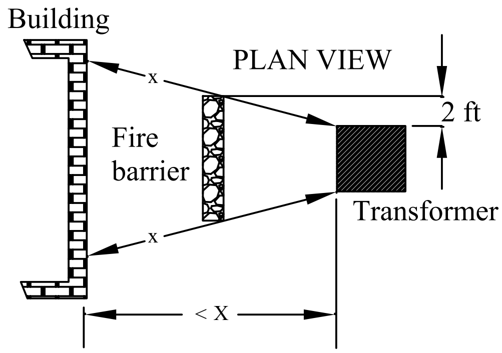


FIG 4



x = Minimum separation distance

NOTES:

1. PLACE TRANSFORMER SO THAT DOORS FACE AWAY FROM WALLS, FENCES OR OTHER FIXED STRUCTURES. 10' CLEARANCE REQUIRED IN FRONT OF THE DOORS

2. NO BUSHES, TREES, OR OTHER OBSTRUCTIONS SHALL BE PLANTED OR INSTALLED IN FRONT OF TRANSFORMER DOORS.

3. THE TRANSFORMER PAD LOCATION MUST BE ACCESSIBLE BY TRUCK AT ALL TIMES. NO PART OF THE BUILDING STRUCTURE SHALL EXTEND DIRECTLY ABOVE THE TRANSFORMER.

4. NO OPENINGS IN BUILDINGS OR STRUCTURE WILL BE PERMITTED WITHIN 10 FEET OF TRANSFORMER. BUILDING MATERIAL, INCLUDING DOOR AND WINDOWS LESS THAN 25 FEET FROM TRANSFORMER SHALL BE FIRE RESISTANT OR NON-COMBUSTIBLE MATERIAL.

5. CLASS 1, DIVISION 1 and 2 LOCATIONS SHALL REQUIRE A MINIMUM OF 25 FEET CLEARANCE (e.g. PROPANE TANKS, GAS PUMPS, ETC. OR ANY PLACE WHERE VOLATILE LIQUID / GAS TRANSFER FILLING OCCURS)
   [SEE NEC ARTICLES 500-5(a) (3) and 450-27]

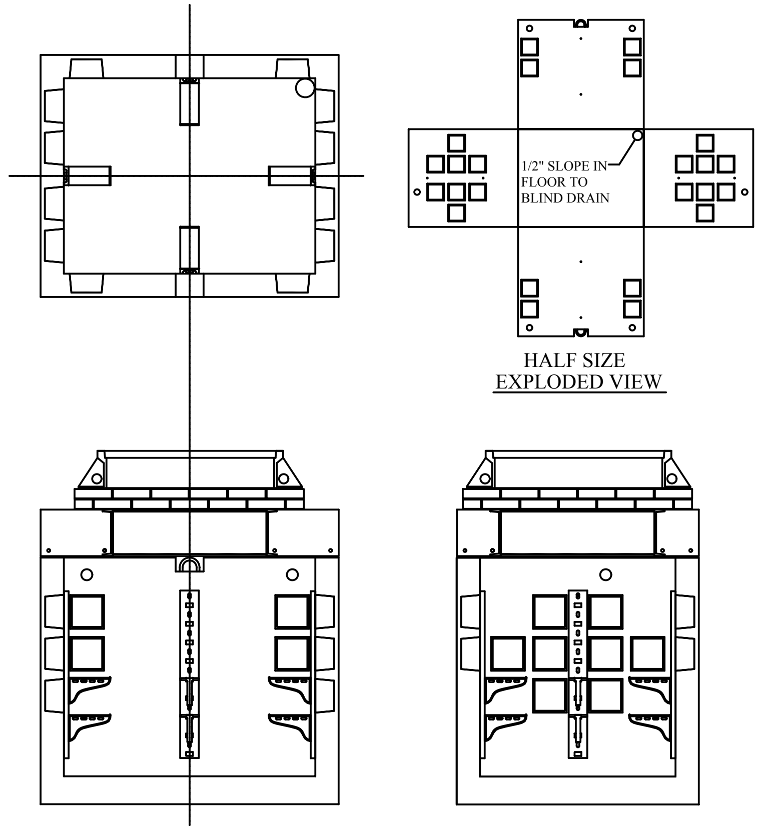
6. MAINTAIN AT LEAST 1 FOOT SEPARATION BETWEEN PADMOUNT TRANSFORMERS AND A GAS METER HEADER.

7. SUBMERSIBLE TRANSFORMERS IN BELOW GRADE VAULTS ARE NOT REQUIRED TO MEET THE ABOVE CLEARANCES FROM BUILDING WALLS. VAULTS MUST BE INSTALLED A MINIMUM OF 10' FROM ANY BUILDING WALLS TO ALLOW ADEQUATE WORKING SPACE FOR REMOVAL OF GRATES.

REFERENCE DRAWINGS

CS-3960 1Ø PADMOUNT TRANSFORMER 25-167kVA
CS-5315 3Ø 13kVA-4kV 1500kVA STEP- DOWN TRANSFORMER
CS-5320 3Ø PADMOUNT TRANSFORMERS 13kVA DEAD FRONT
CS-5322 500 and 1000kVA NETWORK TRANSFORMERS
CS-5325 1500 and 2000kVA NETWORK TRANSFORMERS
CS-5362 3Ø 4kVA or 13kVA 75 - 1500kVA " DEAD FRONT" TRANSFORMER

REVISION	11.02/14: UPDATE TITLE BLOCK & CHANGE CS NUMBER	TRANSFORMER INSTALLATION AND HOUSING CONSTRUCTION: PAD AND ENCLOSURE HOUSED	CONSTRUCTION STANDARD DRAWN BY AH		
prepared by PSEG LONG ISLAND T&D ENGINEERING		TRANSFORMER PAD LOCATION ADJACENT TO BUILDINGS	NUMBER	SHEET No	REV
			5370	2 of 2	11



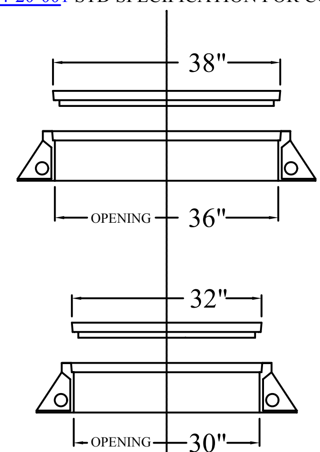
HALF SIZE
EXPLODED VIEW

OTHER RELATED ITEMS FOR INSTALLATION

GRADING BLOCK	ITEM ID 101053
COMMON BRICK	ITEM ID 101051
MORTAR READY MIX	ITEM ID 101094
RACK, NON-METALLIC 36" VERT. MEMBER	ITEM ID 174035
RACK, NON-METALLIC 8" HORIZ. ARM	ITEM ID 174046
RACK, NON-MET. INTEGRAL MOUNT 4" ARM	ITEM ID 174045
ANCHOR BOLT, "HILTI" 1/2"x1-1/2"	ITEM ID 103019
WASHER, BELVILLE, SS 1" O.D. W/1/2" HOLE	ITEM ID 198020
NYLON TIES, CABLE STRAPS 14"x1/2"	ITEM ID 101006

REFERENCE

CS-6533 TYPE TS BOX
PT-14-20-001 STD SPECIFICATION FOR CONCRETE



ITEM ID 131037
CASTIRON
(HIGHWAY RATED)

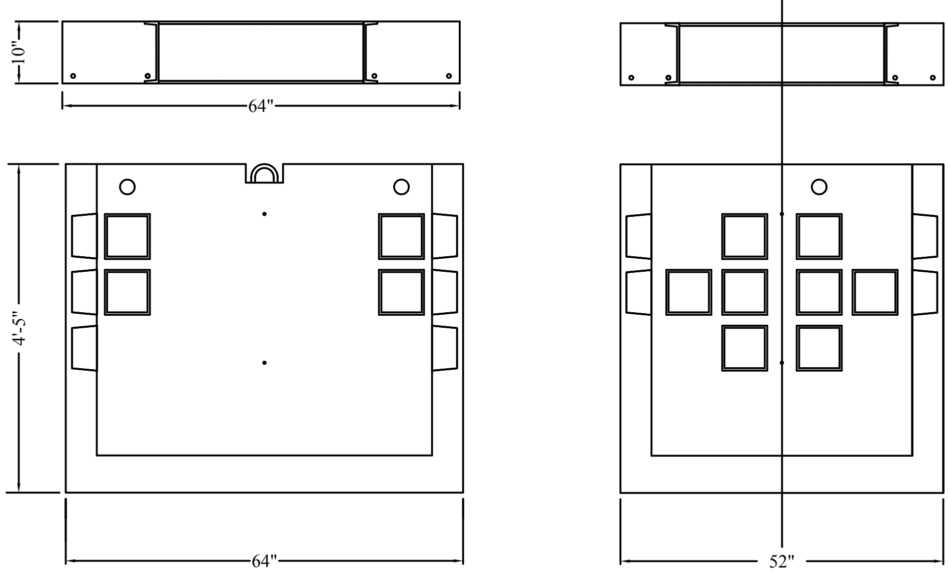
ITEM ID 131055

ITEM ID 131058
CASTIRON
(HIGHWAY RATED)

ITEM ID 131057

ITEM ID #131007

ITEM ID #131008



SECTION SIDE VIEW

SECTION END VIEW

PLAN LAYOUT

(WEIGHT OF BOX) less frame and cover
WALLS & FLOOR - 5,300 LBS.
ROOF................ - 3,100 LBS.

nationalgrid	LIPA Long Island Power Authority	REVISION	MANHOLES AND BOXES	CONSTRUCTION STANDARD
APPROVED BY / DATE	APPROVED BY / DATE	3.02/13: REVISED TITLE BLOCK & ADD ADA NOTE	TYPE TS DISTRIBUTION BOX 4'-6" x 3'-6" x 4'-0" PRECAST CONCRETE COMPONENTS	DRAWN BY AH
[signature] 03/22/13	[signature] 03/31/13			NUMBER 6548 / SHEET No 1 of 2 / REV 3

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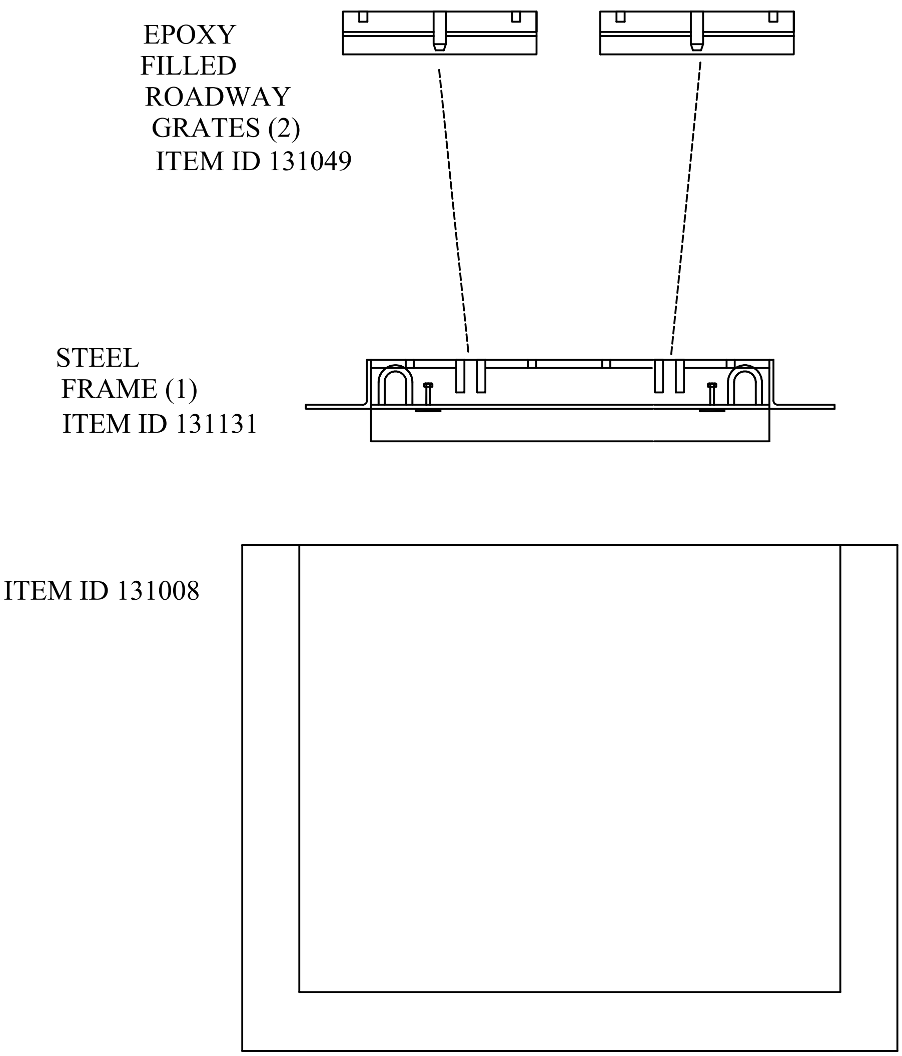
PREPARED BY: National Grid Engineering & Survey, Inc.

Optional installation with rectangular grates



Reference:

PT-25-10-004 Rectangular gratings for manholes.
PT-25-10-005 Frames for rectangular gratings.

When the MH is installed in walkway, orient gratings with long openings perpendicular to the dominant direction of travel to comply with the Americans with Disabilities Act requirements.

REVISION		MANHOLES AND BOXES	CONSTRUCTION STANDARD
	3. 02/13: REVISED TITLE BLOCK & ADD ADA NOTE.	TYPE TS DISTRIBUTION BOX 4'-6" x 3'-6" x 4'-0" PRECAST CONCRETE COMPONENTS	DRAWN BY AH
LONG ISLAND POWER AUTHORITY prepared by nationalgrid			NUMBER 6548 / SHEET No 2 of 2 / REV 3

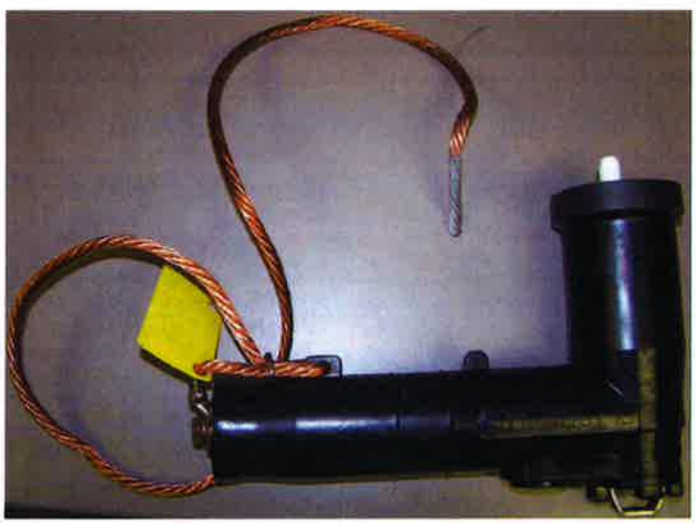
DISTRIBUTION
MATERIAL & STANDARDS
BULLETIN

DATE: June 14, 2007 DM&S 07-05

TO: Electric Design and Construction Department, Electric Service Department, T&D Project Management Department, Purchasing & Materials Management Department

SUBJECT: **Elastimold** Elbow Lightning Arresters (Item ID: 105213)

DESCRIPTION: Recently, we have received **Elastimold** elbow lightning arresters which have the ground lead of the arrester attached to the semi-con body through an eyehole prepared by the manufacturer. This design allows the ground braid to remain attached to the body if the arrester operates and the "bottom" blows off. This connection will replace the installation of the traditional Bare, Solid #10 Copper wire attached to the eyehole on **Elastimold** arresters only (including **Elastimold** Parking Arresters, Item ID: 105212). Continue to run a solid #10 through the eyehole on all other elbow-type lightning arresters.



Louis M. DeBrino

Louis M. DeBrino, Director
Performance Engineering

HAVE A TECHNICAL QUESTION ? PLEASE ASK !!!
CALL – TONY VOTA (516-545-4902)
http://webserver/p/TDE/indexDPE.htm

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Copper building wire rated 600 V or less.
1.2.1.2 Aluminum building wire rated 600 V or less.
1.2.1.3 Tray cable, Type TC, rated 600 V or less.
1.2.1.4 Fire-alarm wire and cable.
1.2.1.5 Connectors, splices, and terminations rated 600 V and less.

1.2.2 Related Requirements:

1.2.2.1 Section 26 05 23 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

1.3 DEFINITIONS

1.3.1 RoHS: Restriction of Hazardous Substances.

1.3.2 VFC: Variable-frequency controller.

1.3.3 VFD: Variable Frequency Drive.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of product.

1.4.2 Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Qualification Data: For manufacturer's authorized service representative.

1.5.2 Field quality-control reports.

1.6 QUALITY ASSURANCE

1.6.1 Testing Agency Qualifications: Member company of NETA.

1.6.1.1 Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

2.1.1 Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

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

2.1.2.1 Alpha Wire Company.
2.1.2.2 Belden Inc.
2.1.2.3 Okonite Company (The).
2.1.2.4 Southwire Company.
2.1.2.5 WESCO.

2.1.3 Standards:

2.1.3.1 Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2.1.3.2 RoHS compliant.
2.1.3.3 Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

2.1.4 Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B496 for stranded conductors.

2.1.5 Conductor Insulation:

2.1.5.1 Type USE-2 and Type SE: Comply with UL 854.
2.1.5.2 Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
2.1.5.3 Type THHN and Type THWN-2: Comply with UL 83.
2.1.5.4 Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
2.1.5.5 Type UF: Comply with UL 83 and UL 493.

2.1.6 Shield:

2.1.6.1 Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.

2.2 TRAY CABLE, TYPE TC

2.2.1 Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.

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

2.2.2.1 Alpha Wire Company.
2.2.2.2 Belden Inc.
2.2.2.3 Okonite Company (The).
2.2.2.4 Southwire Company.
2.2.2.5 WESCO.

2.2.3 Standards:

2.2.3.1 Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2.2.3.2 RoHS compliant.
2.2.3.3 Comply with UL 1277.
2.2.3.4 Comply with ICEA S-73-532/NEMA WC 57 for Type TC cables used for control, thermocouple extension, and instrumentation.
2.2.3.5 Comply with ICEA S-95-658/NEMA WC 70 for Type TC cables used for power distribution.
2.2.3.6 Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

2.2.4 Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

2.2.5 Ground Conductor: Insulated.

2.2.6 Conductor Insulation: Type XHHW-2. Comply with UL 44.

2.2.7 Shield: Metallic.

2.3 FIRE-ALARM WIRE AND CABLE

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

2.3.1.1 Allied Wire & Cable Inc.
2.3.1.2 Draka Cableteq USA; a Prysmian Group company.
2.3.1.3 Genesis Cable Products; Honeywell International, Inc.
2.3.1.4 Rockbestos-Suprenant Cable Corp.
2.3.1.5 Superior Essex Inc.
2.3.1.6 West Penn Wire.

2.3.2 Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.

2.3.2.1 Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

2.3.3 Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

2.3.3.1 Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2.3.3.2 Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

2.3.3.3 Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper shielded with overall outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.4 CONNECTORS AND SPLICES

2.4.1 Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

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

2.4.2.1 3M Electrical Products.
2.4.2.2 AFC Cable Systems; a part of Atkore International.
2.4.2.3 Hubbell Power Systems, Inc.
2.4.2.4 Ideal Industries, Inc.
2.4.2.5 ILSCO.
2.4.2.6 O-Z/Gedney; a brand of Emerson Industrial Automation.
2.4.2.7 Thomas & Betts Corporation; A Member of the ABB Group.

2.4.3 Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

2.4.4 Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

2.4.4.1 Material: Copper.
2.4.4.2 Type: Two hole with standard / long barrels.
2.4.4.3 Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

3.1.1 Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.1.2 Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.1.3 Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.1.4 Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

3.1.5 VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

3.1.6 Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.1.7 PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

3.2.1 Service Entrance: Type USE, single conductor in raceway Multiconductor cable, Type SE.

3.2.2 Exposed Feeders: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway.

3.2.3 Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

3.2.4 Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway Underground feeder cable, Type UF.

3.2.5 Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.

3.2.6 Feeders in Cable Tray: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors larger than No. 1/0 AWG.

3.2.7 Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

3.2.8 Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

3.2.9 Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

3.2.10 Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.

3.2.11 Branch Circuits in Cable Tray: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors larger than No. 1/0 AWG.

3.2.12 Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.2.13 VFC Output Circuits: Type XHHW-2 in metal conduit / Type TC-ER cable with braided shield.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

3.3.1 Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

3.3.2 Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

3.3.3 Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

3.3.4 Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

3.3.5 Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

3.3.6 Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.3.7 Complete cable tray systems installation according to Section 26 05 36 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 INSTALLATION OF FIRE-ALARM WIRING

3.4.1 Comply with NECA 1 and NFPA 72.

3.4.2 Wiring Method: Install wiring in metal pathway:

3.4.2.1 Install plenum cable in environmental airspaces, including plenum ceilings.
3.4.2.2 Fire-alarm circuits and equipment control wiring associated with fire-alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.

3.4.3 Wiring Method:

3.4.3.1 Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
3.4.3.2 Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types “FPL” Cables.
3.4.3.3 Signaling Line Circuits: Power-limited fire-alarm cables may be installed in the same cable or pathway as signaling line circuits.

3.4.4 Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.4.5 Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

3.4.6 Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

3.4.7 Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.

3.4.8 Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 CONNECTIONS

3.5.1 Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.5.2 Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.5.2.1 Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

3.5.3 Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.6 IDENTIFICATION

3.6.1 Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

3.6.2 Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

3.7.1 Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIELD QUALITY CONTROL

3.8.1 Testing Agency: Navy will engage a qualified testing agency to perform tests and inspections.

3.8.2 Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.8.3 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.8.4 Perform tests and inspections with the assistance of a factory-authorized service representative.

3.8.4.1 After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

3.8.4.2 After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:

3.8.4.3 Perform each of the following visual and electrical tests:

3.8.4.3.1 Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.

3.8.4.3.2 Test bolted connections for high resistance using one of the following:

3.8.4.3.2.1 A low-resistance ohmmeter.

3.8.4.3.2.2 Calibrated torque wrench.
3.8.4.3.2.3 Thermographic survey.

3.8.4.3.3 Inspect compression-applied connectors for correct cable match and indentation.
3.8.4.3.4 Inspect for correct identification.
3.8.4.3.5 Inspect cable jacket and condition.
3.8.4.3.6 Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
3.8.4.3.7 Continuity test on each conductor and cable.
3.8.4.3.8 Uniform resistance of parallel conductors.

3.8.4.4 Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

3.8.4.4.1 Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3.8.4.4.2 Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.8.4.5 Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.8.5 Cables will be considered defective if they do not pass tests and inspections.

3.8.6 Prepare test and inspection reports to record the following:

3.8.6.1 Procedures used.
3.8.6.2 Results that comply with requirements.
3.8.6.3 Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 26 05 23

CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Backboards.
1.2.1.2 Category 6 balanced twisted pair cable.
1.2.1.3 Category 6a balanced twisted pair cable.
1.2.1.4 Balanced twisted pair cabling hardware.
1.2.1.5 RS-485 cabling.
1.2.1.6 Low-voltage control cabling.
1.2.1.7 Control-circuit conductors.
1.2.1.8 Identification products.

1.3 DEFINITIONS

1.3.1 EMI: Electromagnetic interference.

1.3.2 Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

1.3.3 Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

1.3.4 RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.

1.5.2 Source quality-control reports.

1.5.3 Field quality-control reports.

1.6 QUALITY ASSURANCE

1.6.1 Testing Agency Qualifications: Accredited by NETA.

1.6.1.1 Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.1.2 Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

2.1.2.1 Flame Travel Distance: 60 inches or less.
2.1.2.2 Peak Optical Smoke Density: 0.5 or less.
2.1.2.3 Average Optical Smoke Density: 0.15 or less.

2.1.3 Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

2.1.4 Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.1.5 RoHS compliant.

2.2 BACKBOARDS

2.2.1 Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 06 10 00 "Rough Carpentry."

2.2.2 Painting: Paint plywood on all sides and edges with flat / eggshell latex paint. Comply with requirements in Section 09 91 23 "Interior Painting."

2.3 CATEGORY 6 BALANCED TWISTED PAIR CABLE

2.3.1 Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

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

2.3.2.1 3M.
2.3.2.2 Belden CDT Networking Division/NORDX.

2.3.2.3 Berk-Tek Leviton; a Nexans/Leviton alliance.
2.3.2.4 Draka USA.
2.3.2.5 General Cable; General Cable Corporation.
2.3.2.6 Genesis Cable Products; Honeywell International, Inc.
2.3.2.7 Hitachi Cable America Inc.
2.3.2.8 Mohawk; a division of Belden Networking, Inc.
2.3.2.9 Superior Essex Inc.

2.3.3 Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

2.3.4 Conductors: 100-ohm, 23 AWG solid copper.

2.3.5 Shielding/Screening: Unshielded twisted pairs (UTP) Shielded twisted pairs (FTP) Screened twisted pairs (F/UTP) Screened and shielded twisted pairs (F/FTP).

2.3.6 Cable Rating: Plenum.

2.3.7 Jacket: Blue / Yellow thermoplastic.

2.4 CATEGORY 6a BALANCED TWISTED PAIR CABLE

2.4.1 Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.

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

2.4.2.1 3M.
2.4.2.2 Belden CDT Networking Division/NORDX.
2.4.2.3 Berk-Tek Leviton; a Nexans/Leviton alliance.
2.4.2.4 Draka USA.
2.4.2.5 General Cable; General Cable Corporation.
2.4.2.6 Genesis Cable Products; Honeywell International, Inc.
2.4.2.7 Hitachi Cable America Inc.
2.4.2.8 Mohawk; a division of Belden Networking, Inc.
2.4.2.9 Superior Essex Inc.

2.4.3 Standard: Comply with TIA-568-C.2 for Category 6a cables.

2.4.4 Conductors: 100-ohm, 23 AWG solid copper.

2.4.5 Shielding/Screening: Unshielded twisted pairs (UTP) Shielded twisted pairs (FTP) Screened twisted pairs (F/UTP) Screened and shielded twisted pairs (F/FTP).

2.4.6 Cable Rating: Plenum.

2.4.7 Jacket: Gray/ Blue thermoplastic.

2.5 BALANCED TWISTED PAIR CABLE HARDWARE

2.5.1 Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

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

- 2.5.2.1 3M.
- 2.5.2.2 AMP NETCONNECT; a TE Connectivity Ltd. company.
- 2.5.2.3 Belden CDT Networking Division/NORDX.
- 2.5.2.4 Berk-Tek Leviton; a Nexans/Leviton alliance.
- 2.5.2.5 Draka USA.
- 2.5.2.6 General Cable; General Cable Corporation.
- 2.5.2.7 Genesis Cable Products; Honeywell International, Inc.
- 2.5.2.8 Hubbell Premise Wiring.
- 2.5.2.9 Leviton Manufacturing Co., Inc.
- 2.5.2.10 Mohawk; a division of Belden Networking, Inc.
- 2.5.2.11 Panduit Corp.
- 2.5.2.12 Siemon Co. (The).
- 2.5.2.13 Superior Essex Inc.

2.5.3 General Requirements for Balanced Twisted Pair Cable Hardware:

- 2.5.3.1 Comply with the performance requirements of Category 6 / Category 6a.
- 2.5.3.2 Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
- 2.5.3.3 Cables shall be terminated with connecting hardware of same category or higher.

2.5.4 Source Limitations: Obtain balanced twisted pair cable hardware from same manufacturer as balanced twisted pair cable, from single source.

2.5.5 Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

2.5.6 Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

- 2.5.6.1 Number of Terminals per Field: One for each conductor in assigned cables.

2.5.7 Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

- 2.5.7.1 Features:
  - 2.5.7.1.1 Universal T568A and T568B wiring labels.
  - 2.5.7.1.2 Labeling areas adjacent to conductors.
  - 2.5.7.1.3 Replaceable connectors.
  - 2.5.7.1.4 24 or 48 ports.
- 2.5.7.2 Construction: 16-gauge steel and mountable on 19-inch equipment racks.
- 2.5.7.3 Number of Jacks per Field: One for each four-pair cable indicated.

2.5.8 Patch Cords: Factory-made, four-pair cables in 48-inchlengths; terminated with an eight-position modular plug at each end.

- 2.5.8.1 Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
- 2.5.8.2 Patch cords shall have color-coded boots for circuit identification.

2.5.9 Plugs and Plug Assemblies:

2.5.9.1 Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
2.5.9.2 Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
2.5.9.3 Marked to indicate transmission performance.

2.5.10 Jacks and Jack Assemblies:

2.5.10.1 Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
2.5.10.2 Designed to snap-in to a patch panel or faceplate.
2.5.10.3 Standards:

2.5.10.3.1 Category 6, unshielded balanced twisted pair cable shall comply with IEC 60603-7-4.
2.5.10.3.2 Category 6, shielded balanced twisted pair cable shall comply with IEC 60603-7.5.
2.5.10.3.3 Category 6a, unshielded balanced twisted pair cable shall comply with IEC 60603-7-41.
2.5.10.3.4 Category 6a, shielded balanced twisted pair cable shall comply with IEC 60603-7.51.

2.5.10.4 Marked to indicate transmission performance.

2.5.11 Faceplate:

2.5.11.1 Four port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2.5.11.2 Eight port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
2.5.11.3 Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
2.5.11.4 Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."
2.5.11.5 For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

2.5.11.5.1 Flush mounting jacks, positioning the cord at a 45-degree angle.

2.5.12 Legend:

2.5.12.1 Machine printed, in the field, using adhesive-tape label.
2.5.12.2 Snap-in, clear-label covers and machine-printed paper inserts.

2.6 TWIN-AXIAL DATA HIGHWAY CABLE

2.6.1 Standard Cable: NFPA 70, Type CM.

2.6.1.1 Paired, 6 pairs, No. 20 AWG, stranded (7x28) tinned-copper conductors.
2.6.1.2 Polypropylene insulation.
2.6.1.3 Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
2.6.1.4 PVC jacket.

2.6.1.5 Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
2.6.1.6 Flame Resistance: Comply with UL 1685.

2.6.2 Plenum-Rated Cable: NFPA 70, Type CMP.

2.6.2.1 Paired, 6 pairs, No. 20 AWG, stranded (7x28) tinned-copper conductors.
2.6.2.2 Plastic insulation.
2.6.2.3 Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
2.6.2.4 Plastic jacket.
2.6.2.5 Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
2.6.2.6 Flame Resistance: Comply with NFPA 262.

2.7 RS-232 CABLE

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

2.7.1.1 Allied Wire & Cable Inc.
2.7.1.2 Belden Inc.
2.7.1.3 General Cable Technologies Corporation.
2.7.1.4 Genesis Cable Products; Honeywell International, Inc.
2.7.1.5 Southwire Company.

2.7.2 PVC-Jacketed, TIA 232-F:

2.7.2.1 Nine, No. 22 AWG, stranded (7x30) tinned copper conductors.
2.7.2.2 Polypropylene insulation.
2.7.2.3 Aluminum foil-polyester tape shield with 100 percent shield coverage.
2.7.2.4 PVC jacket.
2.7.2.5 Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
2.7.2.6 NFPA 70 Type: Type CM.
2.7.2.7 Flame Resistance: Comply with UL 1581.

2.7.3 Plenum-Type, TIA 232-F:

2.7.3.1 Nine, No. 22 AWG, stranded (7x30) tinned copper conductors.
2.7.3.2 PE insulation.
2.7.3.3 Aluminum foil-polyester tape shield with 100 percent shield coverage.
2.7.3.4 Fluorinated ethylene propylene jacket.
2.7.3.5 Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
2.7.3.6 Flame Resistance: Comply with NFPA 262.

2.8 RS-485 CABLE

2.8.1 Standard Cable: NFPA 70, Type CMG.

2.8.1.1 Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2.8.1.2 PVC insulation.
2.8.1.3 Unshielded.

2.8.1.4 PVC jacket.
2.8.1.5 Flame Resistance: Comply with UL 1685.

2.8.2 Plenum-Rated Cable: NFPA 70, Type CMP.

2.8.2.1 Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2.8.2.2 Fluorinated ethylene propylene insulation.
2.8.2.3 Unshielded.
2.8.2.4 Fluorinated ethylene propylene jacket.
2.8.2.5 Flame Resistance: NFPA 262.

2.9 LOW-VOLTAGE CONTROL CABLE

2.9.1 Paired Cable: NFPA 70, Type CMG.

2.9.1.1 Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2.9.1.2 PVC insulation.
2.9.1.3 Unshielded.
2.9.1.4 PVC jacket.
2.9.1.5 Flame Resistance: Comply with UL 1685.

2.9.2 Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

2.9.2.1 Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2.9.2.2 PVC insulation.
2.9.2.3 Unshielded.
2.9.2.4 PVC jacket.
2.9.2.5 Flame Resistance: Comply with NFPA 262.

2.10 CONTROL-CIRCUIT CONDUCTORS

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

2.10.1.1 Encore Wire Corporation.
2.10.1.2 General Cable; General Cable Corporation.
2.10.1.3 Service Wire Co.
2.10.1.4 Southwire Company.

2.10.2 Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

2.10.3 Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway / power-limited tray cable, in cable tray.

2.10.4 Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway power-limited tray cable, in cable tray Type TW or Type TF, complying with UL 83, in raceway.

2.10.5 Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

2.10.5.1 Smoke control signaling and control circuits.

2.11 FIRE-ALARM WIRE AND CABLE

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

2.11.1.1 Allied Wire & Cable Inc.
2.11.1.2 Draka Cableteq USA; a Prysmian Group company.
2.11.1.3 Genesis Cable Products; Honeywell International, Inc.
2.11.1.4 Superior Essex Inc.
2.11.1.5 West Penn Wire.

2.11.2 General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

2.11.3 Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG or size as recommended by system manufacturer.

2.11.3.1 Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

2.11.4 Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

2.11.4.1 Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2.11.4.2 Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
2.11.4.3 Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.12 SOURCE QUALITY CONTROL

2.12.1 Testing Agency: Engage a qualified testing agency to evaluate cables.

2.12.2 Factory test twisted pair cables according to TIA-568-C.2.

2.12.3 Cable will be considered defective if it does not pass tests and inspections.

2.12.4 Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Test cables on receipt at Project site.

3.1.1.1 Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

3.2.1 Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

3.2.1.1 Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
3.2.1.2 Outlet boxes for cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
3.2.1.3 Flexible metal conduit shall not be used.

3.2.2 Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

3.2.3 Install manufactured conduit sweeps and long-radius elbows if possible.

3.2.4 Raceway Installation in Equipment Rooms:

3.2.4.1 Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
3.2.4.2 Install cable trays to route cables if conduits cannot be located in these positions.
3.2.4.3 Secure conduits to backboard if entering the room from overhead.
3.2.4.4 Extend conduits 3 inches above finished floor.
3.2.4.5 Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.2.5 Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

3.3.1 Comply with NECA 1.

3.3.2 General Requirements for Cabling:

3.3.2.1 Comply with TIA-568-C Series of standards.
3.3.2.2 Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3.3.2.3 Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
3.3.2.4 Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
3.3.2.5 Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
3.3.2.6 Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
3.3.2.7 Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
3.3.2.8 Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
3.3.2.9 Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.

3.3.2.10 Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
3.3.2.11 Support: Do not allow cables to lie on removable ceiling tiles.
3.3.2.12 Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
3.3.2.13 Provide strain relief.
3.3.2.14 Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
3.3.2.15 Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

3.3.3 Balanced Twisted Pair Cable Installation:

3.3.3.1 Comply with TIA-568-C.2.
3.3.3.2 Do not untwist balanced twisted pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

3.3.4 Installation of Control-Circuit Conductors:

3.3.4.1 Install wiring in raceways.
3.3.4.2 Use insulated spade lugs for wire and cable connection to screw terminals.
3.3.4.3 Comply with requirements specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

3.3.5 Open-Cable Installation:

3.3.5.1 Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
3.3.5.2 Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
3.3.5.3 Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

3.3.6 Installation of Cable Routed Exposed under Raised Floors:

3.3.6.1 Install plenum-rated cable only.
3.3.6.2 Install cabling after the flooring system has been installed in raised floor areas.
3.3.6.3 Below each feed point, neatly coil a minimum of 72 inches of cable in a coil not less than 12 inches in diameter.

3.3.7 Separation from EMI Sources:

3.3.7.1 Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
3.3.7.2 Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

3.3.7.2.1 Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
3.3.7.2.2 Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
3.3.7.2.3 Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.

3.3.7.3 Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

3.3.7.3.1 Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
3.3.7.3.2 Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
3.3.7.3.3 Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.

3.3.7.4 Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

3.3.7.4.1 Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
3.3.7.4.2 Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
3.3.7.4.3 Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.

3.3.7.5 Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
3.3.7.6 Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 REMOVAL OF CONDUCTORS AND CABLES

3.4.1 Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

3.5.1 Minimum Conductor Sizes:

3.5.1.1 Class 1 remote-control and signal circuits; No 14 AWG.
3.5.1.2 Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3.5.1.3 Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

3.6.1 Comply with TIA-569-D, Annex A, "Firestopping."

3.6.2 Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

3.7.1 For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

3.7.2 For low-voltage control wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

3.8.1 Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.8.2 Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.8.3 Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.9 FIELD QUALITY CONTROL

3.9.1 Testing Agency: Navy will engage a qualified testing agency to perform tests and inspections.

3.9.2 Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.9.3 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.9.4 Perform tests and inspections with the assistance of a factory-authorized service representative.

3.9.5 Tests and Inspections:

3.9.5.1 Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.

3.9.5.2 Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3.9.5.3 Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

3.9.5.3.1 Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

3.9.6 Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

3.9.7 End-to-end cabling will be considered defective if it does not pass tests and inspections.

3.9.8 Prepare test and inspection reports.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section includes grounding and bonding systems and equipment.

1.2.2 Section includes grounding and bonding systems and equipment, plus the following special applications:

1.2.2.1 Underground distribution grounding.
1.2.2.2 Ground bonding common with lightning protection system.
1.2.2.3 Foundation steel electrodes.

1.3 ACTION SUBMITTALS

1.3.1 Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

1.4.1 Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

1.4.1.1 Test wells.
1.4.1.2 Ground rods.
1.4.1.3 Ground rings.
1.4.1.4 Grounding arrangements and connections for separately derived systems.

1.4.2 Qualification Data: For testing agency and testing agency's field supervisor.

1.4.3 Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

1.5.1 Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1.5.1.1 In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1.5.1.1.1 Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:

1.5.1.1.1.1 Test wells.
1.5.1.1.1.2 Ground rods.
1.5.1.1.1.3 Ground rings.
1.5.1.1.1.4 Grounding arrangements and connections for separately derived systems.

1.5.1.1.2 Instructions for periodic testing and inspection of grounding features at test wells / ground rings / grounding connections for separately derived systems based on NFPA 70B.

1.5.1.1.2.1 Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
1.5.1.1.2.2 Include recommended testing intervals.

1.6 QUALITY ASSURANCE

1.6.1 Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.1.2 Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

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

2.2.1.1 Advanced Lightning Technology, Ltd.
2.2.1.2 Burndy; Part of Hubbell Electrical Systems.
2.2.1.3 ERICO; a brand of nVent.
2.2.1.4 Galvan Industries, Inc.; Electrical Products Division, LLC.
2.2.1.5 Harger Lightning & Grounding.
2.2.1.6 ILSCO.
2.2.1.7 O-Z/Gedney; a brand of Emerson Industrial Automation.
2.2.1.8 Siemens Industry, Inc., Energy Management Division.
2.2.1.9 Thomas & Betts Corporation; A Member of the ABB Group.

2.3 CONDUCTORS

2.3.1 Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

2.3.2 Bare Copper Conductors:

2.3.2.1 Solid Conductors: ASTM B3.
2.3.2.2 Stranded Conductors: ASTM B8.
2.3.2.3 Tinned Conductors: ASTM B33.
2.3.2.4 Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
2.3.2.5 Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
2.3.2.6 Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
2.3.2.7 Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3.3 Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

2.4.1 Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

2.4.2 Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4.3 Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.4.4 Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

2.4.5 Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

2.4.6 Cable-to-Cable Connectors: Compression type, copper or copper alloy.

2.4.7 Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

2.4.8 Conduit Hubs: Mechanical type, terminal with threaded hub.

2.4.9 Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

2.4.10 Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

2.4.11 Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

2.4.12 Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

2.4.13 Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

2.4.14 Straps: Solid copper, copper lugs. Rated for 600 A.

2.4.15 Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal two-piece clamp.

2.4.16 U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

2.4.17 Water Pipe Clamps:

2.4.17.1 Mechanical type, two pieces with zinc-plated bolts.

2.4.17.1.1 Material: Die-cast zinc alloy.
2.4.17.1.2 Listed for direct burial.

2.4.17.2 U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.5 GROUNDING ELECTRODES

2.5.1 Ground Rods: Copper-clad Zinc-coated steel, sectional type; 5/8 by 96 inches.

2.5.2 Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.

2.5.2.1 Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches long.
2.5.2.2 Backfill Material: Electrode manufacturer's recommended material.

2.5.3 Ground Plates: 1/4 inch thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

3.1.1 Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

3.1.2 Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

3.1.2.1 Bury at least 30 inches below grade.
3.1.2.2 Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

3.1.3 Grounding Conductors: Green-colored insulation with continuous yellow stripe.

3.1.4 Isolated Grounding Conductors: Green-colored insulation with more than one continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

3.1.5 Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

3.1.5.1 Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
3.1.5.2 Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.1.6 Conductor Terminations and Connections:

3.1.6.1 Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
3.1.6.2 Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3.1.6.3 Connections to Ground Rods at Test Wells: Bolted connectors.
3.1.6.4 Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

3.2.1 Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

3.3.1 Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

3.4.1 Comply with IEEE C2 grounding requirements.

3.4.2 Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

3.4.3 Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.4.4 Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 EQUIPMENT GROUNDING

3.5.1 Install insulated equipment grounding conductors with all feeders and branch circuits.

3.5.2 Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

3.5.2.1 Feeders and branch circuits.
3.5.2.2 Lighting circuits.
3.5.2.3 Receptacle circuits.

3.5.2.4 Single-phase motor and appliance branch circuits.
3.5.2.5 Three-phase motor and appliance branch circuits.
3.5.2.6 Flexible raceway runs.
3.5.2.7 Armored and metal-clad cable runs.
3.5.2.8 Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

3.5.3 Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

3.5.4 Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.5.5 Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

3.5.6 Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

3.5.7 Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.5.8 Metallic Fences: Comply with requirements of IEEE C2.

3.5.8.1 Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
3.5.8.2 Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
3.5.8.3 Barbed Wire: Strands shall be bonded to the grounding conductor.

3.6 FENCE GROUNDING

3.6.1 Fence Grounding: Install at maximum intervals of 1500 feet or a lesser distance if grounding resistance is high except as follows:

3.6.1.1 Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet or a lesser distance if grounding resistance is high.

3.6.1.1.1 Gates and Other Fence Openings: Ground fence on each side of opening.

3.6.1.1.1.1 Bond metal gates to gate posts.
3.6.1.1.1.2 Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

3.6.2 Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

3.6.3 Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

3.6.4 Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

3.6.5 Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

3.6.6 Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.7 INSTALLATION

3.7.1 Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

3.7.2 Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

3.7.3 Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

3.7.3.1 Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
3.7.3.2 Use exothermic welds for all below-grade connections.
3.7.3.3 For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

3.7.4 Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

3.7.4.1 Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

3.7.5 Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

3.7.5.1 Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
3.7.5.2 Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.7.5.3 Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

3.7.6 Grounding and Bonding for Piping:

3.7.6.1 Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

3.7.6.2 Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3.7.6.3 Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

3.7.7 Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

3.7.8 Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

3.7.9 Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of area.

3.7.9.1 Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.

3.7.9.2 Bury ground ring not less than 24 inches from building's foundation.

3.7.10 Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

3.7.10.1 If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.

3.7.10.2 Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.7.11 Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

3.7.12 Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

3.7.12.1 Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.

3.7.12.2 Make connections with clean, bare metal at points of contact.

3.7.12.3 Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

3.7.12.4 Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.

3.7.12.5 Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.8 FIELD QUALITY CONTROL

3.8.1 Testing Agency: Navy will engage a qualified testing agency to perform tests and inspections.

3.8.2 Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.8.3 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.8.4 Perform tests and inspections with the assistance of a factory-authorized service representative.

3.8.5 Tests and Inspections:

3.8.5.1 After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

3.8.5.2 Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3.8.5.3 Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

3.8.5.3.1 Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

3.8.5.3.2 Perform tests by fall-of-potential method according to IEEE 81.

3.8.5.4 Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.8.6 Grounding system will be considered defective if it does not pass tests and inspections.

3.8.7 Prepare test and inspection reports.

3.8.8 Report measured ground resistances that exceed the following values:

3.8.8.1 Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

3.8.8.2 Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.

3.8.8.3 Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

3.8.8.4 Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).

3.8.8.5 Substations and Pad-Mounted Equipment: 5 ohms.

3.8.8.6 Manhole Grounds: 10 ohms.

3.8.8.7 Hand hole application.

3.8.9 Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Steel slotted support systems.
1.2.1.2 Conduit and cable support devices.
1.2.1.3 Support for conductors in vertical conduit.
1.2.1.4 Structural steel for fabricated supports and restraints.
1.2.1.5 Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
1.2.1.6 Fabricated metal equipment support assemblies.

1.3 ACTION SUBMITTALS

1.3.1 Product Data: For each type of product.

1.3.1.1 Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

1.3.1.1.1 Slotted support systems, hardware, and accessories.
1.3.1.1.2 Clamps.
1.3.1.1.3 Hangers.
1.3.1.1.4 Sockets.
1.3.1.1.5 Eye nuts.
1.3.1.1.6 Fasteners.
1.3.1.1.7 Anchors.
1.3.1.1.8 Saddles.
1.3.1.1.9 Brackets.

1.3.1.2 Include rated capacities and furnished specialties and accessories.

1.3.2 Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.

1.3.2.1 Hangers. Include product data for components.
1.3.2.2 Slotted support systems.
1.3.2.3 Equipment supports.

1.3.2.4 Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.3.3 Delegated-Design Submittal: For hangers and supports for electrical systems.

1.3.3.1 Include design calculations and details of hangers.

1.4 INFORMATIONAL SUBMITTALS

1.4.1 Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1.4.1.1 Suspended ceiling components.
1.4.1.2 Ductwork, piping, fittings, and supports.
1.4.1.3 Structural members to which hangers and supports will be attached.
1.4.1.4 Size and location of initial access modules for acoustical tile.
1.4.1.5 Items penetrating finished ceiling, including the following:

1.4.1.5.1 Luminaires.
1.4.1.5.2 Access panels.

1.4.2 Welding certificates.

1.5 QUALITY ASSURANCE

1.5.1 Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M and/or AWS D1.2/D1.2M.

1.5.2 Welding Qualifications: Qualify procedures and personnel according to the following:

1.5.2.1 AWS D1.1/D1.1M.
1.5.2.2 AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.1.1.1 Flame Rating: Class 1.
2.1.1.2 Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

2.2.1 Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

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

2.2.1.1.1 Allied Tube & Conduit; a part of Atkore International.
2.2.1.1.2 B-line, an Eaton business.
2.2.1.1.3 CADDY; a brand of nVent.
2.2.1.1.4 Flex-Strut Inc.
2.2.1.1.5 GS Metals Corp.
2.2.1.1.6 G-Strut.
2.2.1.1.7 Thomas & Betts Corporation; A Member of the ABB Group.
2.2.1.1.8 Unistrut; Part of Atkore International.
2.2.1.1.9 Wesanco, Inc.

2.2.1.2 Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2.2.1.3 Material for Channel, Fittings, and Accessories: Galvanized steel / Stainless steel, Type 304 / Stainless steel, Type 316.
2.2.1.4 Channel Width: 1-5/8 inches / 1-1/4 inches.
2.2.1.5 Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
2.2.1.6 Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
2.2.1.7 Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
2.2.1.8 Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.2.2 Conduit and Cable Support Devices: Steel and malleable-iron / Glass-fiber-resin hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

2.2.3 Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

2.2.4 Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

2.2.5 Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

2.2.5.1 Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

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

2.2.5.1.1.1 Hilti, Inc.
2.2.5.1.1.2 ITW Ramset/Red Head; Illinois Tool Works, Inc.
2.2.5.1.1.3 MKT Fastening, LLC.
2.2.5.1.1.4 Simpson Strong-Tie Co., Inc.

2.2.5.2 Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated / stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

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

2.2.5.2.1.1 B-line, an Eaton business.
2.2.5.2.1.2 Empire Tool and Manufacturing Co., Inc.
2.2.5.2.1.3 Hilti, Inc.
2.2.5.2.1.4 ITW Ramset/Red Head; Illinois Tool Works, Inc.
2.2.5.2.1.5 MKT Fastening, LLC.

2.2.5.3 Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
2.2.5.4 Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
2.2.5.5 Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
2.2.5.6 Toggle Bolts: Stainless-steel springhead type.
2.2.5.7 Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

2.3.1 Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

2.3.2 Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

3.1.1 Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

3.1.1.1 NECA 1.
3.1.1.2 NECA 101
3.1.1.3 NECA 102.
3.1.1.4 NECA 105.
3.1.1.5 NECA 111.

3.1.2 Provide approved recommended "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

3.1.3 Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

3.1.4 Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

3.1.5 Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

3.1.5.1 Secure raceways and cables to these supports with two-bolt conduit clamps / single-bolt conduit clamps using spring friction action for retention in support channel.

3.1.6 Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

3.2.1 Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

3.2.2 Raceway Support Methods: In addition to methods described in NECA 1, EMT IMC and RMC may be supported by openings through structure members, according to NFPA 70.

3.2.3 Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2.4 Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

3.2.4.1 To Wood: Fasten with lag screws or through bolts.
3.2.4.2 To New Concrete: Bolt to concrete inserts.
3.2.4.3 To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
3.2.4.4 To Existing Concrete: Expansion anchor fasteners.
3.2.4.5 Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
3.2.4.6 To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 Spring-tension clamps.
3.2.4.7 To Light Steel: Sheet metal screws.
3.2.4.8 Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

3.2.5 Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

3.3.1 Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.

3.3.2 Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.3.3 Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

3.4.1 Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

3.4.2 Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

3.4.3 Anchor equipment to concrete base as follows:

3.4.3.1 Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.4.3.2 Install anchor bolts to elevations required for proper attachment to supported equipment.

3.4.3.3 Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

3.5.1 Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

3.5.1.1 Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

3.5.2 Touchup: Provide suitable "Exterior Painting" for touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

3.5.3 Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Metal conduits and fittings.
1.2.1.2 Nonmetallic conduits and fittings.
1.2.1.3 Metal wireways and auxiliary gutters.
1.2.1.4 Nonmetal wireways.
1.2.1.5 Surface raceways.
1.2.1.6 Boxes, enclosures, and cabinets.
1.2.1.7 Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

1.3.1 ARC: Aluminum rigid conduit.

1.3.2 GRC: Galvanized rigid steel conduit.

1.3.3 IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.4.2 Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.4.3 Samples: For wireways and surface raceways and for each color and texture specified, 12 inches long.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1.5.1.1 Structural members in paths of conduit groups with common supports.

1.5.1.2 HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

1.5.2 Qualification Data: For professional engineer.

1.5.3 Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

2.1.1 Metal Conduit:

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

2.1.1.1.1 Allied Tube & Conduit; a part of Atkore International.
2.1.1.1.2 Electri-Flex Company.
2.1.1.1.3 FSR Inc.
2.1.1.1.4 Korkap.
2.1.1.1.5 NEC, Inc.
2.1.1.1.6 Opti-Com Manufacturing Network, Inc (OMNI).
2.1.1.1.7 O-Z/Gedney; a brand of Emerson Industrial Automation.
2.1.1.1.8 Perma-Cote.
2.1.1.1.9 Picoma Industries, Inc.
2.1.1.1.10 Republic Conduit.
2.1.1.1.11 Southwire Company.
2.1.1.1.12 Thomas & Betts Corporation; A Member of the ABB Group.
2.1.1.1.13 Topaz Electric; a division of Topaz Lighting Corp.
2.1.1.1.14 Western Tube and Conduit Corporation.
2.1.1.1.15 Wheatland Tube Company.

2.1.1.2 Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2.1.1.3 GRC: Comply with ANSI C80.1 and UL 6.
2.1.1.4 ARC: Comply with ANSI C80.5 and UL 6A.
2.1.1.5 IMC: Comply with ANSI C80.6 and UL 1242.
2.1.1.6 PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

2.1.1.6.1 Comply with NEMA RN 1.
2.1.1.6.2 Coating Thickness: 0.040 inch, minimum.

2.1.1.7 EMT: Comply with ANSI C80.3 and UL 797.
2.1.1.8 FMC: Comply with UL 1; zinc-coated steel.
2.1.1.9 LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

2.1.2 Metal Fittings:

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

2.1.2.1.1 Allied Tube & Conduit; a part of Atkore International.
2.1.2.1.2 Electri-Flex Company.

2.1.2.1.3 FSR Inc.
2.1.2.1.4 Korkap.
2.1.2.1.5 NEC, Inc.
2.1.2.1.6 Opti-Com Manufacturing Network, Inc (OMNI).
2.1.2.1.7 O-Z/Gedney; a brand of Emerson Industrial Automation.
2.1.2.1.8 Picoma Industries, Inc.
2.1.2.1.9 Republic Conduit.
2.1.2.1.10 Southwire Company.
2.1.2.1.11 Thomas & Betts Corporation; A Member of the ABB Group.
2.1.2.1.12 Topaz Electric; a division of Topaz Lighting Corp.
2.1.2.1.13 Western Tube and Conduit Corporation.
2.1.2.1.14 Wheatland Tube Company.

2.1.2.2 Comply with NEMA FB 1 and UL 514B.
2.1.2.3 Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2.1.2.4 Fittings, General: Listed and labeled for type of conduit, location, and use.
2.1.2.5 Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
2.1.2.6 Fittings for EMT:

2.1.2.6.1 Material: Steel or die cast.
2.1.2.6.2 Type: Setscrew or compression.

2.1.2.7 Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
2.1.2.8 Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

2.1.3 Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

2.2.1 Nonmetallic Conduit:

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

2.2.1.1.1 Arnco Corporation.
2.2.1.1.2 CANTEX INC.
2.2.1.1.3 CertainTeed Corporation.
2.2.1.1.4 Champion Fiberglass, Inc.
2.2.1.1.5 Electri-Flex Company.
2.2.1.1.6 FRE Composites.
2.2.1.1.7 Kraloy.
2.2.1.1.8 RACO; Hubbell.
2.2.1.1.9 Thomas & Betts Corporation; A Member of the ABB Group.
2.2.1.1.10 Topaz Electric; a division of Topaz Lighting Corp.
2.2.1.1.11 United Fiberglass.

2.2.1.2 Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2.2.1.3 Fiberglass:

2.2.1.3.1 Comply with NEMA TC 14.
2.2.1.3.2 Comply with UL 2515 for aboveground raceways.
2.2.1.3.3 Comply with UL 2420 for belowground raceways.

2.2.1.4 ENT: Comply with NEMA TC 13 and UL 1653.
2.2.1.5 RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
2.2.1.6 LFNC: Comply with UL 1660.
2.2.1.7 Rigid HDPE: Comply with UL 651A.
2.2.1.8 Continuous HDPE: Comply with UL 651A.
2.2.1.9 Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D3485.
2.2.1.10 RTRC: Comply with UL 2515A and NEMA TC 14.

2.2.2 Nonmetallic Fittings:

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

2.2.2.1.1 Arnco Corporation.
2.2.2.1.2 CANTEX INC.
2.2.2.1.3 CertainTeed Corporation.
2.2.2.1.4 Champion Fiberglass, Inc.
2.2.2.1.5 Electri-Flex Company.
2.2.2.1.6 FRE Composites.
2.2.2.1.7 Kraloy.
2.2.2.1.8 RACO; Hubbell.
2.2.2.1.9 Thomas & Betts Corporation; A Member of the ABB Group.
2.2.2.1.10 Topaz Electric; a division of Topaz Lighting Corp.
2.2.2.1.11 United Fiberglass.

2.2.2.2 Fittings, General: Listed and labeled for type of conduit, location, and use.
2.2.2.3 Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.2.2.3.1 Fittings for LFNC: Comply with UL 514B.

2.2.2.4 Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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

2.3.1.1 B-line, an Eaton business.
2.3.1.2 Hoffman; a brand of nVent.
2.3.1.3 Square D.

2.3.2 Description: Sheet metal, complying with UL 870 and NEMA 250, Type 3R / Type 4 unless otherwise indicated, and sized according to NFPA 70.

2.3.2.1 Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3.3 Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.3.4 Wireway Covers: Hinged type Flanged-and-gasketed type unless otherwise indicated.

2.3.5 Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

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

2.4.1.1 Allied Moulded Products, Inc.
2.4.1.2 Hoffman; a brand of nVent.
2.4.1.3 Lamson & Sessions.
2.4.1.4 Niedax Inc.

2.4.2 Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4.3 Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

2.4.4 Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

2.4.5 Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

2.4.6 Solvents and Adhesives: As recommended by conduit manufacturer.

2.5 SURFACE RACEWAYS

2.5.1 Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5.2 Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

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

2.5.2.1.1 Hubbell Incorporated; Wiring Device-Kellems.
2.5.2.1.2 MonoSystems, Inc.
2.5.2.1.3 Panduit Corp.
2.5.2.1.4 Wiremold / Legrand.

2.5.3 Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

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

2.5.3.1.1 Hubbell Incorporated.
2.5.3.1.2 MonoSystems, Inc.
2.5.3.1.3 Panduit Corp.
2.5.3.1.4 Wiremold / Legrand.

2.6 BOXES, ENCLOSURES, AND CABINETS

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

2.6.1.1 Adalet.
2.6.1.2 Crouse-Hinds, an Eaton business.
2.6.1.3 EGS/Appleton Electric.
2.6.1.4 Erickson Electrical Equipment Company.
2.6.1.5 FSR Inc.
2.6.1.6 Hoffman; a brand of nVent.
2.6.1.7 Hubbell Incorporated.
2.6.1.8 Hubbell Incorporated; Wiring Device-Kellems.
2.6.1.9 Kraloy.
2.6.1.10 Milbank Manufacturing Co.
2.6.1.11 MonoSystems, Inc.
2.6.1.12 O-Z/Gedney; a brand of Emerson Industrial Automation.
2.6.1.13 RACO; Hubbell.
2.6.1.14 Spring City Electrical Manufacturing Company.
2.6.1.15 Stahlin Non-Metallic Enclosures.
2.6.1.16 Thomas & Betts Corporation; A Member of the ABB Group.
2.6.1.17 Topaz Electric; a division of Topaz Lighting Corp.
2.6.1.18 Wiremold / Legrand.

2.6.2 General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

2.6.3 Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

2.6.4 Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

2.6.5 Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

2.6.6 Metal Floor Boxes:

2.6.6.1 Material: Cast metal.
2.6.6.2 Type: Fully adjustable/ Semi-adjustable.
2.6.6.3 Shape: Rectangular.
2.6.6.4 Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6.7 Nonmetallic Floor Boxes: Nonadjustable, round / rectangular.

2.6.7.1 Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6.8 Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

2.6.9 Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

2.6.9.1 Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6.10 Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

2.6.11 Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

2.6.12 Box extensions used to accommodate new building finishes shall be of same material as recessed box.

2.6.13 Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

2.6.14 Gangable boxes are prohibited.

2.6.15 Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 3R / Type 4 / Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.

2.6.15.1 Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2.6.15.2 Nonmetallic Enclosures: Fiberglass.
2.6.15.3 Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

2.6.16 Cabinets:

2.6.16.1 NEMA 250, Type 3R / Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2.6.16.2 Hinged door in front cover with flush latch and concealed hinge.
2.6.16.3 Key latch to match panelboards.
2.6.16.4 Metal barriers to separate wiring of different systems and voltage.
2.6.16.5 Accessory feet where required for freestanding equipment.
2.6.16.6 Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

2.7.1 General Requirements for Handholes and Boxes:

2.7.1.1 Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2.7.1.2 Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7.2 Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

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

2.7.2.1.1 Armorcast Products Company.
2.7.2.1.2 Oldcastle Enclosure Solutions.
2.7.2.1.3 Oldcastle Precast, Inc.
2.7.2.1.4 Quazite: Hubbell Power Systems, Inc.

2.7.2.2 Standard: Comply with SCTE 77.
2.7.2.3 Configuration: Designed for flush burial with open integral closed bottom unless otherwise indicated.
2.7.2.4 Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
2.7.2.5 Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
2.7.2.6 Cover Legend: Molded lettering, "ELECTRIC.".
2.7.2.7 Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
2.7.2.8 Handholes 24 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

2.8.1 Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

2.8.1.1 Tests of materials shall be performed by an independent testing agency.
2.8.1.2 Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2.8.1.3 Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

3.1.1 Outdoors: Apply raceway products as specified below unless otherwise indicated:

3.1.1.1 Exposed Conduit: GRC, Type EPC-40-PVC / RNC, Type EPC-80-PVC.
3.1.1.2 Concealed Conduit, Aboveground: GRC / IMC.
3.1.1.3 Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.
3.1.1.4 Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC / LFNC.
3.1.1.5 Boxes and Enclosures, Aboveground: NEMA 250, Type 3R / Type 4.

3.1.2 Indoors: Apply raceway products as specified below unless otherwise indicated:

3.1.2.1 Exposed, Not Subject to Physical Damage: EMT.

3.1.2.2 Exposed, Not Subject to Severe Physical Damage: EMT.
3.1.2.3 Exposed and Subject to Severe Physical Damage: GRC / IMC. Raceway locations include the following:

3.1.2.3.1 Pump Room.
3.1.2.3.2 Area used for traffic of mechanized carts, forklifts, and pallet-handling units.
3.1.2.3.3 Mechanical rooms.
3.1.2.3.4 All Exterior Wiring.

3.1.2.4 Concealed in Ceilings and Interior Walls and Partitions: EMT.
3.1.2.5 Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
3.1.2.6 Damp or Wet Locations: GRC & IMC.
3.1.2.7 Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel/nonmetal in damp or wet locations.

3.1.3 Minimum Raceway Size: 3/4-inch trade size.

3.1.4 Raceway Fittings: Compatible with raceways and suitable for use and location.

3.1.4.1 Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
3.1.4.2 PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3.1.4.3 EMT: Use setscrew, steel / cast-metal fittings. Comply with NEMA FB 2.10.
3.1.4.4 Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

3.1.5 Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

3.1.6 Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

3.1.7 Install surface raceways only where indicated on Drawings.

3.1.8 Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

3.2.1 Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

3.2.2 Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

3.2.3 Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

3.2.4 Do not fasten conduits onto the bottom side of a metal deck roof.

3.2.5 Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

3.2.6 Complete raceway installation before starting conductor installation.

3.2.7 Arrange stub-ups so curved portions of bends are not visible above finished slab.

3.2.8 Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

3.2.9 Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

3.2.10 Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

3.2.11 Support conduit within 12 inches of enclosures to which attached.

3.2.12 Raceways Embedded in Slabs:

3.2.12.1 Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
3.2.12.2 Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3.2.12.3 Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
3.2.12.4 Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
3.2.12.5 Change from ENT to GRC before rising above floor.

3.2.13 Stub-Ups to Above Recessed Ceilings:

3.2.13.1 Use EMT, RMC for raceways.
3.2.13.2 Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

3.2.14 Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

3.2.15 Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

3.2.16 Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

3.2.17 Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

3.2.18 Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

3.2.19 Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

3.2.20 Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

3.2.21 Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

3.2.22 Surface Raceways:

3.2.22.1 Install surface raceway with a minimum 2-inch radius control at bend points.
3.2.22.2 Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

3.2.23 Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

3.2.24 Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

3.2.24.1 Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
3.2.24.2 Where an underground service raceway enters a building or structure.
3.2.24.3 Conduit extending from interior to exterior of building.
3.2.24.4 Conduit extending into pressurized duct and equipment.
3.2.24.5 Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
3.2.24.6 Where otherwise required by NFPA 70.

3.2.25 Comply with manufacturer's written instructions for solvent welding RNC and fittings.

3.2.26 Expansion-Joint Fittings:

3.2.26.1 Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
3.2.26.2 Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

3.2.26.2.1 Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
3.2.26.2.2 Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
3.2.26.2.3 Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
3.2.26.2.4 Attics: 135 deg F temperature change.

3.2.26.3 Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
3.2.26.4 Install expansion fittings at all locations where conduits cross building or structure expansion joints.
3.2.26.5 Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

3.2.27 Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

3.2.27.1 Use LFMC in damp or wet locations subject to severe physical damage.
3.2.27.2 Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

3.2.28 Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

3.2.29 Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

3.2.30 Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

3.2.31 Locate boxes so that cover or plate will not span different building finishes.

3.2.32 Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

3.2.33 Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.2.34 Set metal floor boxes level and flush with finished floor surface.

3.2.35 Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

3.3.1 Direct-Buried Conduit:

3.3.1.1 Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches in nominal diameter.
3.3.1.2 Install backfill as specified in Section 31 20 00 "Earth Moving."
3.3.1.3 After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."

3.3.1.4 Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

3.3.1.5 Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

3.3.1.5.1 Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.

3.3.1.5.2 For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

3.3.1.6 Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.

3.3.1.7 Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

3.4.1 Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

3.4.2 Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

3.4.3 Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

3.4.4 Install handholes with bottom below frost line, below grade.

3.4.5 Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

3.4.6 Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

3.5.1 Install 0sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

3.6.1 Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.7 PROTECTION

3.7.1 Protect coatings, finishes, and cabinets from damage and deterioration.

3.7.1.1 Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
3.7.1.2 Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Metal conduits and fittings, including GRC and PVC-coated steel conduit.
1.2.1.2 Rigid nonmetallic duct.
1.2.1.3 Flexible nonmetallic duct.
1.2.1.4 Duct accessories.
1.2.1.5 Precast concrete handholes.
1.2.1.6 Utility structure accessories.

1.3 DEFINITIONS

1.3.1 Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

1.3.2 Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

1.3.3 Duct Bank:

1.3.3.1 Two or more ducts installed in parallel, with or without additional casing materials.
1.3.3.2 Multiple duct banks.

1.3.4 GRC: Galvanized rigid (steel) conduit.

1.3.5 Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of product.

1.4.1.1 Include duct-bank materials, including spacers and miscellaneous components.
1.4.1.2 Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
1.4.1.3 Include accessories for manholes, handholes, boxes, and other utility structures.
1.4.1.4 Include underground-line warning tape.
1.4.1.5 Include warning planks.

1.4.2 Shop Drawings:

1.4.2.1 Precast or Factory-Fabricated Underground Utility Structures:

1.4.2.1.1 Include plans, elevations, sections, details, attachments to other work, and accessories.
1.4.2.1.2 Include duct entry provisions, including locations and duct sizes.
1.4.2.1.3 Include reinforcement details.
1.4.2.1.4 Include frame and cover design and manhole chimneys.
1.4.2.1.5 Include grounding details.
1.4.2.1.6 Include joint details.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.

1.5.1.1 Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
1.5.1.2 Drawings shall be signed and sealed by a qualified professional engineer.

1.5.2 Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

1.5.3 Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C858.

1.5.4 Source quality-control reports.

1.5.5 Field quality-control reports.

1.6 MAINTENANCE MATERIALS SUBMITTALS

1.6.1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.6.2 Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.7 QUALITY ASSURANCE

1.7.1 Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.8 FIELD CONDITIONS

1.8.1 Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

1.8.1.1 Notify Architect / Construction Manager no fewer than seven days in advance of proposed interruption of electrical service.

1.8.1.2 Do not proceed with interruption of electrical service without Architect's / Construction Manager's written permission.

1.8.2 Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

1.8.3 Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

2.1.1 GRC: Comply with ANSI C80.1 and UL 6.

2.1.2 Coated Steel Conduit: PVC-coated GRC / IMC.

2.1.2.1 Comply with NEMA RN 1.
2.1.2.2 Coating Thickness: 0.040 inch, minimum.

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

2.1.3.1 AFC Cable Systems; a part of Atkore International.
2.1.3.2 Allied Tube & Conduit; a part of Atkore International.
2.1.3.3 FSR Inc.
2.1.3.4 O-Z/Gedney; a brand of Emerson Industrial Automation.
2.1.3.5 Republic Conduit.
2.1.3.6 Southwire Company.
2.1.3.7 Thomas & Betts Corporation; A Member of the ABB Group.
2.1.3.8 Topaz Electric; a division of Topaz Lighting Corp.
2.1.3.9 Wheatland Tube Company.

2.1.4 Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

2.2.1 Underground Plastic Utilities Duct: Type EPC-80-PVC and Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

2.2.2 Underground Plastic Utilities Duct: Type DB-60 PVC and Type DB-120 PVC RNC, complying with NEMA TC 6 & 8 and ASTM F512 for direct burial, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.

2.2.3 Underground Plastic Utilities Duct: Type EB-20 PVC RNC, complying with NEMA TC 6 & 8, ASTM F512, and UL 651, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.

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

2.2.4.1 ARNCO Corp.
2.2.4.2 CANTEX INC.
2.2.4.3 CertainTeed Corporation.
2.2.4.4 IPEX USA LLC.
2.2.4.5 Lamson & Sessions. Manhattan/CDT.
2.2.4.6 Opti-Com Manufacturing Network, Inc (OMNI).
2.2.4.7 Spiraduct/AFC Cable Systems, Inc.

2.2.5 Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2.6 Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 FLEXIBLE NONMETALLIC DUCTS

2.3.1 HDPE Duct: Type EPEC-40 HDPE / Type EPEC-80 HDPE, complying with NEMA TC 7 and UL 651A.

2.3.1.1 <Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.3.1.1.1 ARNCO Corp.
2.3.1.1.2 Carlon; a brand of Thomas & Betts Corporation.
2.3.1.1.3 Opti-Com Manufacturing Network, Inc (OMNI).

2.3.1.2 Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.4 DUCT ACCESSORIES

2.4.1 Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

2.4.1.1 <Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.4.1.1.1 Allied Tube & Conduit; a part of Atkore International.
2.4.1.1.2 CANTEX INC.
2.4.1.1.3 Carlon; a brand of Thomas & Betts Corporation.
2.4.1.1.4 IPEX USA LLC.
2.4.1.1.5 Underground Devices, Inc.

2.4.2 Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 26 05 53 "Identification for Electrical Systems."

2.4.3 Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.

2.4.3.1 Color: Red dye added to concrete during batching.
2.4.3.2 Mark each plank with "ELECTRIC" in 2-inch-high, 3/8-inch-deep letters.

2.5 PRECAST CONCRETE HANDHOLES AND BOXES

2.5.1 Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

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

- 2.5.2.1 Christy Concrete Products.
- 2.5.2.2 Elmhurst-Chicago Stone Co.
- 2.5.2.3 Oldcastle Precast, Inc.
- 2.5.2.4 Riverton Concrete Products.
- 2.5.2.5 Utility Concrete Products, LLC.
- 2.5.2.6 Utility Vault Co.

2.5.3 Comply with ASTM C858 for design and manufacturing processes.

2.5.4 Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

2.5.5 Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

2.5.6 Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.

- 2.5.6.1 Cover Hinges: Concealed, with hold-open ratchet assembly.
- 2.5.6.2 Cover Handle: Recessed.

2.5.7 Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.

- 2.5.7.1 Cover Hinges: Concealed, with hold-open ratchet assembly.
- 2.5.7.2 Cover Handle: Recessed.

2.5.8 Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

2.5.9 Cover Legend: Molded lettering, "ELECTRIC."

2.5.10 Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

2.5.11 Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

- 2.5.11.1 Extension shall provide increased depth of 12 inches.
- 2.5.11.2 Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

2.5.12 Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.5.13 Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

2.5.13.1 Splayed location.
2.5.13.2 Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
2.5.13.3 Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
2.5.13.4 Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
2.5.13.5 Knockout panels shall be 1-1/2 to 2 inches thick.

2.5.14 Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

2.5.14.1 Type and size shall match fittings to duct to be terminated.
2.5.14.2 Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.

2.5.15 Handholes 30 inches wide by 30 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.6 UTILITY STRUCTURE ACCESSORIES

2.6.1 Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.

2.6.2 <Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.6.2.1 BILCO Company (The).
2.6.2.2 Campbell Foundry Company.
2.6.2.3 Carder Concrete Products.
2.6.2.4 Christy Concrete Products.
2.6.2.5 Elmhurst-Chicago Stone Co.
2.6.2.6 McKinley Iron Works, Inc.
2.6.2.7 Neenah Foundry Company.
2.6.2.8 Oldcastle Precast, Inc.
2.6.2.9 Osburn Associates, Inc.
2.6.2.10 Pennsylvania Insert Corporation.
2.6.2.11 Quazite: Hubbell Power Systems, Inc.
2.6.2.12 Rinker Group, Ltd.
2.6.2.13 Riverton Concrete Products.
2.6.2.14 Underground Devices, Inc.
2.6.2.15 Utility Concrete Products, LLC.

2.6.3 Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.

2.6.3.1 Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

2.6.4 Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-diameter eye, rated 2500-lbf minimum tension.

2.6.5 Pulling-in and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

2.6.5.1 Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

2.6.6 Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

2.6.6.1 Tested Ultimate Pullout Strength: 12,000 lbf minimum.

2.6.7 Ground Rod Sleeve: 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the ducts routed from the facility.

2.6.8 Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

2.6.9 Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.

2.6.9.1 Stanchions: T-section or channel with provisions to connect to other sections or channels to form a continuous unit; 1-1/2 inches in width by nominal 24 inches long; punched with 14 hook holes on 1-1/2-inch centers for cable-arm attachment.

2.6.9.2 Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.

2.6.9.3 Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

2.6.10 Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

2.6.10.1 Stanchions: Nominal 36 inches high by 4 inches wide, with provisions to connect to other sections to form a continuous unit, with minimum of nine holes for arm attachment.

2.6.10.2 Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

2.6.11 Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

2.6.12 Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater required.

2.7 SOURCE QUALITY CONTROL

2.7.1 Test and inspect precast concrete utility structures according to ASTM C1037.

2.7.2 Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

2.7.2.1 Tests of materials shall be performed by an independent testing agency.

2.7.2.2 Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

2.7.2.3 Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

3.1.2 Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

3.1.3 Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 31 10 00 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 31 10 00 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

3.2.1 Duct for Electrical Cables More Than 600 V: Type EPC-80-PVC / Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.

3.2.2 Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC / Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.

3.2.3 Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC / Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.

3.2.4 Duct for Electrical Branch Circuits: Type EPC-80-PVC / Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.

3.2.5 Bored Underground Duct: Type EPEC-40-HDPE / Type EPEC-80-HDPE unless otherwise indicated.

3.2.6 Underground Ducts Crossing Paved Paths Walks and Driveways Roadways and Railroads: Type EPC-40 PVC RNC, encased in reinforced concrete.

3.2.7 Stub-ups: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

3.3.1 Handholes and Boxes for 600 V and Less:

3.3.1.1 Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.

3.3.1.2 Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.

3.3.1.3 Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.

3.3.1.4 Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

3.4.1 Excavation and Backfill: Comply with Section 31 20 00 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

3.4.2 Restoration: Replace area after construction vehicle traffic in immediate area is complete.

3.4.3 Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

3.4.4 Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures as required.

3.5 DUCT AND DUCT-BANK INSTALLATION

3.5.1 Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

3.5.2 Install duct according to NEMA TCB 2.

3.5.3 Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

3.5.4 Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.

3.5.4.1 Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

3.5.5 Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

3.5.6 Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

3.5.7 End Bell Entrances to Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.

3.5.7.1 Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.

3.5.7.2 Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.

3.5.7.3 Grout end bells into structure walls from both sides to provide watertight entrances.

3.5.8 Terminator Entrances to Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.

3.5.8.1 Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.

3.5.8.2 Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch.

3.5.9 Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5.10 Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

3.5.11 Pulling Cord: Install 200-lbf-test nylon cord in empty ducts.

3.5.12 Concrete-Encased Ducts and Duct Bank:

3.5.12.1 Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms for pipes less than 6 inches in nominal diameter.

3.5.12.2 Width: Excavate trench 12 inches wider than duct on each side.

3.5.12.3 Width: Excavate trench 3 inches wider than duct on each side.

3.5.12.4 Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.

3.5.12.5 Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

3.5.12.6 Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

3.5.12.7 Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.

3.5.12.8 Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.

3.5.12.9 Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.

3.5.12.9.1 Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

3.5.12.9.2 Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

3.5.12.9.2.1 Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.

3.5.12.9.3 Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

3.5.12.9.3.1 Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.

3.5.12.10 Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

3.5.12.11 Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

3.5.12.12 Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.

3.5.12.13 Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

3.5.12.13.1 Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.

3.5.12.13.2 If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

3.5.12.14 Pouring Concrete: Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

3.5.13 Direct-Buried Duct and Duct Bank:

3.5.13.1 Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 31 20 00 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.

3.5.13.2 Width: Excavate trench 12 inches wider than duct on each side.

3.5.13.3 Width: Excavate trench 3 inches wider than duct on each side.

3.5.13.4 Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.

3.5.13.5 Set elevation of bottom of duct bank below frost line.

3.5.13.6 Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.

3.5.13.7 Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

3.5.13.8 Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.

3.5.13.9 Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

3.5.13.10 Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

3.5.13.10.1 Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

3.5.13.10.2 Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

3.5.13.10.2.1 Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.

3.5.13.10.3 Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

3.5.13.10.3.1 Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.

3.5.13.11 After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 31 20 00 "Earth Moving" for installation of backfill materials.

3.5.13.11.1 Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.

3.5.13.11.2 Place minimum 6 inches of engineered fill above concrete encasement of duct.

3.5.14 Warning Planks: Bury warning planks approximately 12 inches above direct-buried duct, placing them 24 inches o.c. Align planks along the width and along the centerline of duct or duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

3.5.15 Underground-Line Warning Tape: Bury conducting underground line specified in Section 26 05 53 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

3.6.1 Precast Manhole Installation:

3.6.1.1 Comply with ASTM C891 unless otherwise indicated.
3.6.1.2 Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3.6.1.3 Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

3.6.2 Elevations:

3.6.2.1 Manhole Roof: Install with rooftop at least 15 inches below finished grade.
3.6.2.2 Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3.6.2.3 Install handholes with bottom below frost line, 48 inches below grade.
3.6.2.4 Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
3.6.2.5 Where indicated, cast handhole cover frame integrally with handhole structure.

3.6.3 Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

3.6.4 Waterproofing: Apply waterproofing to exterior surfaces of handholes after concrete has cured at least three days. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

3.6.5 Dampproofing: Apply dampproofing to exterior surfaces of handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 07 11 13 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

3.6.6 Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

3.6.7 Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

3.6.8 Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 GROUNDING

3.7.1 Ground underground ducts and utility structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

3.8.1 Perform the following tests and inspections:

3.8.1.1 Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.

3.8.1.2 Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.

3.8.1.3 Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.8.2 Correct deficiencies and retest as specified above to demonstrate compliance.

3.8.3 Prepare test and inspection reports.

3.9 CLEANING

3.9.1 Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

3.9.2 Clean internal surfaces of manholes, including sump.

3.9.2.1 Sweep floor, removing dirt and debris.

3.9.2.2 Remove foreign material.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Color and legend requirements for raceways, conductors, and warning labels and signs.
1.2.1.2 Labels.
1.2.1.3 Bands and tubes.
1.2.1.4 Tapes and stencils.
1.2.1.5 Tags.
1.2.1.6 Signs.
1.2.1.7 Cable ties.
1.2.1.8 Paint for identification.
1.2.1.9 Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

1.3.1 Product Data: For each type of product.

1.3.1.1 Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

1.3.2 Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.3.3 Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

1.3.4 Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Comply with ASME A13.1 and IEEE C2.

2.1.2 Comply with NFPA 70.

2.1.3 Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

2.1.4 Comply with ANSI Z535.4 for safety signs and labels.

2.1.5 Comply with NFPA 70E and Section 26 05 74 "Protective Device Arc-Flash Study" requirements for arc-flash warning labels.

2.1.6 Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.1.7 Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

2.1.7.1 Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

2.2.1 Raceways and Cables Carrying Circuits at 600 V or Less:

2.2.1.1 Black letters on an orange field.
2.2.1.2 Legend: Indicate voltage and system or service type.

2.2.2 Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

2.2.2.1 Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
2.2.2.2 Colors for 208/120-V Circuits:

2.2.2.2.1 Phase A: Black.
2.2.2.2.2 Phase B: Red.
2.2.2.2.3 Phase C: Blue.

2.2.2.3 Colors for 240-V Circuits:

2.2.2.3.1 Phase A: Black.
2.2.2.3.2 Phase B: Red.

2.2.2.4 Colors for 480/277-V Circuits:

2.2.2.4.1 Phase A: Brown.
2.2.2.4.2 Phase B: Orange.
2.2.2.4.3 Phase C: Yellow.

2.2.2.5 Color for Neutral: White or gray.
2.2.2.6 Color for Equipment Grounds: Bare copper / Green / Green with a yellow stripe.
2.2.2.7 Colors for Isolated Grounds: Green with two or more yellow stripes.

2.2.3 Raceways and Cables Carrying Circuits at More Than 600 V:

2.2.3.1 Black letters on an orange field.
2.2.3.2 Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

2.2.4 Warning Label Colors:

2.2.4.1 Identify system voltage with black letters on an orange background.

2.2.5 Warning labels and signs shall include, but are not limited to, the following legends:

2.2.5.1 Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2.2.5.2 Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.2.6 Equipment Identification Labels:

2.2.6.1 Black letters on a white field.

2.3 LABELS

2.3.1 Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

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

2.3.1.1.1 Brady Corporation.
2.3.1.1.2 Champion America.
2.3.1.1.3 emedco.
2.3.1.1.4 Grafoplast Wire Markers.
2.3.1.1.5 HellermannTyton.
2.3.1.1.6 LEM Products Inc.
2.3.1.1.7 Marking Services, Inc.
2.3.1.1.8 Panduit Corp.
2.3.1.1.9 Seton Identification Products.

2.3.2 Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

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

2.3.2.1.1 Brady Corporation.
2.3.2.1.2 HellermannTyton.
2.3.2.1.3 Marking Services, Inc.
2.3.2.1.4 Panduit Corp.
2.3.2.1.5 Seton Identification Products.

2.3.3 Self-Adhesive Wraparound Labels: Preprinted / Write-on, 3-mil- thick, polyester / vinyl flexible label with acrylic pressure-sensitive adhesive.

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

2.3.3.1.1 A'n D Cable Products.
2.3.3.1.2 Brady Corporation.
2.3.3.1.3 Brother International Corporation.
2.3.3.1.4 emedco.
2.3.3.1.5 Grafoplast Wire Markers.

2.3.3.1.6 Ideal Industries, Inc.
2.3.3.1.7 LEM Products Inc.
2.3.3.1.8 Marking Services, Inc.
2.3.3.1.9 Panduit Corp.
2.3.3.1.10 Seton Identification Products.

2.3.3.2 Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2.3.3.3 Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2.3.3.4 Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

2.3.4 Self-Adhesive Labels: Polyester / Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

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

2.3.4.1.1 A'n D Cable Products.
2.3.4.1.2 Brady Corporation.
2.3.4.1.3 Brother International Corporation.
2.3.4.1.4 emedco.
2.3.4.1.5 Grafoplast Wire Markers.
2.3.4.1.6 HellermannTyton.
2.3.4.1.7 Ideal Industries, Inc.
2.3.4.1.8 LEM Products Inc.
2.3.4.1.9 Marking Services, Inc.
2.3.4.1.10 Panduit Corp.
2.3.4.1.11 Seton Identification Products.

2.3.4.2 Minimum Nominal Size:

2.3.4.2.1 1-1/2 by 6 inches for raceway and conductors
2.3.4.2.2 3-1/2 by 5 inches for equipment.
2.3.4.2.3 As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

2.4.1 Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

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

2.4.1.1.1 Brady Corporation.
2.4.1.1.2 HellermannTyton.
2.4.1.1.3 Marking Services, Inc.
2.4.1.1.4 Panduit Corp.

2.4.2 Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

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

2.4.2.1.1 Brady Corporation.
2.4.2.1.2 Panduit Corp.

2.5 TAPES AND STENCILS

2.5.1 Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

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

2.5.1.1.1 Carlton Industries, LP.
2.5.1.1.2 Champion America.
2.5.1.1.3 HellermannTyton.
2.5.1.1.4 Ideal Industries, Inc.
2.5.1.1.5 Marking Services, Inc.
2.5.1.1.6 Panduit Corp.

2.5.2 Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

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

2.5.2.1.1 Brady Corporation.
2.5.2.1.2 Carlton Industries, LP.
2.5.2.1.3 emedco.
2.5.2.1.4 Marking Services, Inc.

2.5.3 Tape and Stencil: 4-inch- wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.

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

2.5.3.1.1 HellermannTyton.
2.5.3.1.2 LEM Products Inc.
2.5.3.1.3 Marking Services, Inc.
2.5.3.1.4 Seton Identification Products.

2.5.4 Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white or yellow and black stripes and clear vinyl overlay.

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

2.5.4.1.1 Carlton Industries, LP.
2.5.4.1.2 Seton Identification Products.

2.5.5 Underground-Line Warning Tape:

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

- 2.5.5.1.1 Brady Corporation.
- 2.5.5.1.2 Ideal Industries, Inc.
- 2.5.5.1.3 LEM Products Inc.
- 2.5.5.1.4 Marking Services, Inc.
- 2.5.5.1.5 Reef Industries, Inc.
- 2.5.5.1.6 Seton Identification Products.

2.5.5.2 Tape:

- 2.5.5.2.1 Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
- 2.5.5.2.2 Printing on tape shall be permanent and shall not be damaged by burial operations.
- 2.5.5.2.3 Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2.5.5.3 Color and Printing:

- 2.5.5.3.1 Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
- 2.5.5.3.2 Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
- 2.5.5.3.3 Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

2.5.5.4 Tag: Type I:

- 2.5.5.4.1 Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
- 2.5.5.4.2 Width: 3 inches.
- 2.5.5.4.3 Thickness: 4 mils.
- 2.5.5.4.4 Weight: 18.5 lb/1000 sq. ft..
- 2.5.5.4.5 Tensile according to ASTM D882: 30 lbf and 2500 psi.

2.5.5.5 Tag: Type II:

- 2.5.5.5.1 Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
- 2.5.5.5.2 Width: 3 inches.
- 2.5.5.5.3 Thickness: 12 mils.
- 2.5.5.5.4 Weight: 36.1 lb/1000 sq. ft..
- 2.5.5.5.5 Tensile according to ASTM D882: 400 lbf and 11,500 psi.

2.5.5.6 Tag: Type ID:

- 2.5.5.6.1 Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
- 2.5.5.6.2 Width: 3 inches.
- 2.5.5.6.3 Overall Thickness: 5 mils.
- 2.5.5.6.4 Foil Core Thickness: 0.35 mil.
- 2.5.5.6.5 Weight: 28 lb/1000 sq. ft..

2.5.5.6.6 Tensile according to ASTM D882: 70 lbf and 4600 psi.

2.5.5.7 Tag: Type IID:

2.5.5.7.1 Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2.5.5.7.2 Width: 3 inches.
2.5.5.7.3 Overall Thickness: 8 mils.
2.5.5.7.4 Foil Core Thickness: 0.35 mil.
2.5.5.7.5 Weight: 34 lb/1000 sq. ft..
2.5.5.7.6 Tensile according to ASTM D882: 300 lbf and 12,500 psi.

2.5.6 Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 TAGS

2.6.1 Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

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

2.6.1.1.1 Brady Corporation.
2.6.1.1.2 Carlton Industries, LP.
2.6.1.1.3 emedco.
2.6.1.1.4 Marking Services, Inc.
2.6.1.1.5 Seton Identification Products.

2.6.2 Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

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

2.6.2.1.1 Brady Corporation.
2.6.2.1.2 Carlton Industries, LP.
2.6.2.1.3 emedco.
2.6.2.1.4 Grafoplast Wire Markers.
2.6.2.1.5 LEM Products Inc.
2.6.2.1.6 Marking Services, Inc.
2.6.2.1.7 Panduit Corp.
2.6.2.1.8 Seton Identification Products.

2.6.3 Write-on Tags:

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

2.6.3.1.1 Carlton Industries, LP.
2.6.3.1.2 LEM Products Inc.

2.6.3.1.3 Seton Identification Products.
2.6.3.2 Polyester Tags: 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment.
2.6.3.3 Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2.6.3.4 Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

2.7.1 Baked-Enamel Signs:

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

2.7.1.1.1 Carlton Industries, LP.
2.7.1.1.2 Champion America.
2.7.1.1.3 emedco.
2.7.1.1.4 Marking Services, Inc.

2.7.1.2 Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
2.7.1.3 1/4-inch grommets in corners for mounting.
2.7.1.4 Nominal Size: 7 by 10 inches.

2.7.2 Metal-Backed Butyrate Signs:

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

2.7.2.1.1 Brady Corporation.
2.7.2.1.2 Champion America.
2.7.2.1.3 emedco.
2.7.2.1.4 Marking Services, Inc.

2.7.2.2 Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2.7.2.3 1/4-inch grommets in corners for mounting.
2.7.2.4 Nominal Size: 10 by 14 inches.

2.7.3 Laminated Acrylic or Melamine Plastic Signs:

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

2.7.3.1.1 Brady Corporation.
2.7.3.1.2 Carlton Industries, LP.
2.7.3.1.3 emedco.
2.7.3.1.4 Marking Services, Inc.

2.7.3.2 Engraved legend.
2.7.3.3 Thickness:

2.7.3.3.1 For signs up to 20 sq. in., minimum 1/16 inch thick.
2.7.3.3.2 For signs larger than 20 sq. in., 1/8 inch thick.
2.7.3.3.3 Engraved legend with white letters on a dark gray background.
2.7.3.3.4 Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
2.7.3.3.5 Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

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

2.8.1.1 HellermannTyton.
2.8.1.2 Ideal Industries, Inc.
2.8.1.3 Marking Services, Inc.
2.8.1.4 Panduit Corp.

2.8.2 General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

2.8.2.1 Minimum Width: 3/16 inch.
2.8.2.2 Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
2.8.2.3 Temperature Range: Minus 40 to plus 185 deg F.
2.8.2.4 Color: Black, except where used for color-coding.

2.8.3 UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

2.8.3.1 Minimum Width: 3/16 inch.
2.8.3.2 Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
2.8.3.3 Temperature Range: Minus 40 to plus 185 deg F.
2.8.3.4 Color: Black.

2.8.4 Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

2.8.4.1 Minimum Width: 3/16 inch.
2.8.4.2 Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.
2.8.4.3 UL 94 Flame Rating: 94V-0.
2.8.4.4 Temperature Range: Minus 50 to plus 284 deg F.
2.8.4.5 Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

2.9.1 Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

2.9.2 Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

3.2.1 Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

3.2.2 Install identifying devices before installing acoustical ceilings and similar concealment.

3.2.3 Verify identity of each item before installing identification products.

3.2.4 Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

3.2.5 Apply identification devices to surfaces that require finish after completing finish work.

3.2.6 Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

3.2.7 System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

3.2.7.1 Secure tight to surface of conductor, cable, or raceway.

3.2.8 System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

3.2.8.1 Secure tight to surface of conductor, cable, or raceway.

3.2.9 Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

3.2.10 Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for load shedding.

3.2.11 Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

3.2.12 Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:

3.2.12.1 "EMERGENCY POWER."
3.2.12.2 "POWER."

3.2.13 Vinyl Wraparound Labels:

3.2.13.1 Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
3.2.13.2 Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

3.2.14 Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

3.2.15 Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

3.2.16 Self-Adhesive Labels:

3.2.16.1 On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
3.2.16.2 Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

3.2.17 Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

3.2.18 Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

3.2.19 Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

3.2.20 Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

3.2.20.1 Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

3.2.21 Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

3.2.22 Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

3.2.23 Underground Line Warning Tape:

3.2.23.1 During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
3.2.23.2 Limit use of underground-line warning tape to direct-buried cables.
3.2.23.3 Install underground-line warning tape for direct-buried cables and cables in raceways.

3.2.24 Metal Tags:

3.2.24.1 Place in a location with high visibility and accessibility.
3.2.24.2 Secure using UV-stabilized / plenum-rated cable ties.

3.2.25 Nonmetallic Preprinted Tags:

3.2.25.1 Place in a location with high visibility and accessibility.

3.2.25.2 Secure using UV-stabilized / plenum-rated cable ties.

3.2.26 Write-on Tags:

3.2.26.1 Place in a location with high visibility and accessibility.
3.2.26.2 Secure using UV-stabilized / plenum-rated cable ties.

3.2.27 Baked-Enamel Signs:

3.2.27.1 Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
3.2.27.2 Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on minimum 1-1/2-inch- high sign; where two lines of text are required, use signs minimum 2 inches high.

3.2.28 Metal-Backed Butyrate Signs:

3.2.28.1 Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
3.2.28.2 Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

3.2.29 Laminated Acrylic or Melamine Plastic Signs:

3.2.29.1 Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
3.2.29.2 Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

3.2.30 Cable Ties: General purpose, for attaching tags, except as listed below:

3.2.30.1 Outdoors: UV-stabilized nylon.
3.2.30.2 In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

3.3.1 Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

3.3.2 Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

3.3.3 Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch- high, black letters on 20-inch centers.

3.3.3.1 Locate identification at changes in direction, at penetrations of walls and floors, and at 10-foot maximum intervals.

3.3.4 Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Vinyl wraparound labels / Snap-around labels / Self-adhesive labels / Snap-around color-coding bands for raceway and cables.

3.3.4.1 Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

3.3.5 Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels / vinyl tape applied in bands.

3.3.5.1 Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

3.3.6 Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:

3.3.6.1 "EMERGENCY POWER."
3.3.6.2 "POWER."

3.3.7 Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels snap-around color-coding bands / self-adhesive vinyl tape to identify the phase.

3.3.7.1 Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

3.3.8 Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.

3.3.9 Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.

3.3.10 Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.

3.3.11 Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

3.3.12 Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

3.3.12.1 Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

3.3.13 Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

3.3.14 Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:

3.3.14.1 Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
3.3.14.2 Wall surfaces directly external to raceways concealed within wall.
3.3.14.3 Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

3.3.15 Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

3.3.16 Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

3.3.17 Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.

3.3.17.1 Apply to exterior of door, cover, or other access.
3.3.17.2 For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

3.3.17.2.1 Power-transfer switches.
3.3.17.2.2 Controls with external control power connections.

3.3.18 Arc Flash Warning Labeling: Self-adhesive labels.

3.3.19 Operating Instruction Signs: Baked-enamel warning signs / Metal-backed, butyrate warning signs.

3.3.20 Emergency Operating Instruction Signs: Baked-enamel warning signs / Metal-backed, butyrate warning signs / Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer / load shedding.

3.3.21 Equipment Identification Labels:

3.3.21.1 Indoor Equipment: Baked-enamel signs / Metal-backed butyrate signs / Laminated acrylic or melamine plastic sign.
3.3.21.2 Outdoor Equipment: Laminated acrylic or melamine sign / Stenciled legend 4 inches high.
3.3.21.3 Equipment to Be Labeled:

3.3.21.3.1 Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
3.3.21.3.2 Enclosures and electrical cabinets.
3.3.21.3.3 Access doors and panels for concealed electrical items.
3.3.21.3.4 Switchgear.
3.3.21.3.5 Switchboards.
3.3.21.3.6 Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
3.3.21.3.7 Substations.
3.3.21.3.8 Emergency system boxes and enclosures.
3.3.21.3.9 Motor-control centers.
3.3.21.3.10 Enclosed switches.
3.3.21.3.11 Enclosed circuit breakers.
3.3.21.3.12 Enclosed controllers.
3.3.21.3.13 Variable-speed controllers.
3.3.21.3.14 Push-button stations.
3.3.21.3.15 Power-transfer equipment.
3.3.21.3.16 Contactors.
3.3.21.3.17 Remote-controlled switches, dimmer modules, and control devices.

3.3.21.3.18Battery-inverter units.
3.3.21.3.19Battery racks.
3.3.21.3.20Monitoring and control equipment.

END OF SECTION

SECTION 26 05 73.13

SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 DEFINITIONS

1.3.1 Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

1.3.2 Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

1.3.3 One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

1.3.4 Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

1.3.5 Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

1.3.6 Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

1.3.7 SCCR: Short-circuit current rating.

1.3.8 Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.3.9 Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

1.4.1 Product Data:

1.4.1.1 For computer software program to be used for studies.
1.4.1.2 Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form and printed form.

1.4.1.2.1 Short-circuit study input data, including completed computer program input data sheets.
1.4.1.2.2 Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

1.4.1.2.2.1 Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Engineer of Record for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
1.4.1.2.2.2 Revised one-line diagram, reflecting field investigation results and results of short-circuit study. Instructions shall be provided to the vendor of Electrical Gears, MCC, Panelboard & Switches for providing coordinated Circuit Breaker, Fuses, and the Contractor must bear cost of recommended sizes/types instead of those shown in Performance Work Statement Documents.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Qualification Data:

1.5.1.1 For Power Systems Analysis Software Developer.
1.5.1.2 For Power System Analysis Specialist.
1.5.1.3 For Field Adjusting Agency.

1.5.2 Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

1.6.1 Operation and Maintenance Data:

1.6.1.1 For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
1.6.1.2 The following are from the Short-Circuit Study Report:

1.6.1.2.1 Final one-line diagram.
1.6.1.2.2 Final Short-Circuit Study Report.
1.6.1.2.3 Short-circuit study data files and printed form.
1.6.1.2.4 Power system data.

1.7 QUALITY ASSURANCE

1.7.1 Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

1.7.2 Software algorithms shall comply with requirements of standards and guides specified in this Section.

1.7.3 Manual calculations are unacceptable.

1.7.3.1 Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
1.7.3.2 Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

1.7.4 Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

1.7.5 Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.

1.7.6 Field Adjusting Agency Qualifications:

1.7.6.1 Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
1.7.6.2 A member company of NETA.
1.7.6.3 Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

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

2.1.1.1 CGI CYME.
2.1.1.2 ETAP Corporation.
2.1.1.3 ESA Inc.
2.1.1.4 Operation Technology, Inc.
2.1.1.5 Power Analytics, Corporation.
2.1.1.6 SKM Systems Analysis, Inc.

2.1.2 Comply with IEEE 399 and IEEE 551.

2.1.2.1 Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.1.3 Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

2.2.1 Executive summary of study findings.

2.2.2 Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

2.2.3 One-line diagram of modeled power system, showing the following:

2.2.3.1 Protective device designations and ampere ratings.
2.2.3.2 Conductor types, sizes, and lengths.
2.2.3.3 Transformer kilovolt ampere (kVA) and voltage ratings.
2.2.3.4 Motor and generator designations and kVA ratings.
2.2.3.5 Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
2.2.3.6 Derating factors and environmental conditions.
2.2.3.7 Any revisions to electrical equipment required by the study.

2.2.4 Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

2.2.5 Protective Device Evaluation:

2.2.5.1 Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
2.2.5.2 Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
2.2.5.3 For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2.2.5.4 For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
2.2.5.5 Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

2.2.6 Short-Circuit Study Input Data:

2.2.6.1 One-line diagram of system being studied.
2.2.6.2 Power sources available.
2.2.6.3 Manufacturer, model, and interrupting rating of protective devices.
2.2.6.4 Conductors.
2.2.6.5 Transformer data.
2.2.6.6 Collect Motor Information from Process – Vendor/s Responsible for providing Pump Motors.

2.2.7 Short-Circuit Study Output Reports:

2.2.7.1 Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

2.2.7.1.1 Voltage.
2.2.7.1.2 Calculated fault-current magnitude and angle.
2.2.7.1.3 Fault-point X/R ratio.
2.2.7.1.4 Equivalent impedance.

2.2.7.2 Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

2.2.7.2.1 Voltage.
2.2.7.2.2 Calculated symmetrical fault-current magnitude and angle.
2.2.7.2.3 Fault-point X/R ratio.

2.2.7.2.4 Calculated asymmetrical fault currents:

2.2.7.2.4.1 Based on fault-point X/R ratio.
2.2.7.2.4.2 Based on calculated symmetrical value multiplied by 1.6.
2.2.7.2.4.3 Based on calculated symmetrical value multiplied by 2.7.

2.2.7.3 Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

2.2.7.3.1 Voltage.
2.2.7.3.2 Calculated symmetrical fault-current magnitude and angle.
2.2.7.3.3 Fault-point X/R ratio.
2.2.7.3.4 No AC Decrement (NACD) ratio.
2.2.7.3.5 Equivalent impedance.
2.2.7.3.6 Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
2.2.7.3.7 Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

3.1.1 Obtain all data necessary for conduct of the study.

3.1.1.1 Verify completeness of data supplied on one-line diagram. Call any discrepancies to Engineer of Record’s attention.
3.1.1.2 For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3.1.1.3 For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

3.1.2 Gather and tabulate the required input data to support the short-circuit study. Comply with requirements for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

3.1.2.1 Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
3.1.2.2 Obtain electrical power utility impedance at the service.
3.1.2.3 Power sources and ties.
3.1.2.4 For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
3.1.2.5 For reactors, provide manufacturer and model designation, voltage rating, and impedance.
3.1.2.6 For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.

3.1.2.7 Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
3.1.2.8 Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
3.1.2.9 Motor horsepower and NEMA MG 1 code letter designation.
3.1.2.10 Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
3.1.2.11 Derating factors.

3.2 SHORT-CIRCUIT STUDY

3.2.1 Perform study following the general study procedures contained in IEEE 399.

3.2.2 Calculate short-circuit currents according to IEEE 551.

3.2.3 Base study on device characteristics supplied by device manufacturer.

3.2.4 Extent of electrical power system to be studied is indicated on Drawings.

3.2.5 Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:

3.2.5.1 To normal system low-voltage load buses where fault current is 10 kA or less.
3.2.5.2 Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

3.2.6 Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

3.2.7 Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

3.2.8 Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

3.2.8.1 For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

3.2.9 Include in the report identification of any protective device applied outside its capacity.

END OF SECTION

SECTION 26 05 73.16

COORDINATION STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1.2.1.1 Study results shall be used to determine coordination of series-rated devices.

1.3 DEFINITIONS

1.3.1 Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

1.3.2 Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

1.3.3 One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

1.3.4 Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

1.3.5 Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

1.3.6 Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

1.3.7 SCCR: Short-circuit current rating.

1.3.8 Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.3.9 Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

1.4.1 Product Data:

1.4.1.1 For computer software program to be used for studies.

1.4.1.2 Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form along with printed copy.

1.4.1.2.1 Coordination-study input data, including completed computer program input data sheets.

1.4.1.2.2 Study and equipment evaluation reports.

1.4.1.3 Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.

1.4.1.3.1 Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Qualification Data:

1.5.1.1 For Power System Analysis Software Developer.

1.5.1.2 For Power Systems Analysis Specialist.

1.5.1.3 For Field Adjusting Agency.

1.5.2 Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

1.6.1 Operation and Maintenance Data: For overcurrent protective devices to include in emergency, operation, and maintenance manuals.

1.6.1.1 The following are from the Coordination Study Report:

1.6.1.1.1 Final one-line diagram.

1.6.1.1.2 Final protective device coordination study.

1.6.1.1.3 Coordination study data files.

1.6.1.1.4 List of all protective device settings. Type 8 Sizes of Breakers/Fuses.

1.6.1.1.5 Time-current coordination curves.

1.6.1.1.6 Power system data.

1.7 QUALITY ASSURANCE

1.7.1 Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.

1.7.2 Software algorithms shall comply with requirements of standards and guides specified in this Section.

1.7.3 Manual calculations are unacceptable.

1.7.4 Power System Analysis Software Qualifications:

1.7.4.1 Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.
1.7.4.2 Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

1.7.5 Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

1.7.6 Field Adjusting Agency Qualifications:

1.7.6.1 Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.
1.7.6.2 A member company of NETA.
1.7.6.3 Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

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

2.1.1.1 CGI CYME.
2.1.1.2 ETRAP Corporation.
2.1.1.3 ESA Inc.
2.1.1.4 Operation Technology, Inc.
2.1.1.5 Power Analytics, Corporation.
2.1.1.6 SKM Systems Analysis, Inc.

2.1.2 Comply with IEEE 242 and IEEE 399.

2.1.3 Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.1.4 Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

2.1.4.1 Optional Features:

2.1.4.1.1 Arcing faults.
2.1.4.1.2 Simultaneous faults.

2.1.4.1.3 Explicit negative sequence.
2.1.4.1.4 Mutual coupling in zero sequence.

2.2 COORDINATION STUDY REPORT CONTENTS

2.2.1 Executive summary of study findings.

2.2.2 Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

2.2.3 One-line diagram of modeled power system, showing the following:

2.2.3.1 Protective device designations and ampere ratings, Types 8 Sizes of Breakers/Fuses.
2.2.3.2 Conductor types, sizes, and lengths.
2.2.3.3 Transformer kilovolt ampere (kVA) and voltage ratings.
2.2.3.4 Motor designations and kVA ratings.
2.2.3.5 Switchgear, switchboard, motor-control center, and panelboard designations.
2.2.3.6 Any revisions to electrical equipment required by the study.
2.2.3.7 Study Input Data: As described in "Power System Data" Article.

2.2.3.7.1 Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73.13 "Short-Circuit Studies."

2.2.4 Protective Device Coordination Study:

2.2.4.1 Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

2.2.4.1.1 Phase and Ground Relays:

2.2.4.1.1.1 Device tag.
2.2.4.1.1.2 Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
2.2.4.1.1.3 Recommendations on improved relaying systems, if applicable.

2.2.4.1.2 Circuit Breakers:

2.2.4.1.2.1 Adjustable pickups and time delays (long time, short time, and ground).
2.2.4.1.2.2 Adjustable time-current characteristic.
2.2.4.1.2.3 Adjustable instantaneous pickup.
2.2.4.1.2.4 Recommendations on improved trip systems, if applicable.

2.2.4.1.3 Fuses: Show current rating, voltage, and class.
2.2.4.1.4 Coordinated Selective Ratings, Sizes of Breakers/Fuses.

2.2.5 Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

2.2.5.1 Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2.2.5.2 Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
2.2.5.3 Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
2.2.5.4 Plot the following listed characteristic curves, as applicable:

2.2.5.4.1 Power utility's overcurrent protective device.
2.2.5.4.2 Medium-voltage equipment overcurrent relays.
2.2.5.4.3 Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
2.2.5.4.4 Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
2.2.5.4.5 Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
2.2.5.4.6 Cables and conductors damage curves.
2.2.5.4.7 Ground-fault protective devices.
2.2.5.4.8 Motor-starting characteristics and motor damage points.
2.2.5.4.9 Generator short-circuit decrement curve and generator damage point.
2.2.5.4.10 The largest feeder circuit breaker in each motor-control center and panelboard.

2.2.5.5 Maintain selectivity for tripping currents caused by overloads.
2.2.5.6 Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
2.2.5.7 Provide adequate time margins between device characteristics such that selective operation is achieved.
2.2.5.8 Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

3.1.1.1 Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

3.2.1 Obtain all data necessary for conduct of the overcurrent protective device study.

3.2.1.1 Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
3.2.1.2 For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3.2.1.3 For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified

technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

3.2.2 Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

3.2.2.1 Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
3.2.2.2 Electrical power utility impedance at the service.
3.2.2.3 Power sources and ties.
3.2.2.4 Short-circuit current at each system bus (three phase and line to ground).
3.2.2.5 Full-load current of all loads.
3.2.2.6 Voltage level at each bus.
3.2.2.7 For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
3.2.2.8 For reactors, provide manufacturer and model designation, voltage rating, and impedance.
3.2.2.9 For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
3.2.2.10 For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
3.2.2.11 Maximum demands from service meters.
3.2.2.12 Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
3.2.2.13 Motor horsepower and NEMA MG 1 code letter designation.
3.2.2.14 Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
3.2.2.15 Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
3.2.2.16 Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:

3.2.2.16.1 Special load considerations, including starting inrush currents and frequent starting and stopping.
3.2.2.16.2 Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
3.2.2.16.3 Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
3.2.2.16.4 Ratings, types, and settings of utility company's overcurrent protective devices.
3.2.2.16.5 Special overcurrent protective device settings or types stipulated by utility company.
3.2.2.16.6 Time-current-characteristic curves of devices indicated to be coordinated.
3.2.2.16.7 Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
3.2.2.16.8 Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
3.2.2.16.9 Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.

3.2.2.16.10 Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 COORDINATION STUDY

3.3.1 Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

3.3.2 Comply with IEEE 399 for general study procedures.

3.3.3 Base study on device characteristics supplied by device manufacturer.

3.3.4 Extent of electrical power system to be studied is indicated on Drawings.

3.3.5 Begin analysis at the service, extending down to system overcurrent protective devices as follows:

3.3.5.1 To normal system low-voltage load buses where fault current is 10 kA or less.
3.3.5.2 Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

3.3.6 Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

3.3.7 Transformer Primary Overcurrent Protective Devices:

3.3.7.1 Device shall not operate in response to the following:

3.3.7.1.1 Inrush current when first energized.
3.3.7.1.2 Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
3.3.7.1.3 Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

3.3.7.2 Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

3.3.8 Motor Protection:

3.3.8.1 Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
3.3.8.2 Select protection for motors served at voltages more than 600 V according to IEEE 620.

3.3.9 Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

3.3.10 Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

3.3.11 Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

3.3.11.1 For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

3.3.12 Protective Device Evaluation:

3.3.12.1 Evaluate equipment and protective devices and compare to short-circuit ratings.
3.3.12.2 Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3.3.12.3 Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.
3.3.12.4 Include in the report identification of any protective device applied outside its capacity.

3.4 LOAD-FLOW AND VOLTAGE-DROP STUDY

3.4.1 Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

3.4.1.1 Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
3.4.1.2 Determine load flow and voltage drop based on 80 percent of the design capacity of load buses.
3.4.1.3 Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.5 MOTOR-STARTING STUDY

3.5.1 Perform a motor-starting study to analyze the transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of motor starting on the power system stability.

3.5.2 Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and, and voltage sags so as not to affect operation of other utilization equipment on system supplying the motor.

3.6 FIELD ADJUSTING

3.6.1 Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" Performance Work Statement portion.

3.6.2 Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

3.6.3 Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

3.6.3.1 Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.7 DEMONSTRATION

3.7.1 Engage Power Systems Analysis Specialist to train Navy's maintenance personnel in the following:

3.7.1.1 Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.

3.7.1.2 Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.

3.7.1.3 For Navy's maintenance staff certified as NETA ETT-Certified Technicians Level III or NICET Electrical Power Testing Level III Technicians, teach how to adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION

SECTION 26 05 74

PROTECTIVE DEVICE ARC-FLASH HAZARD STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

1.3.1 Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3.2 Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

1.3.3 One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

1.3.4 Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

1.3.5 Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

1.3.6 Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

1.3.7 SCCR: Short-circuit current rating.

1.3.8 Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.3.9 Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For computer software program to be used for studies.

1.4.2 Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form and printed form.

1.4.2.1 Arc-flash study input data, including completed computer program input data sheets.
1.4.2.2 Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
1.4.2.3 Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Engineer of Record for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Qualification Data:

1.5.1.1 For Power Systems Analysis Software Developer.
1.5.1.2 For Power System Analysis Specialist.
1.5.1.3 For Field Adjusting Agency.

1.5.2 Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

1.6.1 Operation and Maintenance Data:

1.6.1.1 Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
1.6.1.2 Operation and Maintenance Procedures: In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

1.7.1 Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

1.7.2 Software algorithms shall comply with requirements of standards and guides specified in this Section.

1.7.3 Manual calculations are unacceptable.

1.7.4 Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1.7.4.1 Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
1.7.4.2 Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

1.7.5 Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

1.7.6 Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.

1.7.7 Field Adjusting Agency Qualifications:

1.7.7.1 Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
1.7.7.2 A member company of NETA.
1.7.7.3 Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

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

2.1.1.1 CGI CYME.
2.1.1.2 ETAP Corporation.
2.1.1.3 ESA Inc.
2.1.1.4 Operation Technology, Inc.
2.1.1.5 Power Analytics, Corporation.
2.1.1.6 SKM Systems Analysis, Inc.

2.1.2 Comply with IEEE 1584 and NFPA 70E.

2.1.3 Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

2.2.1 Executive summary of study findings.

2.2.2 Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

2.2.3 One-line diagram, showing the following:

2.2.3.1 Protective device designations and ampere ratings.
2.2.3.2 Conductor types, sizes, and lengths.
2.2.3.3 Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
2.2.3.4 Motor designations and kVA ratings.
2.2.3.5 Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

2.2.4 Study Input Data: As described in "Power System Data" Article.

2.2.5 Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73.13 “Short-Circuit Studies”

2.2.6 Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 26 05 73.16 "Coordination Studies."

2.2.7 Arc-Flash Study Output Reports:

2.2.7.1 Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:

2.2.7.1.1 Voltage.
2.2.7.1.2 Calculated symmetrical fault-current magnitude and angle.
2.2.7.1.3 Fault-point X/R ratio.
2.2.7.1.4 No AC Decrement (NACD) ratio.
2.2.7.1.5 Equivalent impedance.
2.2.7.1.6 Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
2.2.7.1.7 Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

2.2.8 Incident Energy and Flash Protection Boundary Calculations:

2.2.8.1 Arcing fault magnitude.
2.2.8.2 Protective device clearing time.
2.2.8.3 Duration of arc.
2.2.8.4 Arc-flash boundary.
2.2.8.5 Restricted approach boundary.
2.2.8.6 Limited approach boundary.
2.2.8.7 Working distance.
2.2.8.8 Incident energy.
2.2.8.9 Hazard risk category.
2.2.8.10 Recommendations for arc-flash energy reduction.

2.2.9 Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

2.3.1 Comply with requirements in Section 26 05 53 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

2.3.2 Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

2.3.2.1 Location designation.
2.3.2.2 Nominal voltage.
2.3.2.3 Protection boundaries.

2.3.2.3.1 Arc-flash boundary.
2.3.2.3.2 Restricted approach boundary.
2.3.2.3.3 Limited approach boundary.

2.3.2.4 Arc flash PPE category.

2.3.2.5 Required minimum arc rating of PPE in Cal/cm squared.
2.3.2.6 Available incident energy.
2.3.2.7 Working distance.
2.3.2.8 Engineering report number, revision number, and issue date.

2.3.3 Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

3.2.1 Comply with NFPA 70E and its Annex D for hazard analysis study.

3.2.2 Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis or obtain results from another source.

3.2.2.1 Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73.13 "Short-Circuit Studies."
3.2.2.2 Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 26 05 73.16 "Coordination Studies."

3.2.3 Calculate maximum and minimum contributions of fault-current size.

3.2.3.1 Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
3.2.3.2 Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
3.2.3.3 Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
3.2.3.4 Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.

3.2.4 Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

3.2.5 Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.

3.2.6 Calculate the limited, restricted, and prohibited approach boundaries for each location.

3.2.7 Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

3.2.7.1 Fault contribution from induction motors shall not be considered beyond three to five cycles.
3.2.7.2 Fault contribution from synchronous motors shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

3.2.8 Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:

3.2.8.1 When the circuit breaker is in a separate enclosure.
3.2.8.2 When the line terminals of the circuit breaker are separate from the work location.

3.2.9 Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

3.3.1 Obtain all data necessary for conduct of the arc-flash hazard analysis.

3.3.1.1 Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Engineer of Record's attention.
3.3.1.2 For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
3.3.1.3 For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.

3.3.2 Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

3.3.2.1 Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
3.3.2.2 Obtain electrical power utility impedance or available short circuit current at the service.
3.3.2.3 Power sources and ties.
3.3.2.4 Short-circuit current at each system bus (three phase and line to ground).
3.3.2.5 Full-load current of all loads.
3.3.2.6 Voltage level at each bus.
3.3.2.7 For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
3.3.2.8 For reactors, provide manufacturer and model designation, voltage rating and impedance.
3.3.2.9 For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
3.3.2.10 For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
3.3.2.11 Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.

3.3.2.12 Motor horsepower and NEMA MG 1 code letter designation.
3.3.2.13 Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
3.3.2.14 Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

3.4.1 Apply one arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

3.4.2 Each piece of equipment listed below shall have an arc-flash label applied to it:

3.4.2.1 Motor-control center.
3.4.2.2 Low-voltage switchboard.
3.4.2.3 Switchgear.
3.4.2.4 Medium-voltage switch.
3.4.2.5 Medium voltage transformers
3.4.2.6 Low voltage transformers. Exclude transformers with high voltage side 240 V or less and less than 125 kVA.
3.4.2.7 Panelboard and safety switch over 250 V.
3.4.2.8 Applicable panelboard and safety switch under 250 V.
3.4.2.9 Control panel.

3.4.3 Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.

3.4.3.1 Indicate arc-flash energy.
3.4.3.2 Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

3.5.1 Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.6 DEMONSTRATION

3.6.1 Engage Power Systems Analysis Specialist to train Navy's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION

SECTION 26 09 13

ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section includes equipment and systems used to monitor and control electrical consumption:

1.2.1.1 Multifunction meters.
1.2.1.2 Power meters.
1.2.1.3 Circuit meters and monitors.
1.2.1.4 Circuit meters and explorer instruments.
1.2.1.5 Electrical power monitoring system software.
1.2.1.6 Electrical power monitoring and control software.
1.2.1.7 Network configuration software.
1.2.1.8 Monitoring and control of power distribution equipment.
1.2.1.9 System operator interfaces.
1.2.1.10 Desktop workstations.
1.2.1.11 Portable workstations.
1.2.1.12 Raceways and boxes.
1.2.1.13 Wires and cables.
1.2.1.14 Identification.

1.3 DEFINITIONS

1.3.1 Active Power: The average power consumed by a unit. Also known as "real power."

1.3.2 Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

1.3.3 Apparent (Phasor) Power: "S = VI" where "S" is the apparent power, "V" is the rms value of the voltage, and "I" is the rms value of the current.

1.3.4 Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

1.3.5 KY Pulse: A method of measuring consumption of electricity that is based on a relay operating like a SPST switch.

1.3.6 KYZ Pulse: A method of measuring consumption of electricity based on a relay operating like a SPDT switch.

1.3.7 LAN: Local area network.

1.3.8 L-G: Line to ground.

1.3.9 L-L: Line to line.

1.3.10 L-N: Line to neutral.

1.3.11 Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.

1.3.12 Modbus TCP/IP: An open protocol for exchange of process data.

1.3.13 Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

1.3.14 N-G: Neutral to ground.

1.3.15 Power Factor: The ratio of active power to apparent power, sometimes expressed in percentage.

1.3.16 rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

1.3.17 TCP/IP: Transport control protocol/Internet.

1.3.18 UPS: Uninterruptible power supply; used both in singular and plural context.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of product.

1.4.1.1 Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for power monitoring and control.

1.4.1.2 Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4.2 Shop Drawings: For power monitoring and control of HVAC equipment.

1.4.2.1 Include plans, elevations, sections, and attachment details.

1.4.2.2 Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.

1.4.2.2.1 Attach copies of approved Product Data submittals for products (such as switchboards, switchgear, and motor-control centers) that describe the following:

1.4.2.2.1.1 Location of the meters and gateways, and routing of the connecting wiring.

1.4.2.2.1.2 Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

1.4.2.3 Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

1.4.2.4 Network naming and numbering scheme.
1.4.2.5 Include diagrams for power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
1.4.2.6 Specifications for workstations.
1.4.2.7 UPS sizing calculations for workstation.
1.4.2.8 Surge Suppressors: Data for each device used and where applied.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Field quality-control reports.

1.5.2 Design Data:

1.5.2.1 Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

1.5.2.1.1 Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
1.5.2.1.2 Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
1.5.2.1.3 As-built versions of submittal Product Data.
1.5.2.1.4 Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
1.5.2.1.5 Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
1.5.2.1.6 Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
1.5.2.1.7 Engineering, installation, and maintenance manuals that explain how to do the following:

1.5.2.1.7.1 Design and install new points, panels, and other hardware.
1.5.2.1.7.2 Perform preventive maintenance and calibration.
1.5.2.1.7.3 Debug hardware problems.
1.5.2.1.7.4 Repair or replace hardware.

1.5.2.1.8 Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
1.5.2.1.9 Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.
1.5.2.1.10 Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
1.5.2.1.11 Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
1.5.2.1.12 Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
1.5.2.1.13 Navy training materials.

1.6 CLOSEOUT SUBMITTALS

1.6.1 Operation and Maintenance Data: For power monitoring and control units to include in operation and maintenance manuals.

1.6.2 Software and Firmware Operational Documentation:

1.6.2.1 Software operating and upgrade manuals.
1.6.2.2 Software licenses.
1.6.2.3 Software service agreement.
1.6.2.4 PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Provide separately for each PC.
1.6.2.5 Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on compact disk or portable storage device with a USB interface of the hard-copy submittal.
1.6.2.6 Program Software Backup: On compact disk or portable storage device with a USB interface, complete with data files.
1.6.2.7 Device address list.
1.6.2.8 Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

1.7.1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7.1.1 Addressable Relays: One for every 10 installed. Furnish at least one of each type.
1.7.1.2 Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

1.8.1 Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 COORDINATION

1.9.1 Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

1.9.1.1 Match components and interconnections for optimum performance of specified functions.

1.9.2 Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Microprocessor-based monitoring and control of electrical power distribution system(s) that includes the following:

2.1.1.1 Electrical meters that monitor, control, and connect to the data transmission network.

2.1.1.2 LAN: High-speed, multi-access, open, nonproprietary, industry-standard communication protocols.

2.1.1.3 Include multiple PC-based workstations with web access, with its operating system and application software, connected to data transmission network.

2.1.2 The electrical power monitoring and control system shall be Internet based.

2.1.2.1 System software shall be based on server thin-client architecture, designed around open standards of internet technology.

2.1.2.2 Intent of thin-client architecture is to provide operators complete access to power monitoring and control system via an Internet browser. No special software other than an Internet browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.

2.1.2.3 Internet access shall be password protected.

2.1.3 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.1.4 UL Compliance: Listed and labeled as complying with UL 61010-1.

2.2 PERFORMANCE REQUIREMENTS

2.2.1 Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.

2.2.1.1 Minimum Protection for Power Lines 120 V and More: SPDs complying with UL 1449, listed and labeled for intended use by an NRTL acceptable to authorities having jurisdiction.

2.2.1.2 Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.

2.2.2 Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.

2.2.3 Interface with DDC System for HVAC: Provide factory-installed hardware and software to enable the DDC system for HVAC to monitor, display, and record data for use in processing reports.

2.2.3.1 Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours), power factor.

2.2.3.2 ASHRAE 135 (BACnet) Modbus Industry-accepted, open-protocol communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely monitor meter information from a DDC system for HVAC workstation. Control features and monitoring points displayed locally at metering panel shall be available through the DDC system for HVAC. The New DDC System shall be compatible with existing systems.

2.2.4 Backup Power Source:

2.2.4.1 Electrical power distribution equipment served by a backup power source for controls shall have associated power monitoring and control system products that monitor and control such systems and equipment also served from a backup power source.

2.3 MULTIFUNCTION ENERGY METERS

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

2.3.1.1 Eaton.
2.3.1.2 General Electric Company.
2.3.1.3 Schneider Electric USA, Inc.

2.3.2 Multifunction Energy Meter: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power and energy metering and monitoring; complying with UL 61010-1.

2.3.2.1 Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
2.3.2.2 Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

2.3.3 Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

2.3.3.1 Indoor installation in nontemperature-controlled spaces that have environmental controls to maintain ambient conditions of minus 4 deg to 158 deg F dry bulb and 5 to 95 percent relative humidity, noncondensing.
2.3.3.2 Comply with IEC 60529 degree of protection code of IP65 for the front of the meter, and code of IP30 for the body.

2.3.4 Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

2.3.5 Accuracy:

2.3.5.1 Comply with ANSI C12.20, Class 0.5.
2.3.5.2 Neutral Current Measurement: Not more than 0.65 percent.
2.3.5.3 Power Factor: 1.0 percent.
2.3.5.4 Frequency: 0.1 percent.
2.3.5.5 THD: 1.0 percent.
2.3.5.6 Waveform Sampling: 64 per cycle.

2.3.6 Data Link:

2.3.6.1 RS-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port.

2.3.7 Meter Physical Characteristics:

2.3.7.1 Display: Backlit LCD with antiglare and scratch-resistant lens.
2.3.7.2 Display of Metered Values:

2.3.7.2.1 One screen to show at least three user-selected values displayed at the same time. Selections available to display shall include the following:

2.3.7.2.1.1 All meters.

2.3.7.2.1.2 Measurements.
2.3.7.2.1.3 THD.
2.3.7.2.1.4 Energy.
2.3.7.2.1.5 Demand.
2.3.7.2.1.6 Minimum and maximum values.
2.3.7.2.1.7 Power demand.

2.3.8 Sampling Rate: Continuously sample and record voltage and current at a rate not less than 64 samples per cycle, simultaneously on all voltage and current channels of the meter.

2.3.9 Meters:

2.3.9.1 Instantaneous, rms:

2.3.9.1.1 Current: Each phase, neutral and three-phase average.
2.3.9.1.2 Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
2.3.9.1.3 Active Power (kW): Each phase and three-phase total.
2.3.9.1.4 Reactive Power (kVAR): Each phase and three-phase total.
2.3.9.1.5 Apparent Power (kVA): Each phase and three-phase total.
2.3.9.1.6 Power Factor: Each phase and three-phase total.

2.3.9.2 Energy:

2.3.9.2.1 Active Energy (kWh): Three-phase total.

2.3.9.3 Demand, Derived from Instantaneous rms Meters:

2.3.9.3.1 Current: Present and maximum.
2.3.9.3.2 Active: Present and maximum.
2.3.9.3.3 Reactive: Present and maximum.
2.3.9.3.4 Apparent: Present and maximum.

2.3.9.4 Power Quality Measurements:

2.3.9.4.1 THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.

2.3.10 I/O: Two optically isolated digital outputs for KY pulsing or control. Output signal characteristics shall be 150 mA at 200 V.

2.3.10.1 KY Pulse: Generate standard KY pulses for a user-defined increment of metered active energy as follows:

2.3.10.1.1 User-defined pulse output, associated with kWh.
2.3.10.1.2 User-defined pulse output, associated with kVARh.

2.3.11 Capacities and Characteristics:

2.3.11.1 Power Supply: 120-V ac, 60 Hz.
2.3.11.2 Circuit Connections:

2.3.11.2.1 Voltage: Measurement autoranging, 60- to 400-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers or Connect to instrument grade potential transformers secondary at 120 V. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.

2.3.11.2.2 Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.

2.3.11.2.3 Frequency: 45 to 65 Hz.

2.3.11.2.4 Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.4 POWER METERS

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

2.4.1.1 Eaton.
2.4.1.2 General Electric Company.
2.4.1.3 Schneider Electric USA, Inc.
2.4.1.4 Siemens Industry, Inc., Energy Management Division.

2.4.2 Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1.

2.4.2.1 Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
2.4.2.2 Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

2.4.3 Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

2.4.3.1 Indoor installation in spaces that have environmental controls to maintain ambient conditions of minus 13 to 60 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
2.4.3.2 Comply with IEC 60529 degree of protection code of IP51 for the front of the meter, and code of IP30 for the body.

2.4.4 Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

2.4.5 Accuracy:

2.4.5.1 Comply with ANSI C12.20, Class 0.5.
2.4.5.2 Neutral Current Measurement: Not more than 0.65 percent.
2.4.5.3 Power: 0.6 percent.
2.4.5.4 Power Factor: 0.5 percent.
2.4.5.5 Active Energy: 0.6 percent.
2.4.5.6 Reactive Energy: 2.5 percent.
2.4.5.7 Frequency: 0.05 percent.
2.4.5.8 THD: 1.0 percent.
2.4.5.9 Waveform Sampling: 32 per cycle.

2.4.6 Data Link:

2.4.6.1 RS-485 Modbus RTU protocol, 4-wire connection.

2.4.6.1.1 Provide for firmware and software updates through the communications port.

2.4.7 Meter Physical Characteristics:

2.4.7.1 Display: Backlit LCD with antiglare and scratch-resistant lens.
2.4.7.2 Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values. The screen selections available at the display shall include the following:

2.4.7.2.1 All meters, including those listed under the following:

2.4.7.2.1.1 Measurements.
2.4.7.2.1.2 THD.
2.4.7.2.1.3 Energy.
2.4.7.2.1.4 Demand.
2.4.7.2.1.5 Minimum and maximum values.
2.4.7.2.1.6 Power demand.

2.4.8 Sampling Rate: Continuously sample and record voltage and current at a rate not less than 32 samples per cycle, simultaneously on all voltage and current channels of the meter.

2.4.9 Meters:

2.4.9.1 Measurements: Instantaneous, in real time, rms to the 15th harmonic.

2.4.9.1.1 Voltage: L-L each phase, L-N each phase, and three-phase average.
2.4.9.1.2 Current: Each phase, three-phase average, and neutral.
2.4.9.1.3 Unbalanced current, L-L V ac and L-N V ac.
2.4.9.1.4 Active Power (+/- kW): Each phase and three-phase total.
2.4.9.1.5 Reactive Power (+/- kVAR): Each phase and three-phase total.
2.4.9.1.6 Apparent Power (+/- kVA): Each phase and three-phase total.
2.4.9.1.7 Displacement Power Factor: Each phase and three-phase total.
2.4.9.1.8 Distortion Power Factor: Each phase and three-phase total.
2.4.9.1.9 Frequency.

2.4.9.2 THD from measurements simultaneously from the same cycle, through 15th harmonic.

2.4.9.2.1 Voltage THD: L-L each phase, L-N each phase, and three-phase average.
2.4.9.2.2 Current THD: Each phase and three-phase average.
2.4.9.2.3 Total demand distortion.

2.4.9.3 Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory.

2.4.9.3.1 Active kWh.
2.4.9.3.2 Reactive kVARh.
2.4.9.3.3 Apparent kVAh.

2.4.9.4 Demand: Present, last, predicted, peak.

2.4.9.4.1 Three-phase average current.
2.4.9.4.2 Three-phase total active power (kW).
2.4.9.4.3 Reactive power (kVAR).
2.4.9.4.4 Apparent power (kVA).

2.4.9.5 Minimum and Maximum Values:

2.4.9.5.1 L-L and L-N voltages.
2.4.9.5.2 Current in each phase.
2.4.9.5.3 Power factor.
2.4.9.5.4 Active power total.
2.4.9.5.5 Reactive power total.
2.4.9.5.6 Apparent power total.
2.4.9.5.7 THD L-L and L-N voltages.
2.4.9.5.8 THD current in each phase.
2.4.9.5.9 Frequency.

2.4.10 Power Demand, User Selectable:

2.4.10.1 Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2.4.10.2 Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

2.4.10.2.1 Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
2.4.10.2.2 Fixed block that calculates demand at end of the interval.
2.4.10.2.3 Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

2.4.10.3 Demand Calculation Initiated by a Synchronization Signal:

2.4.10.3.1 Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
2.4.10.3.2 Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
2.4.10.3.3 Provide for synchronizing the demand with the internal of this instrument.

2.4.11 Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

2.4.11.1 Minimum and maximum of real-time rms measurement.
2.4.11.2 Energy.
2.4.11.3 Demand values.
2.4.11.4 Alarms, store the last 40 events.

2.4.12 Alarms: Transmit a digital output and show on display when alarmed. Provide for no fewer than 15 metered items. Each alarm shall be user configured, by using the following options:

2.4.12.1 Date and time stamp.
2.4.12.2 Enable-disable (default) or enable.
2.4.12.3 Pickup magnitude.
2.4.12.4 Pickup time delay.
2.4.12.5 Dropout magnitude.
2.4.12.6 Dropout time delay.
2.4.12.7 Alarm type.
2.4.12.8 Alarm label.

2.4.13 Output Signals: Provide two mechanical relays, rated not less than 250-V ac, 2-A resistive, and rated for 200-k cycles or more. The relays shall be user configurable in one of the following listed modes:

- 2.4.13.1 Normal contact closure where the contacts change state for as long as the signal exists.
- 2.4.13.2 Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
- 2.4.13.3 Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.

2.4.14 Meter Face:

- 2.4.14.1 Display: Backlit LCD display, six lines, with antiglare and scratch-resistant lens.
- 2.4.14.2 Display of Metered Values: One screen to show at least four user-selected values on one screen at the same time.
- 2.4.14.3 Provide for the reset of metered peak values.

2.4.15 Capacities and Characteristics:

- 2.4.15.1 Power Supply: 120-V ac, 60 Hz.
- 2.4.15.2 Circuit Connections:
  - 2.4.15.2.1 Voltage: Measurements autoranging, 60- to 400-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers or Connect to instrument grade potential transformers secondary at 120 V. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
  - 2.4.15.2.2 Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
  - 2.4.15.2.3 Frequency: 45 to 65 Hz.
  - 2.4.15.2.4 Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.5 CIRCUIT METERS AND MONITORS

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

- 2.5.1.1 Eaton.
- 2.5.1.2 General Electric Company.
- 2.5.1.3 Schneider Electric USA, Inc.
- 2.5.1.4 Siemens Industry, Inc., Energy Management Division.

2.5.2 Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.

- 2.5.2.1 Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

2.5.3 Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

2.5.3.1 Indoor installation in spaces that have environmental controls to maintain ambient conditions of 14 to 60 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
2.5.3.2 Comply with IEC 60529 degree of protection code of IP52 for the front of the meter, and code of IP30 for the back.

2.5.4 Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

2.5.5 Accuracy:

2.5.5.1 Comply with ANSI C12.20, Class 0.5.
2.5.5.2 For Voltage and Current: 0.5 percent of reading.
2.5.5.3 For Active Power: 0.2 percent.
2.5.5.4 For Active and Reactive Energy: ANSI 12.20, Class 0.2.
2.5.5.5 For Frequency: 0.01 Hz in the range of 45 to 65 Hz.
2.5.5.6 For Power Factor: 0.2 percent from 0.5 leading to 0.5 lagging.

2.5.6 Data Links:

2.5.6.1 RS-485 Modbus RTU protocol, 4-wire connection.
2.5.6.2 RS-232/RS-485 Modbus RTU/ASCII protocol, 4-wire connection.
2.5.6.3 Modbus TCP:

2.5.6.3.1 10/100BaseTX balanced twisted pair cabling. RJ-45 connector, 100-m link.
2.5.6.3.2 Optical fiber 100BaseFX, LC duplex connector, 1300-m link. Multimode 62.5/125-microsecond, 2000-m link.

2.5.6.4 Provide for firmware and software updates through the communications port.
2.5.6.5 Ethernet 10/100BaseTX balanced twisted pair cabling and RS-485 Modbus serial master port.
2.5.6.6 Ethernet 10/100BaseTX balanced twisted pair cabling and RS-485 Modbus serial master port, Ethernet to serial line gateway, and embedded web server.

2.5.7 Meter Physical Characteristics:

2.5.7.1 Display: Backlit LCD screen with antiglare and scratch-resistant lens.
2.5.7.2 Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.
2.5.7.3 Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

2.5.8 Sampling Rate:

2.5.8.1 Continuously sample and record voltage and current at a rate not less than 128 samples per cycle, simultaneously on all voltage and current channels of the meter.

2.5.9 Meters shall measure, record with time stamp, calculate, and on request display the following:

2.5.9.1 Measurements: Instantaneous, in real time, rms to the 63rd harmonic:

2.5.9.1.1 Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
2.5.9.1.2 Current: Each phase, three-phase average, and neutral.
2.5.9.1.3 Active Power (kW): Each phase and three-phase total.
2.5.9.1.4 Reactive Power (kVAR): Each phase and three-phase total.
2.5.9.1.5 Apparent Power (kVA): Each phase and three-phase total.
2.5.9.1.6 Displacement Power Factor: Each phase and three-phase total.
2.5.9.1.7 Distortion Power Factor: Each phase and three-phase total.
2.5.9.1.8 Frequency.

2.5.9.2 THD from measurements simultaneously from the same cycle, through 63rd harmonic:

2.5.9.2.1 Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
2.5.9.2.2 Current: Each phase, three-phase average, and neutral.

2.5.9.3 Energy: Accumulated, indicate in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.

2.5.9.3.1 Active kWh.
2.5.9.3.2 Reactive kVARh.
2.5.9.3.3 Apparent kVAh.

2.5.9.4 Demand: Three-phase totals, present, predicted, peak.

2.5.9.4.1 Average current.
2.5.9.4.2 Active power (kW).
2.5.9.4.3 Reactive power (kVAR).
2.5.9.4.4 Apparent power (kVA).

2.5.9.5 Average, Minimum and Maximum Values:

2.5.9.5.1 Record, date and time stamp, and save the minimum and maximum values of all rms metered values since the last reset.

2.5.10 Power Demand, User Selectable:

2.5.10.1 Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2.5.10.2 Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

2.5.10.2.1 Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
2.5.10.2.2 Fixed block that calculates demand at end of the interval.
2.5.10.2.3 Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

2.5.10.3 Demand Calculation Initiated by a Synchronization Signal:

2.5.10.3.1 Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.

2.5.10.3.2 Synchronize demand with receipt of a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
2.5.10.3.3 Provide for synchronization to the clock in the instrument.

2.5.11 Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters.

2.5.11.1 Record minimum, maximum, and average values of eight user-selected parameters as follows:

2.5.11.1.1 Every second for one minute for the one-minute curve.
2.5.11.1.2 Every minute for one hour for the one-hour curve.
2.5.11.1.3 Every hour for one day for the one-day curve.
2.5.11.1.4 Every day for one month for the one-month curve.

2.5.11.2 Forecast the trended parameters for the following:

2.5.11.2.1 The next four hours.
2.5.11.2.2 The next four days.

2.5.12 Waveform Capture:

2.5.12.1 Steady State Waveform Capture: Manually initiated.

2.5.12.1.1 Capture, record with time stamp, and store voltage and current waveforms for two cycles.
2.5.12.1.2 Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard shall be user configurable.
2.5.12.1.3 Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 63rd.
2.5.12.1.4 Captured waveforms shall be recorded from actual circuit performance.

2.5.12.2 Disturbance Waveform Capture:

2.5.12.2.1 Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The waveform captures shall be user configurable from 185 cycles on 1 channel at 16 points per cycle, to 3 cycles on 6 channels at 128 points per cycle.

2.5.13 Disturbance Detection and Alarm:

2.5.13.1 Detect and initiate alarm when detecting voltage or current sag and swell.

2.5.13.1.1 Detect disturbance events of less than half-cycle in length, by monitoring and calculating rms magnitude of each half-cycle.
2.5.13.1.2 Event detection shall be with user-defined parameters of threshold and delay. The threshold shall be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument shall automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
2.5.13.1.3 When detecting an alarm condition:

2.5.13.1.3.1 Initiate disturbance waveform capture.
2.5.13.1.3.2 Record the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.
2.5.13.1.3.3 Alarm on shall be visible on the display and be transmitted over the data link.
2.5.13.1.3.4 Display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.

2.5.14 Harmonics Information:

2.5.14.1 Calculate the harmonic magnitudes and angles for each phase voltage and current through the 63rd harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.
2.5.14.2 The current and voltage information for all phases shall be obtained simultaneously from the same cycle.
2.5.14.3 Report harmonic information as a percentage of the fundamental or as a percentage of the rms values, as selected by the user.

2.5.15 Alarms: Alarm events shall be user definable. Provide a minimum of 40 user-defined alarm conditions.

2.5.15.1 User Configuration Options:

2.5.15.1.1 Date and time stamp.
2.5.15.1.2 Enable-disable (default) or enable.
2.5.15.1.3 Pickup magnitude.
2.5.15.1.4 Pickup time delay.
2.5.15.1.5 Dropout magnitude.
2.5.15.1.6 Dropout time delay.
2.5.15.1.7 Alarm type.
2.5.15.1.8 Alarm label.

2.5.15.2 The following classes of events shall be available to be programmed as alarm events:

2.5.15.2.1 Over/under current.
2.5.15.2.2 Over/undervoltage.
2.5.15.2.3 Current imbalance.
2.5.15.2.4 Phase loss, current.
2.5.15.2.5 Phase loss, voltage.
2.5.15.2.6 Voltage imbalance.
2.5.15.2.7 Over kVA.
2.5.15.2.8 Over kW or kVAR into/out of load.
2.5.15.2.9 Over/under frequency.
2.5.15.2.10 Under power factor, true or displacement.
2.5.15.2.11 Over THD.
2.5.15.2.12 Over demand, current or power.
2.5.15.2.13 Reverse power.
2.5.15.2.14 Phase reversal.
2.5.15.2.15 Status input change.
2.5.15.2.16 End of incremental energy interval.
2.5.15.2.17 End of demand interval.
2.5.15.2.18 Over/under analog inputs.
2.5.15.2.19 Current sag/swell.
2.5.15.2.20 Voltage sag/swell.

2.5.15.3 For each over/under metered alarm value, provide for the user to define a pickup, dropout, and delay.
2.5.15.4 The circuit meter and monitor alarms response time shall be not less than one second.
2.5.15.5 Provide for up to four alarms to be combined to give a single result using Boolean algebra operations.

2.5.16 EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.

2.5.17 I/O Module: Modular, with multiple I/O options to accomplish specified performance and one or more spare positions for future.

2.5.17.1 KY Pulse: Generate a standard KY pulses for a user-defined increment of metered active energy as follows:

2.5.17.1.1 User-defined pulse output, associated with kWh.
2.5.17.1.2 Alarm pulse output, which turns on the pulsing at user-defined point.

2.5.17.2 Digital Inputs: As follows:

2.5.17.2.1 One input connection rated 24- to 125-V ac or -V dc, +/- 10 percent, less than 5-mA burden, 1350-V rms isolation.
2.5.17.2.2 Six input connections rated 19- to 30-V dc, 5 mA maximum at 24-V dc. Provide an onboard 24-V dc power supply.
2.5.17.2.3 Two input connections rated 20- to 150-V dc or -V ac, 2 mA maximum.

2.5.17.3 Analog inputs, no fewer than two, adjustable from 0- to 5-V dc or 4 to 20 mA.
2.5.17.4 Outputs to operate field-installed relays, no fewer than two, providing 6- to 240-V ac or 6- to 30-V dc, 2 A rms. 5 A maximum for 10 seconds per hour.
2.5.17.5 Analog outputs, no fewer than two, 4- to 20-mA dc into 600 ohms maximum.

2.5.18 Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

2.5.18.1 Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.

2.5.18.1.1 Each log entry shall hold data of up to 96 parameters each.
2.5.18.1.2 Each log shall be user configurable to log data at a different user-defined schedule interval.
2.5.18.1.3 Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
2.5.18.1.4 Configure log entries to be recorded as Fill & Hold or Circular (First in, First out, or FIFO), as defined by the user.

2.5.18.2 Minimum/Maximum Logs:

2.5.18.2.1 Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
2.5.18.2.2 Minimum/Maximum log shall include the time, date, and value for the minimum and maximum of each of the real-time metered values.

2.5.18.3 Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. Record selected parameters at 100-ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.

2.5.18.4 Waveform Logs: Capture and store waveforms, from 185 cycles on one channel at 16 samples per cycle, up to 3 cycles on six channels at 128 samples per cycle as defined by the user. Waveform log entries shall be externally triggered or forced in response to a user-defined event. Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.

2.5.19 Capacities and Characteristics:

2.5.19.1 Power Supply: 120-V ac, 60 Hz.

2.5.19.2 Circuit Connections:

2.5.19.2.1 Voltage: Measurement autoranging, 0- to 600-V ac L-L, 0- to 347-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers or Connect to instrument grade potential transformers secondary at 120 V. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.

2.5.19.2.2 Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.

2.5.19.2.3 Frequency: 45 to 65 Hz.

2.5.19.2.4 Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.6 CIRCUIT METER AND EXPLORER

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

2.6.1.1 Eaton.

2.6.1.2 General Electric Company.

2.6.1.3 Schneider Electric USA, Inc.

2.6.1.4 Siemens Industry, Inc., Energy Management Division.

2.6.2 Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring, control, and power quality explorer; complying with UL 61010-1.

2.6.2.1 Provide for metering 4-wire Y, 3-wire Y, and 3-wire delta power systems.

2.6.2.2 Equip the instrument with security lock to protect revenue related metering from unauthorized and accidental changes.

2.6.3 Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

2.6.3.1 Indoor installation in spaces that have environmental controls to maintain ambient conditions of 0 to 60 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.

2.6.3.2 Comply with IEC 60529 degree of protection code of IP52.

2.6.3.3 The circuit meter and monitor shall meet UL 61010-1 overvoltage withstand rating of CAT IV.

2.6.4 Accuracy to the following plus/minus values:

2.6.4.1 Voltage and Current Meter: 0.04 percent of reading plus 0.025 percent of full scale.
2.6.4.2 Power and Energy Meter: 0.075 percent of reading plus 0.025 percent of full scale.
2.6.4.3 Energy Meter: Comply with ANSI C12.20, Class 0.20.
2.6.4.4 Frequency Meter: 0.01 Hz in the range of 45 to 67 Hz and accurate to 0.1 Hz in the range of 350 to 450 Hz.
2.6.4.5 Power Factor: 0.002 from 0.5 leading to 0.5 lagging.

2.6.5 Data Links:

2.6.5.1 RS-232 port.
2.6.5.2 RS-485 Modbus RTU protocol, 4-wire connection.
2.6.5.3 Ethernet Modbus/TCP/IP protocol:

2.6.5.3.1 10/100BaseTX balanced twisted pair cabling. RJ-45 connector, 100-m link.
2.6.5.3.2 Optical fiber 100BaseFX, LC duplex connector, 1300-m link. Multimode 62.5/125-microsecond, 2000-m link.
2.6.5.3.3 HTML server, with standard home page and five customizable pages.

2.6.5.4 Firmware and software updates shall be accessible through the communications port.

2.6.6 Physical Characteristics:

2.6.6.1 Display: Backlit LCD screen with antiglare and scratch-resistant lens.
2.6.6.2 Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.
2.6.6.3 Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

2.6.7 Sampling Rate:

2.6.7.1 Sample current and voltage to provide rms accuracy to 255th harmonic of the fundamental frequency of 60 Hz.
2.6.7.2 Continuously sample and record voltage and current at a rate not less than 512 samples per cycle, simultaneously on all voltage and current channels of the meter.

2.6.8 Measure, record with time stamp, and calculate; and, on request, display the following:

2.6.8.1 Measurements: Instantaneous, in real time, rms to the 63rd harmonic:

2.6.8.1.1 Voltage: L-L each phase, L-L three-phase average, L-N each phase, L-N three-phase average, and percent unbalanced.
2.6.8.1.2 Current: Each phase, neutral, ground, three-phase average, apparent rms, and percent unbalanced.
2.6.8.1.3 Active Power (kW): Each phase and three-phase total.
2.6.8.1.4 Reactive Power (kVAR): Each phase and three-phase total.
2.6.8.1.5 Apparent Power (kVA): Each phase and three-phase total.
2.6.8.1.6 Displacement Power Factor: Each phase and three-phase total.
2.6.8.1.7 Distortion Power Factor: Each phase and three-phase total.
2.6.8.1.8 Frequency.

2.6.8.1.9 K-factor for each phase.

2.6.8.2 THD from measurements simultaneously from the same cycle, through 255th harmonic:

2.6.8.2.1 Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
2.6.8.2.2 Current: Each phase, three-phase average, and neutral.
2.6.8.2.3 Power: Active, reactive, and apparent power including power of up to 41st.

2.6.8.3 Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.

2.6.8.3.1 Active kWh.
2.6.8.3.2 Reactive kVARh.
2.6.8.3.3 Apparent kVAh.

2.6.8.4 Demand:

2.6.8.4.1 Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.

2.6.8.4.1.1 Present.
2.6.8.4.1.2 Running average.
2.6.8.4.1.3 Last completed interval.
2.6.8.4.1.4 Peak.

2.6.8.4.2 Current: Each phase, three-phase average, and neutral.

2.6.8.4.2.1 Present.
2.6.8.4.2.2 Last completed interval.
2.6.8.4.2.3 Minimum.
2.6.8.4.2.4 Peak.

2.6.8.4.3 Active Power (kW): Three-phase totals.

2.6.8.4.3.1 Last completed interval.
2.6.8.4.3.2 Predicted.
2.6.8.4.3.3 Peak.
2.6.8.4.3.4 Coincident with peak kVA demand.
2.6.8.4.3.5 Coincident with peal kVAR demand.

2.6.8.4.4 Reactive Power (kVAR): Three-phase totals.

2.6.8.4.4.1 Last completed interval.
2.6.8.4.4.2 Predicted.
2.6.8.4.4.3 Peak.
2.6.8.4.4.4 Coincident with peak kW demand.
2.6.8.4.4.5 Coincident with peal kVA demand.

2.6.8.4.5 Apparent Power (kVA): Three-phase totals.

2.6.8.4.5.1 Last completed interval.
2.6.8.4.5.2 Predicted.
2.6.8.4.5.3 Peak.

2.6.8.4.5.4 Coincident with peak kW demand.
2.6.8.4.5.5 Coincident with peak kVA demand.

2.6.8.4.6 Distortion Power Factor: Three-phase totals.

2.6.8.4.6.1 Last completed interval.
2.6.8.4.6.2 Predicted.
2.6.8.4.6.3 Peak.
2.6.8.4.6.4 Coincident with peak kVA demand.
2.6.8.4.6.5 Coincident with peal kVAR demand.

2.6.9 Average, Minimum and Maximum Values:

2.6.9.1 Record, date and time stamp, and save the minimum and maximum values of all rms metered values since the last reset.
2.6.9.2 Record, date and time stamp, and save maximum, minimum and average over a user-defined interval for the following metered values:

2.6.9.2.1 Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
2.6.9.2.2 Voltage Unbalance: L-L each phase and L-N each phase.
2.6.9.2.3 Current: rms each phase, three-phase average, and calculated neutral current.
2.6.9.2.4 Demand Current: rms each phase and three-phase average.
2.6.9.2.5 Current: Apparent, rms average.
2.6.9.2.6 Active Power (kW): Each phase and three-phase total.
2.6.9.2.7 Reactive Power (kVAR): Each phase and three-phase total.
2.6.9.2.8 Apparent Power (kVA): Each phase and three-phase total.
2.6.9.2.9 Demand Active Power: Each phase and three-phase total.
2.6.9.2.10 Demand Reactive Power: Each phase and three-phase total.
2.6.9.2.11 Demand Apparent Power: Each phase and three-phase total.
2.6.9.2.12 Accumulated Energy: MWh, MVAh, and MVARh.
2.6.9.2.13 Reactive energy (MVARh) by quadrant.
2.6.9.2.14 Power Factor: Three-phase displacement and distortion power factors.
2.6.9.2.15 K-factor for each phase.
2.6.9.2.16 THD L-L and L-N voltages.
2.6.9.2.17 THD current in each phase and neutral.
2.6.9.2.18 Frequency.

2.6.10 Power Demand, User Selectable:

2.6.10.1 Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2.6.10.2 Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

2.6.10.2.1 Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes. The default setting shall be the 15-minute continuous sliding block.
2.6.10.2.2 Fixed block that calculates demand at end of the interval.
2.6.10.2.3 Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

2.6.10.3 Demand Calculation Initiated by a synchronization signal. Synchronize demand with clock in the circuit meter and monitor.

2.6.10.3.1 Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
2.6.10.3.2 Synchronize demand with receipt of a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
2.6.10.3.3 Provide for synchronization to the clock in the instrument.

2.6.10.4 Record, date and time stamp, and save the following demand values of all rms metered values since the last reset, including the following:

2.6.10.4.1 Average demand current, per phase.
2.6.10.4.2 Peak demand current, per phase.
2.6.10.4.3 Average demand for active power, reactive power, and apparent power.
2.6.10.4.4 Predicted demand for active power, reactive power, and apparent power.
2.6.10.4.5 Peak demand for active power, reactive power, and apparent power.

2.6.11 Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters:

2.6.11.1 Record minimum, maximum, and average values of eight user-selected parameters as follows:

2.6.11.1.1 Every second for one minute for the one-minute curve.
2.6.11.1.2 Every minute for one hour for the one-hour curve.
2.6.11.1.3 Every hour for one day for the one-day curve.
2.6.11.1.4 Every day for one month for the one-month curve.

2.6.11.2 Forecast the trended parameters for the following:

2.6.11.2.1 The next four hours.
2.6.11.2.2 The next four days.

2.6.12 Power Analysis Values:

2.6.12.1 THD Voltage: L-L each phase, L-N each phase, and L-N three-phase average.
2.6.12.2 THD Current: Each phase, three-phase average, and neutral current.
2.6.12.3 Total demand distortion.
2.6.12.4 K-factor for each phase.
2.6.12.5 Crest factor, each phase.
2.6.12.6 Displacement power factor.
2.6.12.7 Fundamental voltage, magnitude and angle, each phase.
2.6.12.8 Fundamental currents, magnitude and angle, each phase.
2.6.12.9 Fundamental active power, each phase and three-phase total.
2.6.12.10 Fundamental reactive power, each phase and three-phase total.
2.6.12.11 Harmonic power, each phase and three-phase total.
2.6.12.12 Phase rotation.
2.6.12.13 Voltage and current unbalances.
2.6.12.14 Harmonic magnitudes and angles, each phase.
2.6.12.15 Distortion power.
2.6.12.16 Distortion power factor.

2.6.13 Waveform Capture:

2.6.13.1 Steady State Waveform Capture: Manually initiated over the communications network.

2.6.13.1.1 Capture, record with time stamp, and store voltage and current waveforms at a user-defined resolution of 16 to 512 samples/cycle for up to 30 seconds.

2.6.13.1.2 Capture, record with time stamp, and store 512 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard shall be user configurable.

2.6.13.1.3 Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 255th for the following:

2.6.13.1.3.1 Voltage: L-N and L-G each phase.

2.6.13.1.3.2 Current: Of each phase and neutral current.

2.6.13.1.4 Captured waveforms shall be recorded from actual circuit performance.

2.6.13.2 Disturbance Waveform Capture:

2.6.13.2.1 Capture, record with time stamp, and store digitally sampled data points for each cycle of each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The captured waveform shall be at a user-defined resolution of 16 to 512 samples/cycle per second. The number of pre-alarm cycles shall be adjustable.

2.6.13.3 Waveform samples shall be available for transmission over the communications network, for display, archival, and analysis at computer workstations.

2.6.14 Transient Detection.

2.6.14.1 Detect and capture transient voltage surge events up to 10 kV L-L with a duration as short as 200 ns.

2.6.15 Flicker Detection.

2.6.15.1 Detect and capture flicker events, defined by IEEE 1453, at three levels: instantaneous, short term, and long term.

2.6.15.2 Display the flicker event as plots of magnitude versus time on semi-log graph background.

2.6.16 Sag and Swell Detection and Alarm:

2.6.16.1 Detect and initiate alarm when detecting voltage or current sag and swell.

2.6.16.1.1 Detect disturbance events of less than half-cycle in length, by monitoring and calculating rms magnitude of each half-cycle.

2.6.16.1.2 Event detection shall be with user-defined parameters of threshold and delay. The threshold shall be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument shall automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.

2.6.16.1.3 When detecting an alarm condition:

2.6.16.1.3.1 Initiate disturbance waveform capture.

2.6.16.1.3.2 Initiate 100-ms event recording.

2.6.16.1.3.3 Recording the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.

2.6.16.1.3.4 Causing an alarm on the display and transmit the alarm over the data link.

2.6.16.1.3.5 The user shall have the ability to display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.

2.6.17 100-ms Event Recording: Capture, record with time stamp, and store.

2.6.17.1 Initiate recording by an alarm or external contact closure.
2.6.17.2 User-configured recording, to record for the duration of the alarm up to 300 seconds and can be delayed for 1 to 10 seconds.
2.6.17.3 Records current per-phase and neutral, voltage L-L each phase and L-N each phase, active power per-phase and three-phase total, reactive power each phase and three-phase total, apparent power each phase and three-phase total, and true power factor three-phase total.
2.6.17.4 Operate an output relay in the I/O module of the instrument.

2.6.18 Harmonics Information:

2.6.18.1 Calculate the harmonic magnitudes and angles for each phase voltage and current in each phase and neutral, through the 255th harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.
2.6.18.2 The current and voltage information for all phases shall be obtained simultaneously from the same cycle.
2.6.18.3 Report harmonic information as a percentage of the fundamental or as a percentage of the rms values, as selected by the user.

2.6.19 Alarms:

2.6.19.1 Alarm events may be either user defined or preconfigured by manufacturer from the applicable standards. Provide for multiple levels for each alarm that is based on metered data.
2.6.19.2 The instrument shall calculate the listed key electrical parameters at not less than 100-ms intervals to initiate and record an alarm event. Provide for user-selected range of 1 to 10 seconds of pre-event and up to five minutes of post-event data recording.
2.6.19.3 The following classes of events shall be available to be programmed as alarm events:

2.6.19.3.1 Over/under current.
2.6.19.3.2 Over/undervoltage.
2.6.19.3.3 Current imbalance.
2.6.19.3.4 Phase loss, current.
2.6.19.3.5 Phase loss, voltage.
2.6.19.3.6 Voltage imbalance.
2.6.19.3.7 Wave shape alarm.
2.6.19.3.8 Over kVA.
2.6.19.3.9 Over kW or kVAR into/out of load.
2.6.19.3.10 Over/under frequency.
2.6.19.3.11 Under power factor, true or displacement.
2.6.19.3.12 Over THD.
2.6.19.3.13 Over K-factor.
2.6.19.3.14 Over demand, current or power.
2.6.19.3.15 Reverse power.
2.6.19.3.16 Phase reversal.
2.6.19.3.17 Status input change.
2.6.19.3.18 End of incremental energy interval.
2.6.19.3.19 End of demand interval.
2.6.19.3.20 Over/under analog inputs.
2.6.19.3.21 Current sag/swell.
2.6.19.3.22 Voltage sag/swell.

2.6.19.3.23 Transient events.

2.6.19.4 For each over/under metered alarm value, the user shall define a pickup, dropout, and delay.

2.6.19.5 Waveform Alarms:

2.6.19.5.1 The instrument shall detect anomalous waveform events that are less than half-cycle in length.

2.6.19.5.2 Provide for the user to set a threshold value and an upper limit to determine whether the waveform triggers an alarm. The threshold value and upper limit shall be a value between 1 and 100. The threshold value is the limit at which a waveform triggers the alarm. The upper limit defines the highest waveform value that triggers a waveform alarm. The settable values are as follows:

2.6.19.5.2.1 Phase voltages.
2.6.19.5.2.2 N-G voltages.
2.6.19.5.2.3 Phase currents.
2.6.19.5.2.4 Neutral currents.

2.6.19.5.3 In response to a waveform alarm, the instrument shall:

2.6.19.5.3.1 Log the event and record phase currents and voltages as defined in the 100-ms event recording.

2.6.19.5.3.2 Determine the source of the disturbance (upstream or downstream from the meter) and a statistical level of confidence (low, medium, or high) of the accuracy of the source location.

2.6.19.6 Provide four alarm severity levels to allow the user to respond to the most important events first.

2.6.19.7 Indicate an alarm condition on the front panel of the instrument, as well as reported over the data link to designated workstations.

2.6.19.8 The circuit meter and monitor alarms response time shall be not less than the following:

2.6.19.8.1 Standard, one second.
2.6.19.8.2 High speed, 100 ms.
2.6.19.8.3 Disturbance, half-cycle.

2.6.19.9 Up to four alarms may be combined to give a single result using Boolean algebra operations.

2.6.19.10 Provide e-mail notification of alarm conditions.

2.6.19.11 Automatic Alarm Set-Point Adjustment:

2.6.19.11.1 The instrument software shall provide for recognizing and learning the characteristics of the normal operation of the electrical power system it is connected to, and to select and adjust alarm set points based on that recognition.

2.6.19.11.2 The metered data to be recognized and learned, and the period of time for learning for alarms, disturbances, and waveform alarms, shall be set by the user by selection one of the following two modes:

2.6.19.11.2.1 Fixed Learning: Initially configured user set points are used during the entire learning period.

2.6.19.11.2.2 Dynamic Learning: Initially configured user set points are temporarily replaced by learned set points at the interval specified by the user in the learning setup. The set points continue to be updated at the specified interval until the learning period expires.

2.6.19.11.3 The learning period shall be user configurable. If the learned set points do not change over a predefined period, the learning process can be stopped and the set points either installed or held for review.

2.6.20 EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.

2.6.21 I/O Module: Modular, with multiple I/O options, programmable to accomplish specified performance and one or more spare positions for future. At minimum, the instrument shall provide the following:

2.6.21.1 KYZ Pulse: Solid-state output relay, programmed to generate a standard KYZ pulses for a user-defined increment of metered active energy as follows:

2.6.21.1.1 User-defined pulse output, associated with kWh.
2.6.21.1.2 Alarm pulse output, which turns on the pulsing at user-defined point.

2.6.21.2 Digital inputs, each having the following operating modes:

2.6.21.2.1 Normal: Simple on/off digital inputs.
2.6.21.2.2 Demand Interval Synch Pulse Accept a demand synch pulse from a utility demand meter.
2.6.21.2.3 Conditional Energy Control input to control conditional energy accumulation.

2.6.21.3 Output Relays and Control: Output relays shall have normally open and normally closed contacts and shall operate in response to a user sent command over the data link, or automatically responding to an alarm event. The relays shall be user configured in one of the following listed modes:

2.6.21.3.1 Normal contact closure where the contacts change state for as long as the signal exists.
2.6.21.3.2 Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
2.6.21.3.3 Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.
2.6.21.3.4 End of Power Demand Interval: When the relay operates as a synch pulse for other devices.
2.6.21.3.5 Energy Pulse Output: Relay will pulse quantities used for Absolute kWh, Absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
2.6.21.3.6 Programmed Output: Relay will operate in response to multiple alarms that are arranged to give a single result using Boolean algebra operations.

2.6.22 Onboard Data Logs:

2.6.22.1 Log data, alarms and events, and waveforms in onboard solid-state nonvolatile memory.
2.6.22.2 Onboard data logs shall be available for transmission over the communications network for display, archival, and analysis at computer workstations on demand.
2.6.22.3 Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.

2.6.22.3.1 Each log entry shall hold data of up to 96 parameters each.
2.6.22.3.2 Each log shall be user configurable to log data at a different user-defined schedule interval.

2.6.22.3.3 Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
2.6.22.3.4 Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.

2.6.22.4 Minimum/Maximum Logs:

2.6.22.4.1 Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
2.6.22.4.2 Minimum/Maximum log shall include the time, date, and value for the minimum and maximum of each of the active-time metered values.

2.6.22.5 Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. The log capacity shall be not less than 1000 events. Record selected parameters at 100-ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.
2.6.22.6 Waveform Logs: Capture and store waveforms as follows:

2.6.22.6.1 One cycle, 512 samples, to the 255th harmonic. Manually triggered.
2.6.22.6.2 Adjustable from 8 seconds at 18 samples per cycle, to 264 seconds at 16 samples per cycle. Triggered manually or by a user set alarm.
2.6.22.6.3 Voltage sampling at 5 MHz (83,333 samples per cycle) more than 2 ms to capture transient peaks of less than 1 microsecond.

2.6.23 Programming: Programming of instrument functions shall be similar to BASIC syntax. Provide for initial programming and changes to programs through the communications links.

2.6.23.1 Programming language shall include the following capabilities:

2.6.23.1.1 Scheduled tasks.
2.6.23.1.2 Event tasks.
2.6.23.1.3 Math functions including add, subtract, multiple, divide, sine, cosine, and square root.
2.6.23.1.4 Logical functions including: AND, OR, XOR, NOT, shift, and so forth.
2.6.23.1.5 Loop commands.
2.6.23.1.6 Compare statements.
2.6.23.1.7 Counters and timers.

2.6.23.2 Manufacturer shall provide custom programs to meet Project requirements that are described in the "Capacities and Characteristics" Paragraph.
2.6.23.3 Metering of specialized utility rate structures, including real-time pricing and curtailable rates.
2.6.23.4 Data reduction using smart data logging.
2.6.23.5 Automatic monthly logging/reset of kWh and peak demand.
2.6.23.6 Statistical profile analysis of metered quantities.
2.6.23.7 ITIC/SEMI power quality analysis.
2.6.23.8 Calculations for IEEE 519 verification.
2.6.23.9 Metering of combined utilities: gas, water, steam, and electric.
2.6.23.10 Non-critical control schemes, such as load control or power factor correction, based on multiple conditions, for example, time of day and input status.

2.6.24 Capacities and Characteristics:

2.6.24.1 Power Supply: 120-V ac, 60 Hz.

2.6.24.2 Circuit Connections:

2.6.24.2.1 Voltage: Measurements autoranging, 0- to 600-V ac L-L, 0- to 347-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers or Connect to instrument grade potential transformers secondary at 120 V. Meter impedance shall be 2-megohm L-L or greater.
2.6.24.2.2 Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 15 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
2.6.24.2.3 Frequency: 45 to 67 Hz, and 350 to 450 Hz.
2.6.24.2.4 Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.6.24.3 Onboard, Field-Upgradeable, Solid-State Nonvolatile Memory: 8 MB.
2.6.24.4 Number of Onboard Data Logs: 14.
2.6.24.5 Number of Minimum/Maximum Log Files: Two.
2.6.24.6 Alarm Log Capacity: Not less than 1000 events.
2.6.24.7 Custom Programs: Provide the following programs with the instrument:

2.6.24.7.1 Metering of specialized utility rate structures, including real-time pricing and curtailable rates.
2.6.24.7.2 Data reduction using smart data logging.
2.6.24.7.3 Automatic monthly logging/reset of kWh and peak demand.
2.6.24.7.4 Statistical profile analysis of metered quantities.
2.6.24.7.5 Calculations for IEEE 519 verification.
2.6.24.7.6 Metering of combined utilities: gas, water, steam, and electric.
2.6.24.7.7 Non-critical control schemes, such as load control or power factor correction, based on multiple conditions such as time of day and input status.

2.7 PC OPERATING SYSTEM SOFTWARE

2.7.1 Description: System software shall monitor, analyze, display, control, and save all the parameters and features available at the connected meter.

2.7.2 Software: Configured to run on a portable laptop computer, a single PC, or a tablet computer, with capability for accessing a single meter at a time, at the location of the meter. System is not connected to LAN.

2.7.3 Minimum Requirements:

2.7.3.1 Real-time multitasking and multiuser 64-bit operating system that allows execution of multiple real-time programs and custom program development.
2.7.3.2 Operating system shall be capable of operating Microsoft Windows applications.
2.7.3.3 Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

2.8 NETWORKED PC OPERATING SYSTEM SOFTWARE

2.8.1 Description: System software shall monitor, analyze, display, control, and save parameters and features available at each of the connected meters.

2.8.2 Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be web enabled.

2.8.3 System Software Minimum Requirements:

2.8.3.1 Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple workstations operating and concurrent execution of multiple real-time programs and custom program development.
2.8.3.2 Operating system shall be capable of operating Microsoft Windows applications.
2.8.3.3 Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
2.8.3.4 Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

2.8.4 Operator Interface Software:

2.8.4.1 Minimize operator training through use of English language prorating and English language point identification.
2.8.4.2 Minimize use of a typewriter-style keyboard through use of a pointing device, touchscreen, or mouse.
2.8.4.3 Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
2.8.4.4 Automatic sign-off period shall be programmable from 1 to 60 minutes in 1-minute increments on a per operator basis.
2.8.4.5 Record operator sign-on and sign-off activity.
2.8.4.6 Security Access:

2.8.4.6.1 Operator access to electrical monitoring and control system shall be under password control.
2.8.4.6.2 An alphanumeric password shall be user assignable to each operator.
2.8.4.6.3 Software shall have at least five access levels.

2.8.4.6.3.1 View - View information. No change privileges allowed.
2.8.4.6.3.2 User - Same as View, but is able to initiate control functions.
2.8.4.6.3.3 Controller - Same as User, but is able to initiate communications.
2.8.4.6.3.4 Operator - Same as Controller, but is able to modify configurations.
2.8.4.6.3.5 Supervisor - Same as Operator, but is able to administer security privileges.

2.8.4.6.4 Each menu item shall be assigned an access level so that a one-for-one correspondence between operator-assigned access level(s) and menu-item access level(s) is required to gain access to menu item.
2.8.4.6.5 Display menu items to operator with those menu items capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.

2.8.5 Graphic Interface Software:

2.8.5.1 Include a full interactive graphical selection means of accessing and displaying system data to operator.
2.8.5.2 Descriptors for graphics, points, alarms, and such shall be modified through workstation under password control.
2.8.5.3 Display operator accessed data on the monitor.

2.8.5.4 Help Features: On-line context-sensitive help utility to facilitate operator training and understanding.

2.9 POWER MONITORING AND CONTROL SOFTWARE

2.9.1 Data Storage and Data Sharing:

2.9.1.1 Query and download logs of interval data stored on metering devices.
2.9.1.2 Query and download logs of alarm and event data stored on metering devices.
2.9.1.3 Query and download logs of waveform capture data stored on metering devices.
2.9.1.4 Query and download logs of interval data generated by the software and calculated by the meters.
2.9.1.5 Query and download logs of alarm and event data generated by the software and calculated by the meters.
2.9.1.6 Automatically re-arm the waveform recorders, on upload of information.
2.9.1.7 Provide a facility to archive, trim, and back up the database on demand, or on a schedule.
2.9.1.8 Provide a facility to view historical data from archived databases.
2.9.1.9 Support user changes to the database.

2.9.1.9.1 Support on-line changes while the data storage/retrieval application is running.
2.9.1.9.2 Suffer no interruption to its operation while changes are being made.
2.9.1.9.3 Require no restart once the configuration has been performed.

2.9.2 Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

2.9.2.1 Site plan showing each building, and additional site elements, which are being controlled or monitored by the electrical power monitoring and control system.
2.9.2.2 Plan for each building floor, showing the following:

2.9.2.2.1 Locations and identification of all monitored and controlled electrical equipment.

2.9.2.3 Control schematic for each device that is controlled by the meters of this Section, including a graphic system schematic representation, similar to that indicated on Drawings, with device identification.
2.9.2.4 Graphic display for each piece of equipment connected to the electrical monitoring and control system through a data link.
2.9.2.5 Electrical power monitoring and control system network riser diagram that shows schematic layout for entire system including meters, gateways and other network devices.

2.10 NETWORK CONFIGURATION SOFTWARE

2.10.1 Network Management Graphical Interface Features:

2.10.1.1 Add and remove devices in the power monitoring and control network.
2.10.1.2 Application for naming devices based on a user-defined naming scheme.
2.10.1.3 Add and remove I/O servers in the power monitoring and control network.
2.10.1.4 Edit communication properties for devices including timeouts and delays.
2.10.1.5 Display mandatory fields when adding a new device.
2.10.1.6 Allow to manually connect and disconnect serial, Ethernet, modem, and Ethernet gateway sites.

2.10.1.7 Enable and disable devices and sites in the power monitoring and control network without interruption to other devices or sites.
2.10.1.8 Pool modem resources so that the software uses any available modem.
2.10.1.9 Monitor the following diagnostics:

2.10.1.9.1 Communication request/response and error rates, and timeouts.
2.10.1.9.2 Log acquisition services.

2.10.2 Database Maintenance Features:

2.10.2.1 Backup, archive, and trim data, event, and waveform logs.

2.10.2.1.1 Record start and end date for operation.
2.10.2.1.2 Allow copying data to another database.
2.10.2.1.3 Be capable of selecting any or all of the logs specified for the meters that are Work of this Section.

2.10.2.1.3.1 Data logs.
2.10.2.1.3.2 Event logs.
2.10.2.1.3.3 Waveform logs.

2.10.3 Web Reporter: Allow viewing historical data in preformatted report templates via a web browser.

2.10.3.1 Features:

2.10.3.1.1 User-configurable report generator to trigger on event, based on a schedule, or manual initiation.
2.10.3.1.2 Format reports in HTML, PDF, TIF, Excel, XML, or user-selected printer, or network folder.
2.10.3.1.3 Distribution of reports via email.

2.10.3.2 Report on power and demand profiles.
2.10.3.3 Power quality report with CBEMA evaluation.
2.10.3.4 EN 50160 compliance report.
2.10.3.5 100-ms PQ report.
2.10.3.6 Energy over Period Report:

2.10.3.6.1 User-defined rollup interval by day, week, month, or year.
2.10.3.6.2 Compare daily energy to the following:

2.10.3.6.2.1 Previous day.
2.10.3.6.2.2 Same day, previous week.
2.10.3.6.2.3 Same day, previous month.
2.10.3.6.2.4 User-defined specific day.

2.10.3.6.3 Compare weekly energy to the following:

2.10.3.6.3.1 Previous week.
2.10.3.6.3.2 Same week from previous month.
2.10.3.6.3.3 Same week from previous year.
2.10.3.6.3.4 User-defined specific week.

2.10.3.6.4 Compare monthly energy to the following:

2.10.3.6.4.1 Previous month.

2.10.3.6.4.2 Same month from previous year.
2.10.3.6.4.3 User-defined specific month.

2.10.3.6.5 Compare annual energy to the following:

2.10.3.6.5.1 Previous year.
2.10.3.6.5.2 User-defined specific year.

2.10.3.7 Energy by daily period report for the user-defined periods. Aggregate consumption of the periods by the day, week, and year.
2.10.3.8 Tabular Report: Show values for multiple measurements and measurements from multiple devices in tabular format.
2.10.3.9 Trend Report:

2.10.3.9.1 Show values for multiple measurements and measurements from multiple devices in any of the following graphical formats:

2.10.3.9.1.1 Line chart.
2.10.3.9.1.2 Pie graph.
2.10.3.9.1.3 Bar chart.
2.10.3.9.1.4 Column chart.
2.10.3.9.1.5 Smooth line chart.
2.10.3.9.1.6 Stacked column chart.
2.10.3.9.1.7 Stacked bar chart.

2.10.3.10 Alarm and Event History: User formatted, based on the meters and priority; and with user-defined alarm and event reports.
2.10.3.11 System Configuration Report:

2.10.3.11.1 Device name.
2.10.3.11.2 Device type.
2.10.3.11.3 Device address.
2.10.3.11.4 Connection status.
2.10.3.11.5 Device protocol.
2.10.3.11.6 Device description.

2.10.3.12 Each default report shall include the following:

2.10.3.12.1 Summary aggregation of data from the selected devices.
2.10.3.12.2 Individual device information.
2.10.3.12.3 Raw data.

2.10.3.13 The reporting tool shall provide a graphical interface to create and manage multiple Time of Use schedules:

2.10.3.13.1 Tariffs including energy cost rates per kWh, kVARh, and kVAh, and demand charges per kW, kVAR, and kVA.
2.10.3.13.2 Off-peak and on-peak times.

2.11 MONITORING AND CONTROL OF POWER DISTRIBUTION EQUIPMENT

2.11.1 Power Distribution Equipment: Web-enabled, direct connected to the LAN or intranet.

2.11.2 Instrument Transformers: Comply with IEEE C57.13.

2.11.2.1 Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.

2.11.2.2 Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

2.11.3 Ethernet Connectivity:

2.11.3.1 A multipoint, RS-485 Modbus serial communications network shall be included within the equipment to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications.

2.11.3.2 Serial communications network shall be wired to an Ethernet server in the incoming section of the equipment. Hardware and cabling required for the connection to the network shall be included within the power distribution equipment.

2.11.3.3 Serial communications devices within the equipment shall be factory addressed and tested to verify reliable communications to the equipment's Ethernet Server.

2.11.4 Ethernet Gateways:

2.11.4.1 User configurable; complying with UL 60950-1, and IEEE 802.3, Class 3 PoE.

2.11.4.2 Include provisions to set initial Ethernet parameters via a local operator interface, or standard (RJ-45) Ethernet port, that is accessible from the front of the equipment. Initial setup shall be limited to basic Ethernet addressing parameters, as assigned by Navy.

2.11.4.3 Common Gateway Features:

2.11.4.3.1 User configurable, with secure password-protected login process.

2.11.4.3.2 Include communications diagnostic information for serial and Ethernet ports as well as internal health status and memory management information through embedded HTML web pages for viewing using a standard web browser.

2.11.4.3.3 Include embedded HTML pages providing real-time information from devices connected to the Ethernet gateway's RS-485 port(s) through a standard web browser.

2.11.4.3.4 Allow firmware upgrades through the communications port.

2.11.4.4 Include a "Quick-Start" guide with the equipment to describe the commissioning process for setting the equipment's Ethernet network address and for ensuring trouble-free data access from any PC on the network, using a standard web browser.

2.11.4.5 Implement a common user interface ("look and feel") across all styles of power equipment.

2.11.5 Distribution Equipment Monitoring:

2.11.5.1 Main menu and summary pages, factory configured, to display data for each communicating device within the power equipment lineup.

2.11.5.2 Display Data:

2.11.5.2.1 Circuit summary page to display circuit name, three-phase average rms current, real power (kW), power factor, and breaker status (if applicable).

2.11.5.2.2 Load current summary page to display circuit name, and phase a, b, and c rms current values.

2.11.5.2.3 Demand current summary page to display circuit name, and phase a, b, and c average demand current values.

2.11.5.2.4 Power summary page to display circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.

2.11.5.2.5 Energy summary page to display circuit name, real energy (kWh), reactive energy (kVARh), and time/date of last reset.

2.11.5.2.6 For unit substations equipped with dry-type transformer(s) and microbased temperature controller(s), the circuit summary web page listed above shall be augmented with transformer coil temperatures, phase a, b and c current values, and cooling fan status (on/off).

2.11.5.2.7 For motor-control centers, the circuit summary web page shall be tailored specifically for this application, to display circuit name, three-phase average rms current, thermal capacity (percentage), drive output frequency (in Hertz, where applicable), and contactor status.

2.12 SYSTEM OPERATOR INTERFACES

2.12.1 Operator means of system access shall be through the following:

2.12.1.1 Desktop workstation with hardwired connection through LAN port.

2.13 DESKTOP WORKSTATIONS

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

2.13.1.1 Dell Inc.
2.13.1.2 HP.
2.13.1.3 Lenovo.

2.13.2 Performance Requirements:

2.13.2.1 Performance requirements may dictate equipment exceeding minimum requirements indicated.
2.13.2.2 Capable of running Microsoft Windows.
2.13.2.3 ENERGY STAR compliant.

2.13.3 Personal Computer:

2.13.3.1 Minimum Processor Speed: , Core i3.
2.13.3.2 RAM:

2.13.3.2.1 Capacity: 8 GB.
2.13.3.2.2 Speed and Type: 1333 MHz,.

2.13.3.3 Primary Hard Drive:

2.13.3.3.1 Media: Solid state, nominal rotational speed of 7200 rpm.
2.13.3.3.2 Number of Hard Drives: Two.

2.13.3.4 Second Hard Drive:

2.13.3.4.1 Media: Solid state.

2.13.3.5 Video Card:

2.13.3.5.1 Capable of supporting four monitors.
2.13.3.5.2 Resolution: 1920 by 1200 pixels minimum for each monitor.

2.13.3.6 Sound Card:

2.13.3.6.1 At least 128 voice wavetable synthesis.
2.13.3.6.2 Capable of delivering three-dimensional sound effects.
2.13.3.6.3 High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.

2.13.3.7 Network Interface Card: Include card with connection, as applicable.

2.13.3.7.1 10-100-1000 base TX Ethernet with RJ45 connector port.
2.13.3.7.2 100 base FX Ethernet with SC or ST port.

2.13.3.8 Wireless Ethernet, 802.11 a/b/g/n.
2.13.3.9 Optical Modem: Full duplex link for connection to optical fiber cable provided.
2.13.3.10 I/O Ports:

2.13.3.10.1 Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
2.13.3.10.2 One serial port.
2.13.3.10.3 One parallel port.
2.13.3.10.4 Two PS/2 ports.
2.13.3.10.5 One RJ-45.
2.13.3.10.6 One stereo line-in and line-out on back panel.
2.13.3.10.7 One microphone and headphone connector on front panel.
2.13.3.10.8 One IEEE 1394 on front and back panel with PCI-e card.
2.13.3.10.9 One ESATA port on back panel.

2.13.3.11 Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.

2.13.4 Keyboard:

2.13.4.1 101-key enhanced keyboard.
2.13.4.2 Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
2.13.4.3 Wireless operation within up to 72 inches in front of workstation.

2.13.5 Pointing Device:

2.13.5.1 Either a two- or three-button mouse.
2.13.5.2 Wireless operation within up to 72 inches in front of workstation.

2.13.6 Flat Panel Display Monitor:

2.13.6.1 Number of Displays: Two.

2.13.6.1.1 Display Support: Individual tilt adjustable base. Desk mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization. Wall mounted, adjustable bracket capable of supporting number of monitors specified above with integral power and display cable organization. As per Navy's Choice.

2.13.6.2 Color display with 30" diagonal viewable area.
2.13.6.3 Aspect Ratio: 16 to 9.
2.13.6.4 Resolution: 1920 by 1080 pixels at 60 Hz with pixel size of 0.277 mm or smaller.

2.13.6.5 Digital input signal.

2.13.7 Speakers:

2.13.7.1 Two, with individual controls for volume, bass, and treble.
2.13.7.2 Signal to Noise Ratio: At least 65 dB.
2.13.7.3 Power: At least 4 W per speaker/channel.
2.13.7.4 Magnetic shielding to prevent distortion on the video monitor.

2.13.8 I/O Cabling: Include applicable cabling to connect I/O devices.

2.13.9 Software:

2.13.9.1 Factory-installed operating system.

2.14 RACEWAYS AND BOXES

2.14.1 Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.

2.14.2 Comply with requirements in Section 27 05 28 "Pathways for Communications Systems" for control wiring, RS-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

2.15 WIRES AND CABLES

2.15.1 Electrical Power Wiring: Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

2.15.1.1 Copper conductors are Type THHN/THWN-2.

2.15.2 Control Wiring: Comply with requirements in Section 26 05 23 "Control-Voltage Electrical Power Cables."

2.15.2.1 Optical-Fiber Cable: Multimode, 50/125-micrometer OM3, six-fiber, tight-buffer, optical-fiber cable, with aqua jacket.
2.15.2.2 Balanced Twisted Pair Cable: 100-ohm, four-pair Category 6.
2.15.2.3 Workstation Outlets: Four-port-connector assemblies mounted in single or multigang faceplate. Coordinate color and labels with Section 26 27 26 "Wiring Devices."
2.15.2.4 RS-485 Cable: Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2.15.2.5 Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

2.15.2.5.1 Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
2.15.2.5.2 Ordinary Switching Circuits: Three conductors unless otherwise indicated.
2.15.2.5.3 Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

2.15.3 RS-232 Cable:

2.15.3.1 PVC-Jacketed, RS-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

2.15.3.1.1 Type CM.
2.15.3.1.2 Flame Resistance: UL 1581, vertical tray.

2.15.3.2 Plenum-Type, RS-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

2.15.3.2.1 Type CMP.
2.15.3.2.2 Flame Resistance: NFPA 262, flame test.

2.16 SURGE PROTECTION DEVICES

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

2.16.1.1 ABB Low Voltage products; Member of ABB Group.
2.16.1.2 Advanced Protection Technologies Inc. (APT).
2.16.1.3 ALLTEC.
2.16.1.4 Eaton.
2.16.1.5 Emerson Electric Co.
2.16.1.6 GE Zenith Controls.
2.16.1.7 LEA International.
2.16.1.8 Leviton Manufacturing Co., Inc.
2.16.1.9 Mersen USA.
2.16.1.10 PowerLogics, Inc./PQ Protection.
2.16.1.11 Schneider Electric USA, Inc.
2.16.1.12 Siemens Industry, Inc., Energy Management Division.

2.16.2 SPDs: Comply with UL 1449, Type 1 Type 2.

2.16.2.1 Include LED indicator lights for power and protection status.
2.16.2.2 Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
2.16.2.3 Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

2.16.3 Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual metal-oxide varistors in a given mode.

2.16.4 Comply with UL 1283.

2.16.5 Protection modes and UL 1449 SPD for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

2.16.5.1 L-N: 1200 V for 480Y/277 V.
2.16.5.2 L-G: 1200 V for 480Y/277 V.
2.16.5.3 N-G: 1200 V for 480Y/277 V.

2.16.5.4 L-L: 2000 V for 480Y/277 V.

2.16.6 Protection modes and UL 1449 SPD for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

2.16.6.1 L-N: 700 V.
2.16.6.2 L-G: 700 V.
2.16.6.3 N-G: 700 V.
2.16.6.4 L-L: 1200 V.

2.16.7 SCCR: Equal or exceed 200 kA.

2.16.8 Nominal Rating: 20 kA.

2.16.9 Indoor Enclosures: NEMA 250, Type 1.

2.16.10 Outdoor Enclosures: NEMA 250, Type 3R / Type 4.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting performance of the Work.

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

3.2 POWER MONITORING AND CONTROL SYSTEM INSTALLATION

3.2.1 Comply with NECA 1.

3.2.2 Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

3.2.3 Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2.4 Wiring and Cabling Installation:

3.2.4.1 Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
3.2.4.2 Comply with Section 26 05 23 "Control-Voltage Electrical Power Cables" for control wiring.

3.2.5 Raceways Installation:

3.2.5.1 Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.
3.2.5.2 Comply with Section 27 05 28 "Pathways for Communications Systems" for control wiring, RS-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

3.2.6 Identification Installation:

3.2.6.1 Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
3.2.6.2 Comply with Section 27 15 13 "Communications Copper Horizontal Cabling" for identification products and cable management system requirements for twisted pair cable, RS-485 cable, low-voltage control cable, and RS-232 cable.

3.3 WORKSTATION INSTALLATION

3.3.1 Desktop Workstations Installation:

3.3.1.1 Install workstation(s) at location(s) directed by Navy.
3.3.1.2 Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single, duplex electrical power receptacle.
3.3.1.3 Install software on workstation(s) and verify that software functions properly.
3.3.1.4 Develop Project-specific graphics, trends, reports, logs, and historical database.
3.3.1.5 Power workstation through a UPS unit. Locate UPS adjacent to workstation.

3.3.2 Portable Workstations Installation:

3.3.2.1 Turn over portable workstations to Navy at Substantial Completion.
3.3.2.2 Install software on workstation(s) and verify that software functions properly.

3.3.3 Graphics Application:

3.3.3.1 Use system schematics indicated as starting point to create graphics.
3.3.3.2 Develop Project-specific library of symbols for representing system equipment and products.
3.3.3.3 Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
3.3.3.4 Submit sketch of graphic layout with description of all text for each graphic for Navy's and EOR's review before creating graphic using graphics software.
3.3.3.5 Seek Navy input in graphics development once using graphics software.
3.3.3.6 Final editing shall be done on-site with Navy's review and feedback.
3.3.3.7 Refine graphics as necessary for Navy acceptance.
3.3.3.8 On receiving Navy acceptance, print a hard copy to include in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of the system operation and maintenance manual.

3.4 NETWORK NAMING AND NUMBERING

3.4.1 Coordinate with Navy and provide unique naming and addressing for networks and devices.

3.5 GROUNDING

3.5.1 For data communication wiring, comply with NECA/BICSI 568.

3.5.2 For low-voltage control wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

3.6.1 Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.6.2 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.6.3 Perform the following tests and inspections with the assistance of a factory-authorized service representative:

3.6.3.1 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6.3.2 Visually inspect balanced twisted pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.

3.6.3.3 Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3.6.3.4 Test balanced twisted pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

3.6.3.4.1 Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

3.6.3.4.2 Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

3.6.3.5 Optical-Fiber Cable Tests:

3.6.3.5.1 Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

3.6.3.5.2 Link End-to-End Attenuation Tests:

3.6.3.5.2.1 Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to IEC 61280-4-1.

3.6.3.5.2.2 Attenuation test results for links shall be less than that calculated according to equation in TIA-568-C.0.

3.6.3.5.3 Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

3.6.3.6 Power Monitoring and Control System Tests.

3.6.3.6.1 Test Analog Signals:

3.6.3.6.1.1 Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.

3.6.3.6.1.2 Check analog current signals using a precision current meter at zero, 50, and 100 percent.

3.6.3.6.1.3 Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

3.6.3.6.2 Test Digital Signals:

3.6.3.6.2.1 Check digital signals using a jumper wire.

3.6.3.6.2.2 Check digital signals using an ohmmeter to test for contact making or breaking.

3.6.3.6.3 I/O Control Loop Tests:

3.6.3.6.3.1 Test every I/O point to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.

3.6.3.6.3.2 Test every I/O point throughout its full operating range.

3.6.3.6.3.3 Test every control loop to verify that operation is stable and accurate.

3.6.3.6.3.4 Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.

3.6.3.6.3.5 Test and adjust every control loop for proper operation according to sequence of operation.

3.6.3.6.3.6 Test software and hardware interlocks for proper operation.

3.6.3.6.3.7 Operate each analog point at the following:

3.6.3.6.3.7.1 Upper quarter of range.

3.6.3.6.3.7.2 Lower quarter of range.

3.6.3.6.3.7.3 At midpoint of range.

3.6.3.6.3.8 Exercise each binary point.

3.6.3.6.3.9 For every I/O point in the system, read and record each value at workstation, at controller, and at field instrument simultaneously. Value displayed at workstation and at field instrument shall match.

3.6.3.6.3.10 Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

3.6.4 Wiring and cabling will be considered defective if they do not pass tests and inspections.

3.6.5 Prepare test and inspection reports.

3.7 FINAL REVIEW

3.7.1 Submit written request to EOR and Construction Manager when the power monitoring and control system is ready for final review. Written request shall state the following:

3.7.1.1 The system has been thoroughly inspected for compliance with Performance Work Statement Documents and found to be in full compliance.

3.7.1.2 The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.

3.7.1.3 The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
3.7.1.4 The system is complete and ready for final review.

3.7.2 Review by Engineer of Record (EOR) and Construction Manager will be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

3.7.3 Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

3.7.4 Final review shall include a demonstration to parties participating in final review.

3.8 MAINTENANCE SERVICE

3.8.1 Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include semiannual preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.9 SOFTWARE SERVICE AGREEMENT

3.9.1 Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

3.9.2 Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

3.9.2.1 Upgrade Notice: At least 30 days to allow Navy to schedule and access the system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

3.10.1 Engage a factory-authorized service representative to train Navy's maintenance personnel to adjust, operate, and maintain the power monitoring and control system.

3.10.2 Extent of Training:

3.10.2.1 Base extent of training on scope and complexity of power monitoring and control system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
3.10.2.2 Inform Navy of anticipated training requirements if more than minimum training requirements are indicated.
3.10.2.3 Minimum Training Requirements:

3.10.2.3.1 Provide no fewer than two days of training total.
3.10.2.3.2 Stagger training over multiple training classes to accommodate Navy's requirements. All training shall occur before end of warranty period.

3.10.2.3.3 Total days of training shall be broken into not more than three separate training classes.
3.10.2.3.4 Each training class shall be no fewer than three consecutive day(s).

3.10.3 Attendee Training Manuals:

3.10.3.1 Provide each attendee with a color hard copy of all training materials and visual presentations.
3.10.3.2 Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3.10.3.3 In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.

3.10.4 Instructor Requirements:

3.10.4.1 One or multiple qualified instructors, as required, to provide training.
3.10.4.2 Instructors shall have no fewer than five years of providing instructional training on no fewer than five past projects with similar electrical monitoring and control system scope and complexity.

3.10.5 Training Outline: Submit training outline for Navy review at least 10 business days before scheduling training. Outline shall include a detailed agenda for each training day that is broken down into each training session that day, training objectives for each training session, and synopses for each lesson planned.

3.10.6 On-Site Training:

3.10.6.1 Navy will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
3.10.6.2 Instructor shall provide training materials, projector, and other audiovisual equipment used in training.
3.10.6.3 Provide as much of training located on-site as deemed feasible and practical by Navy.
3.10.6.4 On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
3.10.6.5 The workstation provided with the system shall be used in training. If workstation is not indicated, provide a temporary workstation to convey training content.

3.10.7 Off-Site Training:

3.10.7.1 Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.
3.10.7.2 Provide capability to remotely access to Project monitoring and control system for use in training.
3.10.7.3 Provide a workstation for use by each attendee.

3.11 At Completion of Training:

3.11.1 Staff familiar with the system installed are capable of demonstrating operation of the system during final review.

3.11.2 Demonstration shall include, but not be limited to, the following:

3.11.2.1 Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
3.11.2.2 Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and workstations.
3.11.2.3 Trends, summaries, logs, and reports set-up for Project.
3.11.2.4 Software's ability to communicate with controllers, workstations, and uploading and downloading of control programs.
3.11.2.5 Software's ability to edit control programs off-line.
3.11.2.6 Data entry to show Project-specific customizing capability including parameter changes.
3.11.2.7 Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
3.11.2.8 Execution of digital and analog commands in graphic mode.
3.11.2.9 Spreadsheet and curve plot software and its integration with database.
3.11.2.10 Online user guide and help functions.
3.11.2.11 For Each Meter:

3.11.2.11.1 Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
3.11.2.11.2 Operator Interface: Ability to connect directly to each meter with a portable workstation.
3.11.2.11.3 Wiring Labels: Match control drawings.
3.11.2.11.4 Network Communication: Ability to locate a meter on the network. Communication architecture matches Shop Drawings.
3.11.2.11.5 Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

3.11.2.12 For Each Workstation:

3.11.2.12.1 I/O point lists agree with naming conventions.
3.11.2.12.2 Graphics are complete.
3.11.2.12.3 UPS unit, if applicable, operates.

END OF SECTION

SECTION 26 22 13

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS

1.3.1 Product Data: For each type of product.

1.3.1.1 Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
1.3.1.2 Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

1.3.2 Shop Drawings:

1.3.2.1 Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1.3.2.2 Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
1.3.2.3 Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

1.4.1 Qualification Data: For testing agency.

1.4.2 Seismic Qualification Data: Certificates, for transformers, accessories, and components, from manufacturer.

1.4.2.1 Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
1.4.2.2 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
1.4.2.3 Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4.3 Source quality-control reports.

1.4.4 Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

1.5.1 Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

1.6.1 Testing Agency Qualifications: Accredited by NETA.

1.6.1.1 Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.

1.7.1.1 If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

1.7.2 Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

1.7.3 Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.7.4 Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.1.1.1 Acme Electric Corporation.
2.1.1.2 Eaton.
2.1.1.3 Federal Pacific.
2.1.1.4 General Electric Company.
2.1.1.5 Siemens Industry, Inc., Energy Management Division.
2.1.1.6 Square D; by Schneider Electric.

2.1.2 Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

2.2.1 Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2.1.1 The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified.

2.3 GENERAL TRANSFORMER REQUIREMENTS

2.3.1 Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

2.3.2 Comply with NFPA 70.

2.3.2.1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2.3.3 Transformers Rated 15 kVA and Larger:

2.3.3.1 Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2.3.3.2 Marked as compliant with DOE 2016 efficiency levels by an NRTL.

2.3.4 Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.4 DISTRIBUTION TRANSFORMERS

2.4.1 Comply with NFPA 70, and list and label as complying with UL 1561.

2.4.2 Provide transformers that are constructed to withstand seismic forces specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

2.4.3 Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

2.4.3.1 One leg per phase.
2.4.3.2 Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
2.4.3.3 Grounded to enclosure.

2.4.4 Coils: Continuous windings except for taps.

2.4.4.1 Coil Material: Copper.
2.4.4.2 Internal Coil Connections: Brazed or pressure type.
2.4.4.3 Terminal Connections: Bolted.

2.4.5 Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

2.4.6 Enclosure: Totally enclosed, nonventilated.

2.4.6.1 NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.

2.4.6.2 KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
2.4.6.3 Wiring Compartment: Sized for conduit entry and wiring installation.
2.4.6.4 Finish: Comply with NEMA 250.

2.4.6.4.1 Finish Color: ANSI 61 gray weather-resistant enamel.

2.4.7 Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.

2.4.8 Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

2.4.9 Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

2.4.10 Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

2.4.11 Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

2.4.12 Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

2.4.13 K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

2.4.13.1 Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
2.4.13.2 Indicate value of K-factor on transformer nameplate.
2.4.13.3 Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.

2.4.14 Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

2.4.14.1 Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2.4.14.2 Include special terminal for grounding the shield.

2.4.15 Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

2.4.16 Wall Brackets: Wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.

2.4.17 Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:

2.4.17.1 9.00 kVA and Less: 40 dBA.
2.4.17.2 9.01 to 30.00 kVA: 45 dBA.
2.4.17.3 30.01 to 50.00 kVA: 45 dBA for K-factors of 1, 4, and 9.
2.4.17.4 50.01 to 150.00 kVA: 50 dBA for K-factors of 1, 4, and 9.
2.4.17.5 150.01 to 300.00 kVA: 55 dBA for K-factors of 1, 4, and 9.
2.4.17.6 300.01 to 500.00 kVA: 60 dBA for K-factors of 1, 4, and 9.
2.4.17.7 500.01 to 700.00: 62 dBA for K-factors of 1, 4, and 9.

2.5 IDENTIFICATION

2.5.1 Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

2.5.2 Nameplates: Self-adhesive label for each distribution transformer. Self-adhesive labels are specified in Section 26 05 53 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

2.6.1 Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

2.6.1.1 Resistance measurements of all windings at rated voltage connections and at all tap connections.
2.6.1.2 Ratio tests at rated voltage connections and at all tap connections.
2.6.1.3 Phase relation and polarity tests at rated voltage connections.
2.6.1.4 No load losses, and excitation current and rated voltage at rated voltage connections.
2.6.1.5 Impedance and load losses at rated current and rated frequency at rated voltage connections.
2.6.1.6 Applied and induced tensile tests.
2.6.1.7 Regulation and efficiency at rated load and voltage.
2.6.1.8 Insulation-Resistance Tests:

2.6.1.8.1 High-voltage to ground.
2.6.1.8.2 Low-voltage to ground.
2.6.1.8.3 High-voltage to low-voltage.

2.6.1.9 Temperature tests.

2.6.2 Factory Sound-Level Tests: Conduct prototype sound-level tests on production-line products.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

3.1.2 Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

3.1.3 Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

3.1.4 Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

3.1.5 Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

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

3.2 INSTALLATION

3.2.1 Install wall-mounted transformers level and plumb with wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.

3.2.1.1 Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

3.2.1.2 Brace wall-mounted transformers as specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

3.2.2 Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

3.2.3 Construct concrete bases according to Section 03 30 00 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.2.3.1 Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

3.2.4 Secure transformer to concrete base according to manufacturer's written instructions.

3.2.5 Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

3.2.6 Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

3.3.1 Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.3.2 Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.3.3 Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.3.4 Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

3.4.1 Testing Agency: Navy will engage a qualified testing agency to perform tests and inspections.

3.4.2 Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.4.3 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.4.4 Perform tests and inspections with the assistance of a factory-authorized service representative.

3.4.5 Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:

3.4.5.1 Visual and Mechanical Inspection.

3.4.5.1.1 Inspect physical and mechanical condition.
3.4.5.1.2 Inspect anchorage, alignment, and grounding.
3.4.5.1.3 Verify that resilient mounts are free and that any shipping brackets have been removed.
3.4.5.1.4 Verify the unit is clean.
3.4.5.1.5 Perform specific inspections and mechanical tests recommended by manufacturer.
3.4.5.1.6 Verify that as-left tap connections are as specified.
3.4.5.1.7 Verify the presence of surge arresters and that their ratings are as specified.

3.4.5.2 Electrical Tests:

3.4.5.2.1 Measure resistance at each winding, tap, and bolted connection.
3.4.5.2.2 Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
3.4.5.2.3 Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
3.4.5.2.4 Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

3.4.6 Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:

3.4.6.1 Visual and Mechanical Inspection:

3.4.6.1.1 Inspect physical and mechanical condition.
3.4.6.1.2 Inspect anchorage, alignment, and grounding.
3.4.6.1.3 Verify that resilient mounts are free and that any shipping brackets have been removed.
3.4.6.1.4 Verify the unit is clean.
3.4.6.1.5 Perform specific inspections and mechanical tests recommended by manufacturer.
3.4.6.1.6 Verify that as-left tap connections are as specified.
3.4.6.1.7 Verify the presence of surge arresters and that their ratings are as specified.

3.4.6.2 Electrical Tests:

3.4.6.2.1 Measure resistance at each winding, tap, and bolted connection.
3.4.6.2.2 Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
3.4.6.2.3 Perform power-factor or dissipation-factor tests on all windings.

3.4.6.2.4 Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
3.4.6.2.5 Perform an excitation-current test on each phase.
3.4.6.2.6 Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
3.4.6.2.7 Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

3.4.7 Remove and replace units that do not pass tests or inspections and retest as specified above.

3.4.8 Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

3.4.8.1 Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
3.4.8.2 Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
3.4.8.3 Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

3.4.9 Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

3.5.1 Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

3.5.2 Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

3.6.1 Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Lighting and appliance branch-circuit panelboards.
1.2.1.2 Load centers.

1.3 DEFINITIONS

1.3.1 ATS: Acceptance testing specification.

1.3.2 GFCI: Ground-fault circuit interrupter.

1.3.3 GFEP: Ground-fault equipment protection.

1.3.4 HID: High-intensity discharge.

1.3.5 MCCB: Molded-case circuit breaker.

1.3.6 SPD: Surge protective device.

1.3.7 VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of panelboard.

1.4.1.1 Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
1.4.1.2 Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1.4.2 Shop Drawings: For each panelboard and related equipment.

1.4.2.1 Include dimensioned plans, elevations, sections, and details.
1.4.2.2 Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.

1.4.2.3 Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
1.4.2.4 Detail bus configuration, current, and voltage ratings.
1.4.2.5 Short-circuit current rating of panelboards and overcurrent protective devices.
1.4.2.6 Include evidence of NRTL listing for series rating of installed devices.
1.4.2.7 Include evidence of NRTL listing for SPD as installed in panelboard.
1.4.2.8 Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
1.4.2.9 Include wiring diagrams for power, signal, and control wiring.
1.4.2.10 Key interlock scheme drawing and sequence of operations.
1.4.2.11 Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Qualification Data: For testing agency.

1.5.2 Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

1.6.1 Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1.6.1.1 Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
1.6.1.2 Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

1.7.1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7.1.1 Keys: Two spares for each type of panelboard cabinet lock.
1.7.1.2 Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
1.7.1.3 Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
1.7.1.4 Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

1.8.1 Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

1.9.1 Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

1.9.2 Handle and prepare panelboards for installation according to NECA 407.

1.10 FIELD CONDITIONS

1.10.1 Environmental Limitations:

1.10.1.1 Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10.1.2 Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1.10.1.2.1 Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.

1.10.1.2.2 Altitude: Not exceeding 6600 feet.

1.10.2 Service Conditions: NEMA PB 1, usual service conditions, as follows:

1.10.2.1 Ambient temperatures within limits specified.

1.10.2.2 Altitude not exceeding 6600 feet.

1.10.3 Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Navy or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1.10.3.1 Notify Construction Manager / Navy no fewer than two days in advance of proposed interruption of electric service.

1.10.3.2 Do not proceed with interruption of electric service without Construction Manager's / Navy's written permission.

1.10.3.3 Comply with NFPA 70E.

1.11 WARRANTY

1.11.1 Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1.11.1.1 Panelboard Warranty Period: 24 months from date of Substantial Completion.

1.11.2 Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1.11.2.1 SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

2.1.1 Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

2.1.2 Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

2.1.3 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.1.4 Comply with NEMA PB 1.

2.1.5 Comply with NFPA 70.

2.1.6 Enclosures: Flush and Surface-mounted, dead-front cabinets.

2.1.6.1 Rated for environmental conditions at installed location.

2.1.6.1.1 Indoor Dry and Clean Locations: NEMA 250, Type 1.
2.1.6.1.2 Outdoor Locations: NEMA 250, Type 3R.
2.1.6.1.3 Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
2.1.6.1.4 Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
2.1.6.1.5 Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2.1.6.2 Height: 84 inches maximum.
2.1.6.3 Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
2.1.6.4 Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
2.1.6.5 Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
2.1.6.6 Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
2.1.6.7 Finishes:

2.1.6.7.1 Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
2.1.6.7.2 Back Boxes: Same finish as panels and trim.
2.1.6.7.3 Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

2.1.7 Incoming Mains:

2.1.7.1 Location: Convertible between top and bottom.
2.1.7.2 Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

2.1.8 Phase, Neutral, and Ground Buses:

2.1.8.1 Material: Hard-drawn copper, 98 percent conductivity.

2.1.8.1.1 Plating shall run entire length of bus.
2.1.8.1.2 Bus shall be fully rated the entire length.

2.1.8.2 Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
2.1.8.3 Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
2.1.8.4 Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
2.1.8.5 Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
2.1.8.6 Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
2.1.8.7 Split Bus: Vertical buses divided into individual vertical sections.

2.1.9 Conductor Connectors: Suitable for use with conductor material and sizes.

2.1.9.1 Material: Hard-drawn copper, 98 percent conductivity.
2.1.9.2 Terminations shall allow use of 75 deg C rated conductors without derating.
2.1.9.3 Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
2.1.9.4 Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
2.1.9.5 Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
2.1.9.6 Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
2.1.9.7 Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
2.1.9.8 Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
2.1.9.9 Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

2.1.10 NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

2.1.11 Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

2.1.11.1 Percentage of Future Space Capacity: 20 percent.

2.1.12 Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.

2.1.12.1 Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2.1.12.2 Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.1.13 Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

2.1.13.1 Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2.1.13.2 Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

2.2.1 Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 POWER PANELBOARDS

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

2.3.1.1 Eaton.
2.3.1.2 General Electric Company; GE Energy Management - Electrical Distribution.
2.3.1.3 Siemens Industry, Inc., Energy Management Division.
2.3.1.4 Square D; by Schneider Electric.

2.3.2 Panelboards: NEMA PB 1, distribution type.

2.3.3 Doors: Secured with vault-type latch with tumbler lock; keyed alike.

2.3.3.1 For doors more than 36 inches high, provide two latches, keyed alike.

2.3.4 Mains: Circuit breaker / Fused switch / Lugs only, as indicated on plans.

2.3.5 Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers / Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3.6 Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers / Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3.7 Branch Overcurrent Protective Devices: Fused switches.

2.3.8 Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

2.3.8.1 Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2.3.8.2 External Control-Power Source: 120-V branch circuit / 24-V control circuit, as required for the Control System.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

2.4.1.1 Eaton.
2.4.1.2 General Electric Company; GE Energy Management - Electrical Distribution.
2.4.1.3 Siemens Industry, Inc., Energy Management Division.
2.4.1.4 Square D; by Schneider Electric.

2.4.2 Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

2.4.3 Mains: Circuit breaker or lugs only, as shown on plan.

2.4.4 Branch Overcurrent Protective Devices: Plug-in / Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.4.5 Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

2.4.5.1 Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2.4.5.2 External Control-Power Source: 120-V branch circuit / 24-V control circuit as required by the Control System

2.4.6 Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4.7 Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.4.8 Column-Type Panelboards: Single row of overcurrent devices with narrow gutter extension and overhead junction box equipped with ground and neutral terminal buses.

2.4.8.1 Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

2.5 LOAD CENTERS

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

2.5.1.1 Eaton.
2.5.1.2 General Electric Company; GE Energy Management - Electrical Distribution.
2.5.1.3 Siemens Industry, Inc., Energy Management Division.
2.5.1.4 Square D; by Schneider Electric.

2.5.2 Load Centers: Comply with UL 67.

2.5.3 Mains: Circuit breaker or lugs only, as indicated on plan.

2.5.4 Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

2.5.5 Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.

2.5.6 Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

2.6.1.1 Eaton.
2.6.1.2 General Electric Company; GE Energy Management - Electrical Distribution.
2.6.1.3 Siemens Industry, Inc., Energy Management Division.
2.6.1.4 Square D; by Schneider Electric.

2.6.2 MCCB: Comply with UL 489, with series-connected rating / interrupting capacity to meet available fault currents.

2.6.2.1 Thermal-Magnetic Circuit Breakers:

2.6.2.1.1 Inverse time-current element for low-level overloads.
2.6.2.1.2 Instantaneous magnetic trip element for short circuits.
2.6.2.1.3 Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2.6.2.2 Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
2.6.2.3 Electronic Trip Circuit Breakers:

2.6.2.3.1 RMS sensing.
2.6.2.3.2 Field-replaceable rating plug or electronic trip.
2.6.2.3.3 Digital display of settings, trip targets, and indicated metering displays.
2.6.2.3.4 Multi-button keypad to access programmable functions and monitored data.
2.6.2.3.5 Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
2.6.2.3.6 Integral test jack for connection to portable test set or laptop computer.
2.6.2.3.7 Field-Adjustable Settings:

2.6.2.3.7.1 Instantaneous trip.
2.6.2.3.7.2 Long- and short-time pickup levels.
2.6.2.3.7.3 Long and short time adjustments.
2.6.2.3.7.4 Ground-fault pickup level, time delay, and I squared T response.

2.6.2.4 Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
2.6.2.5 GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
2.6.2.6 GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
2.6.2.7 Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
2.6.2.8 Subfeed Circuit Breakers: Vertically mounted.

2.6.2.9 MCCB Features and Accessories:

2.6.2.9.1 Standard frame sizes, trip ratings, and number of poles.
2.6.2.9.2 Breaker handle indicates tripped status.
2.6.2.9.3 UL listed for reverse connection without restrictive line or load ratings.
2.6.2.9.4 Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
2.6.2.9.5 Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
2.6.2.9.6 Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
2.6.2.9.7 Communication Capability: Integral / Din-rail-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 26 09 13 "Electrical Power Monitoring and Control."
2.6.2.9.8 Shunt Trip: 120-V / 24-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
2.6.2.9.9 Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
2.6.2.9.10 Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
2.6.2.9.11 Auxiliary Contacts: Two, SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
2.6.2.9.12 Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
2.6.2.9.13 Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
2.6.2.9.14 Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
2.6.2.9.15 Multipole units enclosed in a factory assembled to operate as a single unit.
2.6.2.9.16 Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
2.6.2.9.17 Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.6.3 Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

2.6.3.1 Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 26 28 13 "Fuses."
2.6.3.2 Fused Switch Features and Accessories:

2.6.3.2.1 Standard ampere ratings and number of poles.
2.6.3.2.2 Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
2.6.3.2.3 Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

2.7 IDENTIFICATION

2.7.1 Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

2.7.2 Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

2.7.3 Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.

2.7.3.1 Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.7.4 Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

2.7.4.1 Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.8 ACCESSORY COMPONENTS AND FEATURES

2.8.1 Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

2.8.2 Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

3.1.2 Receive, inspect, handle, and store panelboards according to NECA 407 / NEMA PB 1.1.

3.1.3 Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

3.1.4 Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

3.2.1 Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.2.2 Comply with NECA 1.

3.2.3 Install panelboards and accessories according to NECA 407.

3.2.4 Equipment Mounting:

3.2.4.1 Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."

3.2.4.2 Attach panelboard to the vertical finished or structural surface behind the panelboard.

3.2.5 Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

3.2.6 Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

3.2.7 Mount top of trim 90 inches above finished floor unless otherwise indicated.

3.2.8 Mount panelboard cabinet plumb and rigid without distortion of box.

3.2.9 Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

3.2.10 Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

3.2.11 Install overcurrent protective devices and controllers not already factory installed.

3.2.11.1 Set field-adjustable, circuit-breaker trip ranges.

3.2.11.2 Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

3.2.12 Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

3.2.13 Install filler plates in unused spaces.

3.2.14 Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

3.2.15 Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2.16 Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

3.3.1 Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.3.2 Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Navy's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.3.3 Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.3.4 Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.3.5 Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

3.4.1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

3.4.2 Perform tests and inspections.

3.4.2.1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.4.3 Acceptance Testing Preparation:

3.4.3.1 Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
3.4.3.2 Test continuity of each circuit.

3.4.4 Tests and Inspections:

3.4.4.1 Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. Certify compliance with test parameters.
3.4.4.2 Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3.4.4.3 Perform the following infrared scan tests and inspections and prepare reports:

3.4.4.3.1 Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
3.4.4.3.2 Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
3.4.4.3.3 Instruments and Equipment:

3.4.4.3.3.1 Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3.4.5 Panelboards will be considered defective if they do not pass tests and inspections.

3.4.6 Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

3.5.1 Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.5.2 Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73.16 "Coordination Studies." Provide Circuit Breaker with recommended Trip Settings per Final Coordination Study.

3.5.3 Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Engineer of Record of effect on phase color coding.

3.5.3.1 Measure loads during period of normal facility operations.

3.5.3.2 Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Engineer of Record. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3.5.3.3 After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.

3.5.3.4 Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

3.6.1 Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Standard-grade receptacles, 125 V, 20 A.
1.2.1.2 USB receptacles.
1.2.1.3 GFCI receptacles, 125 V, 20 A.
1.2.1.4 SPD receptacles, 125 V, 20 A.
1.2.1.5 Hazardous (classified) location receptacles.
1.2.1.6 Twist-locking receptacles.
1.2.1.7 Toggle switches, 120/277 V, 20 A.
1.2.1.8 Occupancy sensors.
1.2.1.9 Wall-box dimmers.
1.2.1.10 Wall plates.
1.2.1.11 Floor service fittings.
1.2.1.12 Poke-through assemblies.
1.2.1.13 Prefabricated multioutlet assemblies.

1.3 DEFINITIONS

1.3.1 AFCI: Arc-fault circuit interrupter.

1.3.2 BAS: Building automation system.

1.3.3 EMI: Electromagnetic interference.

1.3.4 GFCI: Ground-fault circuit interrupter.

1.3.5 Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.3.6 RFI: Radio-frequency interference.

1.3.7 SPD: Surge protective device.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of product.

1.4.2 Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.4.3 Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

1.6.1 Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

1.7.1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7.1.1 Service/Power Poles: One for every 10, but no fewer than one.
1.7.1.2 Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
1.7.1.3 Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
1.7.1.4 SPD Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

2.1.1 Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2.1.2 Comply with NFPA 70.

2.1.3 RoHS compliant.

2.1.4 Comply with NEMA WD 1.

2.1.5 Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

2.1.5.1 Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2.1.5.2 Devices shall comply with requirements in this Section.

2.1.6 Devices for Navy-Furnished Equipment:

2.1.6.1 Receptacles: Match plug configurations.
2.1.6.2 Cord and Plug Sets: Match equipment requirements.

2.1.7 Device Color:

2.1.7.1 Wiring Devices Connected to Normal Power System: White or As selected by Engineer of Record unless otherwise indicated or required by NFPA 70 or device listing.
2.1.7.2 Wiring Devices Connected to Essential Electrical System: Red.
2.1.7.3 SPD Devices: Blue.
2.1.7.4 Isolated-Ground Receptacles: Orange or As specified above, with orange triangle on face.

2.1.8 Wall Plate Color: For plastic covers, match device color.

2.1.9 Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

2.2.1 Duplex Receptacles, 125 V, 20 A:

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

2.2.1.1.1 Eaton (Arrow Hart).
2.2.1.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.2.1.1.3 Leviton Manufacturing Co., Inc.
2.2.1.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.2.1.2 Description: Two pole, three wire, and self-grounding.
2.2.1.3 Configuration: NEMA WD 6, Configuration 5-20R.
2.2.1.4 Standards: Comply with UL 498 and FS W-C-596.

2.2.2 Isolated-Ground Duplex Receptacles, 125 V, 20 A:

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

2.2.2.1.1 Eaton (Arrow Hart).
2.2.2.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.2.2.1.3 Leviton Manufacturing Co., Inc.
2.2.2.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.2.2.2 Description: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.
2.2.2.3 Configuration: NEMA WD 6, Configuration 5-20R.
2.2.2.4 Standards: Comply with UL 498 and FS W-C-596.

2.2.3 Tamper-Resistant Duplex Receptacles, 125 V, 20 A:

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

2.2.3.1.1 Eaton (Arrow Hart).
2.2.3.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.2.3.1.3 Leviton Manufacturing Co., Inc.

2.2.3.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.2.3.2 Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
2.2.3.3 Configuration: NEMA WD 6, Configuration 5-20R.
2.2.3.4 Standards: Comply with UL 498 and FS W-C-596.
2.2.3.5 Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

2.2.4 Weather-Resistant Duplex Receptacle, 125 V, 20 A:

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

2.2.4.1.1 Eaton (Arrow Hart).
2.2.4.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.2.4.1.3 Leviton Manufacturing Co., Inc.
2.2.4.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.2.4.2 Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2.2.4.3 Configuration: NEMA WD 6, Configuration 5-20R.
2.2.4.4 Standards: Comply with UL 498.
2.2.4.5 Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.2.5 Tamper- and Weather-Resistant Duplex Receptacles, 125 V, 20 A:

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

2.2.5.1.1 Eaton (Arrow Hart).
2.2.5.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.2.5.1.3 Leviton Manufacturing Co., Inc.
2.2.5.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.2.5.2 Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2.2.5.3 Configuration: NEMA WD 6, Configuration 5-20R.
2.2.5.4 Standards: Comply with UL 498.
2.2.5.5 Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.3 USB RECEPTACLES

2.3.1 USB Charging Receptacles:

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

2.3.1.1.1 Eaton (Arrow Hart).
2.3.1.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.3.1.1.3 Leviton Manufacturing Co., Inc.
2.3.1.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.3.1.2 Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
2.3.1.3 USB Receptacles: Quad, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
2.3.1.4 Standards: Comply with UL 1310 and USB 3.0 devices.

2.3.2 Tamper-Resistant Duplex and USB Charging Receptacles:

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

2.3.2.1.1 Eaton (Arrow Hart).
2.3.2.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.3.2.1.3 Leviton Manufacturing Co., Inc.
2.3.2.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.3.2.2 Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Integral shutters that operate only when a plug is inserted in the line voltage receptacle.
2.3.2.3 Line Voltage Receptacles: Two pole, three wire, and self-grounding; NEMA WD 6, Configuration 5-20R.
2.3.2.4 USB Receptacles: Dual USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
2.3.2.5 Standards: Comply with UL 498, UL 1310, USB 3.0 devices, and FS W-C-596.
2.3.2.6 Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

2.4 GFCI RECEPTACLES, 125 V, 20 A

2.4.1 Duplex GFCI Receptacles, 125 V, 20 A:

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

2.4.1.1.1 Eaton (Arrow Hart).
2.4.1.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.4.1.1.3 Leviton Manufacturing Co., Inc.
2.4.1.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.4.1.2 Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
2.4.1.3 Configuration: NEMA WD 6, Configuration 5-20R.
2.4.1.4 Type: Feed through.
2.4.1.5 Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

2.4.2 Tamper-Resistant Duplex GFCI Receptacles, 125 V, 20 A:

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

2.4.2.1.1 Hubbell Incorporated; Wiring Device-Kellems.
2.4.2.1.2 Pass & Seymour/Legrand (Pass & Seymour).

2.4.2.2 Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.

2.4.2.3 Configuration: NEMA WD 6, Configuration 5-20R.
2.4.2.4 Type: Feed through.
2.4.2.5 Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
2.4.2.6 Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

2.4.3 Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:

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

2.4.3.1.1 Eaton (Arrow Hart).
2.4.3.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.4.3.1.3 Leviton Manufacturing Co., Inc.
2.4.3.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.4.3.2 Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2.4.3.3 Configuration: NEMA WD 6, Configuration 5-15R.
2.4.3.4 Type: Non-feed through.
2.4.3.5 Standards: Comply with UL 498 and UL 943 Class A.
2.4.3.6 Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.5 SPD RECEPTACLES, 125 V, 20 A

2.5.1 Duplex SPD Receptacles, 125 V, 20 A:

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

2.5.1.1.1 Eaton (Arrow Hart).
2.5.1.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.5.1.1.3 Leviton Manufacturing Co., Inc.
2.5.1.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.5.1.2 Description: Two pole, three wire, and self-grounding. Integral SPD in line to ground, line to neutral, and neutral to ground. LED indicator light.
2.5.1.3 SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
2.5.1.4 Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
2.5.1.5 Configuration: NEMA WD 6, Configuration 5-20R.
2.5.1.6 Standards: Comply with NEMA WD 1, UL 498, UL 1449, and FS W-C-596.

2.5.2 Isolated-Ground Duplex SPD Receptacles, 125 V, 20 A:

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

2.5.2.1.1 Eaton (Arrow Hart).
2.5.2.1.2 Hubbell Incorporated; Wiring Device-Kellems.

2.5.2.1.3 Leviton Manufacturing Co., Inc.
2.5.2.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.5.2.2 Description: Two pole, three wire, and self-grounding. Integral SPD in line to ground, line to neutral, and neutral to ground. LED indicator light.
2.5.2.3 SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
2.5.2.4 Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
2.5.2.5 Grounding: Equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
2.5.2.6 Configuration: NEMA WD 6, Configuration 5-20R.
2.5.2.7 Standards: Comply with UL 498, UL 1449, and FS W-C-596.

2.6 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

2.6.1 Hazardous (Classified) Locations Receptacles:

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

2.6.1.1.1 Eaton (Arrow Hart).
2.6.1.1.2 EGS/Appleton Electric.
2.6.1.1.3 Killark.

2.6.1.2 Description: Pin and sleeve receptacle with matching connector.

2.6.1.3 Class II:

2.6.1.3.1 Division: 2.
2.6.1.3.2 Group: E, F, G.

2.6.1.4 Class III:

2.6.1.4.1 Division: 2.

2.6.1.5 Raintight.
2.6.1.6 Voltage: 250 V ac.
2.6.1.7 Hertz: 60 Hz.
2.6.1.8 Amperage: 20 / 30 / 60 A.
2.6.1.9 Wires and Poles: Two wire, three pole / Three wire, three pole / Three wire, four pole / Four wire, four pole as indicated.
2.6.1.10 Standards: Comply with NEMA FB 11 and UL 1203.

2.7 TWIST-LOCKING RECEPTACLES

2.7.1 Twist-Lock, Single Receptacles, 120 V, 20 A:

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

2.7.1.1.1 Eaton (Arrow Hart).
2.7.1.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.7.1.1.3 Leviton Manufacturing Co., Inc.
2.7.1.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.7.1.2 Configuration: NEMA WD 6, Configuration L5-20R.
2.7.1.3 Standards: Comply with UL 498.

2.7.2 Twist-Lock, Single Receptacles, 250 V, 20 A:

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

2.7.2.1.1 Eaton (Arrow Hart).
2.7.2.1.2 Hubbell Premise Wiring.
2.7.2.1.3 Leviton Manufacturing Co., Inc.
2.7.2.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.7.2.2 Configuration: NEMA WD 6, Configuration L6-20R.
2.7.2.3 Standards: Comply with UL 498.

2.8 TOGGLE SWITCHES, 120/277 V, 20 A

2.8.1 Single-Pole Switches, 120/277 V, 20 A:

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

2.8.1.1.1 Eaton (Arrow Hart).
2.8.1.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.8.1.1.3 Leviton Manufacturing Co., Inc.
2.8.1.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.8.1.2 Standards: Comply with UL 20 and FS W-S-896.

2.8.2 Two-Pole Switches, 120/277 V, 20 A:

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

2.8.2.1.1 Eaton (Arrow Hart).
2.8.2.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.8.2.1.3 Leviton Manufacturing Co., Inc.
2.8.2.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.8.2.2 Comply with UL 20 and FS W-S-896.

2.8.3 Three-Way Switches, 120/277 V, 20 A:

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

2.8.3.1.1 Eaton (Arrow Hart).
2.8.3.1.2 Hubbell Incorporated; Wiring Device-Kellems.

2.8.3.1.3 Leviton Manufacturing Co., Inc.
2.8.3.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.8.3.2 Comply with UL 20 and FS W-S-896.

2.8.4 Four-Way Switches, 120/277 V, 20 A:

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

2.8.4.1.1 Eaton (Arrow Hart).
2.8.4.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.8.4.1.3 Leviton Manufacturing Co., Inc.
2.8.4.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.8.4.2 Standards: Comply with UL 20 and FS W-S-896.

2.8.5 Pilot-Light, Single-Pole Switches: 120/277 V, 20 A:

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

2.8.5.1.1 Eaton (Arrow Hart).
2.8.5.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.8.5.1.3 Leviton Manufacturing Co., Inc.
2.8.5.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.8.5.2 Description: Illuminated when switch is on.
2.8.5.3 Standards: Comply with UL 20 and FS W-S-896.

2.8.6 Lighted Single-Pole Switches, 120/277 V, 20 A:

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

2.8.6.1.1 Eaton (Arrow Hart).
2.8.6.1.2 Hubbell Premise Wiring.
2.8.6.1.3 Leviton Manufacturing Co., Inc.
2.8.6.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.8.6.2 Description: Handle illuminated when switch is off.
2.8.6.3 Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.8.7 Key-Operated, Single-Pole Switches, 120/277 V, 20 A:

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

2.8.7.1.1 Eaton (Arrow Hart).
2.8.7.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.8.7.1.3 Leviton Manufacturing Co., Inc.
2.8.7.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.8.7.2 Description: Factory-supplied key in lieu of switch handle.
2.8.7.3 Standards: Comply with UL 20 and FS W-S-896.

2.8.8 Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120/277 V, 20 A:

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

2.8.8.1.1 Eaton (Arrow Hart).
2.8.8.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.8.8.1.3 Leviton Manufacturing Co., Inc.
2.8.8.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.8.8.2 Description: For use with mechanically held lighting contactors.
2.8.8.3 Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.8.9 Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120/277 V, 20 A:

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

2.8.9.1.1 Eaton (Arrow Hart).
2.8.9.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.8.9.1.3 Leviton Manufacturing Co., Inc.
2.8.9.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.8.9.2 Description: For use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
2.8.9.3 Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.9 OCCUPANCY SENSORS

2.9.1 Wall Switch Sensor Light Switch, Dual Technology:

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

2.9.1.1.1 Eaton (Arrow Hart).
2.9.1.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.9.1.1.3 Leviton Manufacturing Co., Inc.
2.9.1.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.9.1.2 Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual (ultrasonic and passive infrared) technology.
2.9.1.3 Standards: Comply with UL 20.
2.9.1.4 Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
2.9.1.5 Adjustable time delay of five / 10 / 15 / 20 minutes.
2.9.1.6 Able to be locked to Automatic / Manual-On mode.
2.9.1.7 Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.
2.9.1.8 Connections: Provisions for connection to BAS.
2.9.1.9 Connections: RJ-45 communications outlet.
2.9.1.10 Connections: Integral wireless networking.

2.9.2 Wall Sensor Light Switch, Passive Infrared:

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

2.9.2.1.1 Cooper Industries.
2.9.2.1.2 Hubbell Premise Wiring.
2.9.2.1.3 Leviton Manufacturing Co., Inc.
2.9.2.1.4 Pass & Seymour/Legrand (Pass & Seymour).

2.9.2.2 Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using passive infrared technology.
2.9.2.3 Standards: Comply with UL 20.
2.9.2.4 Connections: Provisions for connection to BAS.
2.9.2.5 Connections: Hard wired.
2.9.2.6 Connections: Wireless.
2.9.2.7 Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
2.9.2.8 Integral relay for connection to BAS.
2.9.2.9 Adjustable time delay of five / 10 / 15 / 20 minutes.
2.9.2.10 Able to be locked to Automatic / Manual-On mode.
2.9.2.11 Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.

2.9.3 Wall Sensor Light Switch, Ultrasonic:

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

2.9.3.1.1 Eaton (Arrow Hart).
2.9.3.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.9.3.1.3 Leviton Manufacturing Co., Inc.

2.9.3.2 Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using ultrasonic technology.
2.9.3.3 Standards: Comply with UL 20.
2.9.3.4 Connections: Provisions for connection to BAS.
2.9.3.5 Connections: RJ-45 communications outlet.
2.9.3.6 Connections: Integral wireless networking.
2.9.3.7 Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
2.9.3.8 Integral relay for connection to BAS.
2.9.3.9 Adjustable time delay of five / 10 / 15 / 20 minutes.
2.9.3.10 Able to be locked to Automatic / Manual-On mode.
2.9.3.11 Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.

2.10 DIMMERS

2.10.1 Wall-Box Dimmers:

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

2.10.1.1.1 Eaton (Arrow Hart).
2.10.1.1.2 Hubbell Incorporated; Wiring Device-Kellems.
2.10.1.1.3 Leviton Manufacturing Co., Inc.
2.10.1.1.4 Lutron Electronics Co., Inc.

2.10.1.1.5 Pass & Seymour/Legrand (Pass & Seymour).

2.10.1.2 Description: Modular, full-wave, solid-state dimmer switch with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
2.10.1.3 Control: Continuously adjustable slider, toggle switch; with single-pole or three-way switching.
2.10.1.4 Standards: Comply with UL 1472.
2.10.1.5 Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

2.10.1.5.1 1200 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off."

2.10.1.6 Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
2.10.1.7 LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.11 WALL PLATES

2.11.1 Single Source: Obtain wall plates from same manufacturer of wiring devices.

2.11.2 Single and combination types shall match corresponding wiring devices.

2.11.2.1 Plate-Securing Screws: Metal with head color to match plate finish.
2.11.2.2 Material for Finished Spaces: satin-finished, Type 302 stainless steel.
2.11.2.3 Material for Unfinished Spaces: Galvanized steel.
2.11.2.4 Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

2.11.3 Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum thermoplastic with lockable cover.

2.11.4 Antimicrobial Cover Plates:

2.11.4.1 Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
2.11.4.2 Tarnish resistant.

2.12 FLOOR SERVICE FITTINGS

2.12.1 Flush-Type Floor Service Fittings:

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

2.12.1.1.1 Eaton (Arrow Hart).
2.12.1.1.2 Hubbell Premise Wiring.
2.12.1.1.3 Thomas & Betts Power Solutions; ABB Group.
2.12.1.1.4 Wiremold / Legrand.

2.12.1.2 Description: Type: Modular, flush-type, dual-service units suitable for wiring method used, with cover flush with finished floor.
2.12.1.3 Compartments: Barrier separates power from voice and data communication cabling.
2.12.1.4 Service Plate and Cover: Rectangular / Round, with satin finish.
2.12.1.5 Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
2.12.1.6 Data Communication Outlet: Blank cover with bushed cable opening. Two modular, keyed, color-coded, RJ-45 jacks for twisted pair cable.

2.12.2 Flap-Type Service Fittings:

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

2.12.2.1.1 Eaton (Arrow Hart).
2.12.2.1.2 Hubbell Premise Wiring.
2.12.2.1.3 Thomas & Betts Power Solutions; ABB Group.

2.12.2.2 Description: Type: Modular, flap-type, dual-service units suitable for wiring method used, with flaps flush with finished floor.
2.12.2.3 Compartments: Barrier separates power from voice and data communication cabling.
2.12.2.4 Flaps: Rectangular / Round, with satin finish.
2.12.2.5 Service Plate: Same finish as flaps.
2.12.2.6 Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
2.12.2.7 Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for twisted pair cable.

2.12.3 Above-Floor Service Fittings:

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

2.12.3.1.1 Eaton (Arrow Hart).
2.12.3.1.2 Hubbell Premise Wiring.
2.12.3.1.3 Thomas & Betts Corporation; A Member of the ABB Group.
2.12.3.1.4 Wiremold / Legrand.

2.12.3.2 Description: Type: Modular, above-floor, dual-service units suitable for wiring method used.
2.12.3.3 Compartments: Barrier separates power from voice and data communication cabling.
2.12.3.4 Service Plate: Rectangular / Round, with satin finish.
2.12.3.5 Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
2.12.3.6 Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for twisted pair cable.

2.13 PREFABRICATED MULTIOUTLET ASSEMBLIES

2.13.1 Description: Two-piece surface metal raceway, with factory-wired multioutlet harness.

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

2.13.2.1 Hubbell Incorporated; Wiring Device-Kellems.

2.13.2.2 Wiremold / Legrand.

2.13.3 Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

2.13.4 Raceway Material: Metal, with manufacturer's standard finish.

2.13.5 Multioutlet Harness:

2.13.5.1 Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
2.13.5.2 Receptacle Spacing: 9 inches.
2.13.5.3 Wiring: No. 12 AWG solid, Type THHN copper, two circuit, connecting alternating receptacles.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

3.1.2 Coordination with Other Trades:

3.1.2.1 Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
3.1.2.2 Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3.1.2.3 Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
3.1.2.4 Install wiring devices after all wall preparation, including painting, is complete.

3.1.3 Conductors:

3.1.3.1 Do not strip insulation from conductors until right before they are spliced or terminated on devices.
3.1.3.2 Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3.1.3.3 The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
3.1.3.4 Existing Conductors:

3.1.3.4.1 Cut back and pigtail, or replace all damaged conductors.
3.1.3.4.2 Straighten conductors that remain and remove corrosion and foreign matter.
3.1.3.4.3 Pigtailing existing conductors is permitted, provided the outlet box is large enough.

3.1.4 Device Installation:

3.1.4.1 Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.

3.1.4.2 Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3.1.4.3 Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
3.1.4.4 Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
3.1.4.5 When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
3.1.4.6 Use a torque screwdriver when a torque is recommended or required by manufacturer.
3.1.4.7 When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
3.1.4.8 Tighten unused terminal screws on the device.
3.1.4.9 When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

3.1.5 Receptacle Orientation:

3.1.5.1 Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.
3.1.5.2 Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

3.1.6 Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

3.1.7 Dimmers:

3.1.7.1 Install dimmers within terms of their listing.
3.1.7.2 Verify that dimmers used for fan-speed control are listed for that application.
3.1.7.3 Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

3.1.8 Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.1.9 Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

3.2.1 Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

3.3.1 Comply with Section 26 05 53 "Identification for Electrical Systems."

3.3.2 Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3.3 Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

3.4 FIELD QUALITY CONTROL

3.4.1 Test Instruments: Use instruments that comply with UL 1436.

3.4.2 Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

3.4.3 Perform the following tests and inspections with the assistance of a factory-authorized service representative:

- 3.4.3.1 In healthcare facilities, prepare reports that comply with NFPA 99.
- 3.4.3.2 Test Instruments: Use instruments that comply with UL 1436.
- 3.4.3.3 Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

3.4.4 Tests for Receptacles:

- 3.4.4.1 Line Voltage: Acceptable range is 105 to 132 V.
- 3.4.4.2 Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
- 3.4.4.3 Ground Impedance: Values of up to 2 ohms are acceptable.
- 3.4.4.4 GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
- 3.4.4.5 Using the test plug, verify that the device and its outlet box are securely mounted.
- 3.4.4.6 Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

3.4.5 Test straight-blade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz..

3.4.6 Wiring device will be considered defective if it does not pass tests and inspections.

3.4.7 Prepare test and inspection reports.

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Fusible switches.
1.2.1.2 Nonfusible switches.
1.2.1.3 Receptacle switches.
1.2.1.4 Shunt trip switches.
1.2.1.5 Molded-case circuit breakers (MCCBs).
1.2.1.6 Molded-case switches.
1.2.1.7 Enclosures.

1.3 DEFINITIONS

1.3.1 NC: Normally closed.

1.3.2 NO: Normally open.

1.3.3 SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1.4.1.1 Enclosure types and details for types other than NEMA 250, Type 1.
1.4.1.2 Current and voltage ratings.
1.4.1.3 Short-circuit current ratings (interrupting and withstand, as appropriate).
1.4.1.4 Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
1.4.1.5 Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
1.4.1.6 Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

1.4.2 Shop Drawings: For enclosed switches and circuit breakers.

1.4.2.1 Include plans, elevations, sections, details, and attachments to other work.
1.4.2.2 Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Qualification Data: For qualified testing agency.

1.5.2 Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, accessories, and components, from manufacturer.

1.5.2.1 Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
1.5.2.2 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
1.5.2.3 Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5.3 Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

1.6.1 Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

1.6.1.1 In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1.6.1.1.1 Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
1.6.1.1.2 Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF and calculation program in electronic format.

1.7 MAINTENANCE MATERIAL SUBMITTALS

1.7.1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7.1.1 Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
1.7.1.2 Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

1.8.1 Testing Agency Qualifications: Accredited by NETA.

1.8.1.1 Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 FIELD CONDITIONS

1.9.1 Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1.9.1.1 Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
1.9.1.2 Altitude: Not exceeding 6600 feet.

1.10 WARRANTY

1.10.1 Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1.10.1.1 Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.1.1.1 The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.2 GENERAL REQUIREMENTS

2.2.1 Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

2.2.2 Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

2.2.3 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2.2.4 Comply with NFPA 70.

2.3 FUSIBLE SWITCHES

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

2.3.1.1 ABB Inc.
2.3.1.2 Eaton.
2.3.1.3 General Electric Company.
2.3.1.4 Siemens Industry, Inc., Energy Management Division.
2.3.1.5 Square D; by Schneider Electric.

2.3.2 Type HD, Heavy Duty:

2.3.2.1 Single / Double throw.
2.3.2.2 Three / six pole.
2.3.2.3 600-V ac.
2.3.2.4 200 A and smaller.
2.3.2.5 UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
2.3.2.6 Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

2.3.3 Accessories:

2.3.3.1 Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2.3.3.2 Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
2.3.3.3 Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
2.3.3.4 Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
2.3.3.5 Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac / 120-V ac 12-V dc / 24-V dc.
2.3.3.6 Hookstick Handle: Allows use of a hookstick to operate the handle.
2.3.3.7 Lugs: Mechanical type, suitable for number, size, and conductor material.
2.3.3.8 Service-Rated Switches: Labeled for use as service equipment.

2.4 NONFUSIBLE SWITCHES

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

2.4.1.1 Eaton.
2.4.1.2 General Electric Company.
2.4.1.3 Siemens Industry, Inc., Energy Management Division.
2.4.1.4 Square D; by Schneider Electric.

2.4.2 Type GD, General Duty, Three Pole, Single Throw, 240-V ac, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

2.4.3 Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

2.4.4 Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

2.4.5 Type HD, Heavy Duty, Three Pole, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

2.4.6 Accessories:

2.4.6.1 Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2.4.6.2 Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
2.4.6.3 Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
2.4.6.4 Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
2.4.6.5 Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac / 120-V ac / 12-V dc / 24-V dc.
2.4.6.6 Hookstick Handle: Allows use of a hookstick to operate the handle.
2.4.6.7 Lugs: Mechanical type, suitable for number, size, and conductor material.
2.4.6.8 Service-Rated Switches: Labeled for use as service equipment.

2.5 RECEPTACLE SWITCHES

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

2.5.1.1 Eaton.
2.5.1.2 General Electric Company.
2.5.1.3 Siemens Industry, Inc., Energy Management Division.
2.5.1.4 Square D; by Schneider Electric.

2.5.2 Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 600-V ac, 30 / 60 / 100 A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate required fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

2.5.3 Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: 600-V ac, 30 / 60 / 100 A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

2.5.4 Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

2.5.5 Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

2.5.6 Accessories:

2.5.6.1 Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2.5.6.2 Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
2.5.6.3 Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
2.5.6.4 Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
2.5.6.5 Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac / 120-V ac / 12-V dc / 24-V dc.
2.5.6.6 Hookstick Handle: Allows use of a hookstick to operate the handle.
2.5.6.7 Lugs: Mechanical type, suitable for number, size, and conductor material.
2.5.6.8 Service-Rated Switches: Labeled for use as service equipment.

2.6 SHUNT TRIP SWITCHES

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

2.6.1.1 Bussmann, an Eaton business.
2.6.1.2 Littelfuse, Inc.
2.6.1.3 Mersen USA.

2.6.2 General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.

2.6.3 Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: 600-V ac, 30 / 60 / 100 A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate required fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

2.6.4 Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: 600-V ac, 30 / 60 / 100 A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

2.6.5 Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer source of enough capacity to operate shunt trip, pilot, indicating and control devices.

2.6.6 Accessories:

2.6.6.1 Oiltight key switch for key-to-test function.
2.6.6.2 Oiltight red / green ON pilot light.
2.6.6.3 Isolated neutral lug; 200 percent rating.
2.6.6.4 Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
2.6.6.5 Form C alarm contacts that change state when switch is tripped.
2.6.6.6 Three-pole, double-throw, fire-safety and alarm relay; 120-V ac / 24-V dc coil voltage.
2.6.6.7 Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
2.6.6.8 Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
2.6.6.9 Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
2.6.6.10 Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
2.6.6.11 Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 24-V ac / 120-V ac / 12-V dc / 24-V dc.
2.6.6.12 Hookstick Handle: Allows use of a hookstick to operate the handle.
2.6.6.13 Lugs: Mechanical type, suitable for number, size, and conductor material.
2.6.6.14 Service-Rated Switches: Labeled for use as service equipment.

2.7 MOLDED-CASE CIRCUIT BREAKERS

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

2.7.1.1 Eaton.
2.7.1.2 General Electric Company.
2.7.1.3 NOARK Electric North America.

2.7.1.4 Siemens Industry, Inc., Energy Management Division.
2.7.1.5 Square D; by Schneider Electric.

2.7.2 Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

2.7.3 Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

2.7.4 The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be100 percent rated or series rated. Circuit breaker/circuit breaker Fuse/circuit breaker combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end-use equipment along with the statement "Caution - Series Rated System. With Amps Available. Identical Replacement Component Required."

2.7.5 MCCBs shall be equipped with a device for locking in the isolated position.

2.7.6 Lugs shall be suitable for 140 deg F rated wire on 125-A circuit breakers and below 194 deg F rated wire, sized according to the 167 deg F temperature rating in NFPA 70.

2.7.7 Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

2.7.8 Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2.7.9 Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

2.7.10 Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

2.7.10.1 Instantaneous trip.
2.7.10.2 Long- and short-time pickup levels.
2.7.10.3 Long- and short-time time adjustments.
2.7.10.4 Ground-fault pickup level, time delay, and I-squared t response.

2.7.11 Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

2.7.12 Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

2.7.13 Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

2.7.14 Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

2.7.15 Features and Accessories:

2.7.15.1 Standard frame sizes, trip ratings, and number of poles.
2.7.15.2 Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
2.7.15.3 Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
2.7.15.4 Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
2.7.15.5 Communication Capability: Circuit-breaker-mounted Integral communication module with functions and features compatible with power monitoring and control system, specified in Section 26 09 13 "Electrical Power Monitoring and Control."
2.7.15.6 Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
2.7.15.7 Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
2.7.15.8 Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
2.7.15.9 Alarm Switch: One NO / NC contact that operates only when circuit breaker has tripped.
2.7.15.10 Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
2.7.15.11 Zone-Selective Interlocking: Integral with electronic ground-fault trip unit; for interlocking ground-fault protection function.
2.7.15.12 Electrical Operator: Provide remote control for on, off, and reset operations.
2.7.15.13 Accessory Control Power Voltage: Integrally mounted, self-powered;.

2.8 MOLDED-CASE SWITCHES

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

2.8.1.1 Eaton.
2.8.1.2 General Electric Company.
2.8.1.3 NOARK Electric North America.
2.8.1.4 Siemens Industry, Inc., Energy Management Division.
2.8.1.5 Square D; by Schneider Electric.

2.8.2 Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

2.8.3 Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

2.8.4 Features and Accessories:

2.8.4.1 Standard frame sizes and number of poles.
2.8.4.2 Lugs:

2.8.4.2.1 Mechanical type, suitable for number, size, trip ratings, and conductor material.
2.8.4.2.2 Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F temperature rating in NFPA 70.

2.8.4.3 Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
2.8.4.4 Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
2.8.4.5 Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
2.8.4.6 Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
2.8.4.7 Alarm Switch: One NO / NC contact that operates only when switch has tripped.
2.8.4.8 Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
2.8.4.9 Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
2.8.4.10 Electrical Operator: Provide remote control for on, off, and reset operations.
2.8.4.11 Accessory Control Power Voltage: Integrally mounted,; 24-V ac / 120-V ac / 12-V dc / 24-V dc.

2.9 ENCLOSURES

2.9.1 Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

2.9.2 Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12).

2.9.3 Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

2.9.4 Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover directly operable through the front cover of the enclosure (NEMA 250 Type 1) directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R) / externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

2.9.5 Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

2.9.6 NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.1.2.1 Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

3.2.1 Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Navy or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

3.2.1.1 Notify Construction Manager / Navy no fewer than seven days in advance of proposed interruption of electric service.
3.2.1.2 Indicate method of providing temporary electric service.
3.2.1.3 Do not proceed with interruption of electric service without Construction Manager's / Navy's written permission.
3.2.1.4 Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

3.3.1 Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

3.3.1.1 Indoor, Dry and Clean Locations: NEMA 250, Type 12.
3.3.1.2 Outdoor Locations: NEMA 250, Type 3R / Type 4X.
3.3.1.3 Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
3.3.1.4 Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
3.3.1.5 Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
3.3.1.6 Hazardous Areas Indicated on Drawings: NEMA 250, Type 7 / Type 9 with cover attached by Type 316 stainless steel bolts.

3.4 INSTALLATION

3.4.1 Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.4.2 Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

3.4.3 Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

3.4.4 Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4.5 Install fuses in fusible devices.

3.4.6 Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

3.5.1 Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.5.1.1 Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

3.5.1.2 Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL

3.6.1 Testing Agency: Navy will engage a qualified testing agency to perform tests and inspections.

3.6.2 Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.6.3 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.6.4 Perform tests and inspections with the assistance of a factory-authorized service representative.

3.6.5 Tests and Inspections for Switches:

3.6.5.1 Visual and Mechanical Inspection:

3.6.5.1.1 Inspect physical and mechanical condition.

3.6.5.1.2 Inspect anchorage, alignment, grounding, and clearances.

3.6.5.1.3 Verify that the unit is clean.

3.6.5.1.4 Verify blade alignment, blade penetration, travel stops, and mechanical operation.

3.6.5.1.5 Verify that fuse sizes and types match the Specifications and Drawings.

3.6.5.1.6 Verify that each fuse has adequate mechanical support and contact integrity.

3.6.5.1.7 Inspect bolted electrical connections for high resistance using one of the two following methods:

3.6.5.1.7.1 Use a low-resistance ohmmeter.

3.6.5.1.7.1.1 Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

3.6.5.1.7.2 Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

3.6.5.1.7.2.1 Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

3.6.5.1.8 Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
3.6.5.1.9 Verify correct phase barrier installation.
3.6.5.1.10 Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

3.6.5.2 Electrical Tests:

3.6.5.2.1 Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
3.6.5.2.2 Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
3.6.5.2.3 Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
3.6.5.2.4 Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
3.6.5.2.5 Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

3.6.6 Tests and Inspections for Molded Case Circuit Breakers:

3.6.6.1 Visual and Mechanical Inspection:

3.6.6.1.1 Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
3.6.6.1.2 Inspect physical and mechanical condition.
3.6.6.1.3 Inspect anchorage, alignment, grounding, and clearances.
3.6.6.1.4 Verify that the unit is clean.
3.6.6.1.5 Operate the circuit breaker to ensure smooth operation.
3.6.6.1.6 Inspect bolted electrical connections for high resistance using one of the two following methods:

3.6.6.1.6.1 Use a low-resistance ohmmeter.

3.6.6.1.6.1.1 Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

3.6.6.1.6.2 Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

3.6.6.1.6.2.1 Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

3.6.6.1.7 Inspect operating mechanism, contacts, and chutes in unsealed units.

3.6.6.1.8 Perform adjustments for final protective device settings in accordance with the coordination study.

3.6.6.2 Electrical Tests:

3.6.6.2.1 Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

3.6.6.2.2 Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

3.6.6.2.3 Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.

3.6.6.2.4 Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.

3.6.6.2.5 Determine the following by primary current injection:

3.6.6.2.5.1 Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3.6.6.2.5.2 Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3.6.6.2.5.3 Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3.6.6.2.5.4 Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

3.6.6.2.6 Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.

3.6.6.2.7 Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.

3.6.6.2.8 Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

3.6.6.2.9 Verify operation of charging mechanism. Investigate units that do not function as designed.

3.6.6.3 Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6.6.4 Perform the following infrared scan tests and inspections and prepare reports:

3.6.6.4.1 Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

3.6.6.4.2 Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

3.6.6.4.3 Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3.6.6.5 Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

3.6.7 Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.6.8 Prepare test and inspection reports.

3.6.8.1 Test procedures used.

3.6.8.2 Include identification of each enclosed switch and circuit breaker tested and describe test results.

3.6.8.3 List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

3.7.1 Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.7.2 Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73.16 "Coordination Studies."

END OF SECTION

SECTION 26 29 13.03

MANUAL AND MAGNETIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

- 1.2.1.1 Manual motor controllers.
- 1.2.1.2 Enclosed full-voltage magnetic motor controllers.
- 1.2.1.3 Combination full-voltage magnetic motor controllers.
- 1.2.1.4 Multispeed magnetic motor controllers.
- 1.2.1.5 Enclosures.
- 1.2.1.6 Accessories.
- 1.2.1.7 Identification.

1.3 DEFINITIONS

1.3.1 CPT: Control power transformer.

1.3.2 MCCB: Molded-case circuit breaker.

1.3.3 MCP: Motor circuit protector.

1.3.4 NC: Normally closed.

1.3.5 OCPD: Overcurrent protective device.

1.3.6 SCCR: Short-circuit current rating.

1.3.7 SCPD: Short-circuit protective device.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of product.

- 1.4.1.1 Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4.2 Shop Drawings: For each type of magnetic controller.

- 1.4.2.1 Include plans, elevations, sections, and mounting details.

1.4.2.2 Indicate dimensions, weights, required clearances, and location and size of each field connection.
1.4.2.3 Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
1.4.2.4 Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.4.3 Product Schedule: List the following for each enclosed controller:

1.4.3.1 Each installed magnetic controller type.
1.4.3.2 NRTL listing.
1.4.3.3 Factory-installed accessories.
1.4.3.4 Nameplate legends.
1.4.3.5 SCCR of integrated unit.
1.4.3.6 For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.

1.4.3.6.1 Listing document proving Type 2 coordination.

1.4.3.7 For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by an NRTL acceptable to authorities having jurisdiction.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Qualification Data: For testing agency.

1.5.2 Seismic Qualification Data: Certificates, for magnetic controllers, from manufacturer.

1.5.2.1 Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
1.5.2.2 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
1.5.2.3 Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5.3 Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

1.6.1 Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.

1.6.1.1 In addition to items specified in Section 01 77 00 "Closeout Procedures," include the following:

1.6.1.1.1 Routine maintenance requirements for magnetic controllers and installed components.
1.6.1.1.2 Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.

1.6.1.1.3 Manufacturer's written instructions for setting field-adjustable overload relays.

1.6.1.1.4 Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.6.1.1.5 Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS

1.7.1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7.1.1 Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.7.1.2 Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.7.1.3 Indicating Lights: Two of each type and color installed.

1.7.1.4 Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.

1.7.1.5 Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

1.8.1 Testing Agency Qualifications: Accredited by NETA.

1.8.1.1 Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

1.9.1 Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.9.2 If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; connect factory-installed space heaters to temporary electrical service.

1.10 FIELD CONDITIONS

1.10.1 Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1.10.1.1 Ambient Temperature: Not less than23 deg F and not exceeding 104 deg F.

1.10.1.2 Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.

1.10.1.3 The effect of solar radiation is not significant.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2.1.2 UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.

2.1.3 NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

2.1.4 Seismic Performance: Magnetic controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.1.4.1 The term "withstand" means "the controller will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2.1.4.2 Component Importance Factor: 1.5.

2.2 MANUAL MOTOR CONTROLLERS

2.2.1 Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

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

2.2.1.1.1 Eaton.
2.2.1.1.2 General Electric Company.
2.2.1.1.3 Siemens Industry, Inc., Energy Management Division.
2.2.1.1.4 Square D; by Schneider Electric.

2.2.1.2 Standard: Comply with NEMA ICS 2, general purpose, Class A.
2.2.1.3 Configuration: Nonreversing, Two speed.
2.2.1.4 Surface mounting or Motor Control Center (MCC) as indicated.
2.2.1.5 Red (on) pilot light.

2.2.2 Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

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

2.2.2.1.1 Eaton.
2.2.2.1.2 General Electric Company.
2.2.2.1.3 Siemens Industry, Inc., Energy Management Division.
2.2.2.1.4 Square D; by Schneider Electric.

2.2.2.2 Configuration: Nonreversing.
2.2.2.3 Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.

2.2.2.4 Overload Relays: NEMA ICS 2, bimetallic class as schedule on Drawings.
2.2.2.5 Pilot Light: Red in On.

2.2.3 Integral Horsepower Manual Controllers (IHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

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

2.2.3.1.1 Eaton.
2.2.3.1.2 General Electric Company.
2.2.3.1.3 Rockwell Automation, Inc.
2.2.3.1.4 Siemens Industry, Inc., Energy Management Division.
2.2.3.1.5 Square D; by Schneider Electric.

2.2.3.2 Configuration: Nonreversing.
2.2.3.3 Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
2.2.3.4 Overload Relays: NEMA ICS 2, bimetallic class as scheduled on Drawings.

2.3 ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS

2.3.1 Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.

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

2.3.2.1 Eaton.
2.3.2.2 General Electric Company.
2.3.2.3 Siemens Industry, Inc., Energy Management Division.
2.3.2.4 Square D; by Schneider Electric.

2.3.3 Standard: Comply with NEMA ICS 2, general purpose, Class A.

2.3.4 Configuration: Nonreversing.

2.3.5 Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.

2.3.5.1 Operating Voltage: Manufacturer's standard, unless indicated.

2.3.6 Control Power:

2.3.6.1 For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.

2.3.6.1.1 Spare CPT Capacity: 50 VA.

2.3.7 Overload Relays:

2.3.7.1 Thermal Overload Relays:

2.3.7.1.1 Inverse-time-current characteristic.
2.3.7.1.2 Class 20 tripping characteristic.
2.3.7.1.3 Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
2.3.7.1.4 Ambient compensated.
2.3.7.1.5 Automatic resetting.

2.3.7.2 Solid-State Overload Relay:

2.3.7.2.1 Switch or dial selectable for motor-running overload protection.
2.3.7.2.2 Sensors in each phase.
2.3.7.2.3 Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
2.3.7.2.4 Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

2.3.8 Digital communication module, using RS-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port to transmit the following to the LAN:

2.3.8.1 Instantaneous rms current each phase, and 3-phase average.
2.3.8.2 Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
2.3.8.3 Active Energy (kWh): 3-phase total.
2.3.8.4 Power Factor: Each phase and 3-phase total.

2.4 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

2.4.1 Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.

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

2.4.2.1 Eaton.
2.4.2.2 General Electric Company.
2.4.2.3 Siemens Industry, Inc., Energy Management Division.
2.4.2.4 Square D; by Schneider Electric.

2.4.3 Standard: Comply with NEMA ICS 2, general purpose, Class A.

2.4.4 Configuration: Nonreversing.

2.4.5 Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.

2.4.5.1 Operating Voltage: Manufacturer's standard, unless indicated.

2.4.6 Control Power:

2.4.6.1 For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.

2.4.6.1.1 Spare CPT Capacity as Indicated on Drawings: 50 VA.

2.4.7 Overload Relays:

2.4.7.1 Thermal Overload Relays:

2.4.7.1.1 Inverse-time-current characteristic.
2.4.7.1.2 Class 20 tripping characteristic.
2.4.7.1.3 Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
2.4.7.1.4 Ambient compensated.
2.4.7.1.5 Automatic resetting.

2.4.7.2 Solid-State Overload Relay:

2.4.7.2.1 Switch or dial selectable for motor-running overload protection.
2.4.7.2.2 Sensors in each phase.
2.4.7.2.3 Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

2.4.8 Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

2.4.9 Digital communication module, using RS-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port to transmit the following to the LAN:

2.4.9.1 Instantaneous rms current each phase, and 3-phase average.
2.4.9.2 Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
2.4.9.3 Active Energy (kWh): 3-phase total.
2.4.9.4 Power Factor: Each phase and 3-phase total.

2.4.10 Fusible Disconnecting Means:

2.4.10.1 NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2.4.10.2 Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.4.11 Nonfusible Disconnecting Means:

2.4.11.1 NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2.4.11.2 Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.4.12 MCP Disconnecting Means:

2.4.12.1 UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
2.4.12.2 Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.4.13 MCCB Disconnecting Means:

2.4.13.1 UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2.4.13.2 Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2.4.13.3 Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.5 MULTISPEED MAGNETIC CONTROLLERS

2.5.1 Description: Two speed, full voltage, across the line, electrically held.

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

2.5.2.1 Eaton.
2.5.2.2 General Electric Company.
2.5.2.3 Siemens Industry, Inc., Energy Management Division.
2.5.2.4 Square D; by Schneider Electric.

2.5.3 Standard: Comply with NEMA ICS 2, general purpose, Class A.

2.5.3.1 Configuration: Nonreversing, multispeed.
2.5.3.2 Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

2.5.3.2.1 Operating Voltage: Manufacturer's standard, unless indicated.

2.5.3.3 Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
2.5.3.4 Control Power: 24 / 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

2.5.3.4.1 Spare CPT Capacity: 50 VA.

2.5.3.5 Compelling relays shall ensure that motor will start only at low speed.
2.5.3.6 Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.
2.5.3.7 Decelerating timer relays shall ensure automatically timed deceleration through each speed.
2.5.3.8 Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.

2.5.4 Overload Relays:

2.5.4.1 Thermal Overload Relays: Bimetallic type.

2.5.4.1.1 Inverse-time-current characteristic.
2.5.4.1.2 Class 20 tripping characteristic.
2.5.4.1.3 Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
2.5.4.1.4 Ambient compensated.
2.5.4.1.5 Automatic resetting.

2.5.4.2 Solid-State Overload Relay:

2.5.4.2.1 Switch or dial selectable for motor-running overload protection.
2.5.4.2.2 Sensors in each phase.
2.5.4.2.3 Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

2.5.5 Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

2.5.6 Digital communication module, using RS-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port to transmit the following to the LAN:

2.5.6.1 Instantaneous rms current each phase, and 3-phase average.
2.5.6.2 Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.
2.5.6.3 Active Energy (kWh): 3-phase total.
2.5.6.4 Power Factor: Each phase and 3-phase total.

2.6 ENCLOSURES

2.6.1 Comply with NEMA 250, type 12, complying with environmental conditions at installed location.

2.6.2 The construction of the enclosures shall comply with NEMA ICS 6.

2.6.3 Controllers in hazardous (classified) locations shall comply with UL 1203.

2.7 ACCESSORIES

2.7.1 General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

2.7.1.1 Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.

2.7.1.1.1 Push Buttons: As indicated in the controller schedule.
2.7.1.1.2 Pilot Lights: As indicated in the controller schedule.

2.7.1.2 Elapsed Time Meters: Heavy duty with digital readout in hours; resettable.
2.7.1.3 Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.

2.7.2 Motor protection relays shall be with solid-state sensing circuit and isolated output contacts for hardwired connections.

2.7.2.1 Phase-failure.
2.7.2.2 Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.

2.7.2.3 Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.

2.7.3 Breather assemblies, to maintain interior pressure and release condensation in Type 4 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

2.7.4 Space heaters, with NC auxiliary contacts, to mitigate condensation in Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

2.7.5 Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.8 IDENTIFICATION

2.8.1 Controller Nameplates: Baked enamel signs / Metal backed butyrate signs, as described in Section 26 05 53 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

2.8.2 Arc-Flash Warning Labels:

2.8.2.1 Comply with requirements in Section 26 05 75 "Protective Device Arc-Flash Hazard Study." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

2.8.2.2 Comply with requirements in Section 26 05 53 "Identification for Electrical Systems." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.

2.8.2.2.1 The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

2.8.2.2.1.1 Location designation.
2.8.2.2.1.2 Nominal voltage.
2.8.2.2.1.3 Flash protection boundary.
2.8.2.2.1.4 Hazard risk category.
2.8.2.2.1.5 Incident energy.
2.8.2.2.1.6 Working distance.
2.8.2.2.1.7 Engineering report number, revision number, and issue date.

2.8.2.2.2 Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

3.2.1 Comply with NECA 1.

3.2.2 Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 26 05 29 "Hangers and Supports for Electrical Systems" unless otherwise indicated.

3.2.3 Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."

3.2.4 Comply with requirements for seismic control devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

3.2.5 Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.2.6 Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2.7 Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

3.3 IDENTIFICATION

3.3.1 Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

3.4.1 Testing Agency: Navy will engage a qualified testing agency to perform tests and inspections.

3.4.2 Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.4.3 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.4.4 Perform tests and inspections with the assistance of a factory-authorized service representative.

3.4.5 Tests and Inspections:

3.4.5.1 Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
3.4.5.2 Visual and Mechanical Inspection:

3.4.5.2.1 Compare equipment nameplate data with drawings and specifications.
3.4.5.2.2 Inspect physical and mechanical condition.
3.4.5.2.3 Inspect anchorage, alignment, and grounding.
3.4.5.2.4 Verify the unit is clean.
3.4.5.2.5 Inspect contactors:

3.4.5.2.5.1 Verify mechanical operation.
3.4.5.2.5.2 Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.

3.4.5.2.6 Motor-Running Protection:

3.4.5.2.6.1 Verify overload element rating is correct for its application.
3.4.5.2.6.2 If motor-running protection is provided by fuses, verify correct fuse rating.

3.4.5.2.7 Inspect bolted electrical connections for high resistance using one of the two following methods:

3.4.5.2.7.1 Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
3.4.5.2.7.2 Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

3.4.5.2.8 Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3.4.5.3 Electrical Tests:

3.4.5.3.1 For the contactor and circuit breaker, perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.
3.4.5.3.2 Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
3.4.5.3.3 Test motor protection devices according to manufacturer's published data.
3.4.5.3.4 Test circuit breakers as follows:

3.4.5.3.4.1 Operate the circuit breaker to ensure smooth operation.
3.4.5.3.4.2 For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.

3.4.5.3.5 Perform operational tests by initiating control devices.

3.4.5.4 Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.

3.4.5.4.1 Comply with the recommendations of NFPA 70B, "Testing and Test Methods" Chapter, "Infrared Inspection" Article.
3.4.5.4.2 After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
3.4.5.4.3 Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each motor controller 11 months after date of Substantial Completion.

3.4.5.4.4 Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:

3.4.5.4.4.1 Description of equipment to be tested.
3.4.5.4.4.2 Discrepancies.
3.4.5.4.4.3 Temperature difference between the area of concern and the reference area.
3.4.5.4.4.4 Probable cause of temperature difference.
3.4.5.4.4.5 Areas inspected. Identify inaccessible and unobservable areas and equipment.
3.4.5.4.4.6 Load conditions at time of inspection.
3.4.5.4.4.7 Photographs and thermograms of the deficient area.
3.4.5.4.4.8 Recommended action.

3.4.5.4.5 Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.
3.4.5.4.6 Act on inspection results and recommended action, and considering the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Navy’s operations permit. Retest until deficiencies are corrected.

3.4.6 Motor controller will be considered defective if it does not pass tests and inspections.

3.4.7 Prepare test and inspection reports.

3.5 SYSTEM FUNCTION TESTS

3.5.1 System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.

3.5.1.1 Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
3.5.1.2 Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3.5.1.3 Verify the correct operation of sensing devices, alarms, and indicating devices.

3.5.2 Motor controller will be considered defective if it does not pass the system function tests and inspections.

3.5.3 Prepare test and inspection reports.

3.6 DEMONSTRATION

3.6.1 Engage a factory-authorized service representative to train Navy's maintenance personnel to adjust, operate, and maintain switchgear.

END OF SECTION

SECTION 26 41 13

LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Provide a functional and aesthetically unobstructed Lightning Protection Accessories per UL listed and NFPA 780 standards; but not limited to the following.

1.2.1.1 Air Terminal and Bracing.
1.2.1.2 Main Conductors.
1.2.1.3 Secondary Conductors.
1.2.1.4 Ground Loop Conductor.
1.2.1.5 Ground Rods.
1.2.1.6 Conductor Splices and Connections.
1.2.1.7 Underground Grounding Loop.
1.2.1.8 Bonding Strap and Jumpers to Buildings Metal Structures.

1.2.2 Provide Shop Drawing prepared by Licensed Engineer and/or by Certified Installer and submit for approval from AHJ.

1.2.2.1 Ordinary structures.

1.2.3 Provide Final, Approved Shop Drawing (approved by AHJ) to Engineer of Record for Final Approval for Installation.

1.3 ACTION SUBMITTALS

1.3.1 Product Data: For each type of product.

1.3.2 Shop Drawings:

1.3.2.1 Include layouts of the lightning protection system, with details of the components to be used in the installation.
1.3.2.2 Include raceway locations needed for the installation of conductors.
1.3.2.3 Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
1.3.2.4 Include roof attachment details, coordinated with roof installation.
1.3.2.5 Calculations required by NFPA 780 for bonding of metal bodies.

1.4 INFORMATIONAL SUBMITTALS

1.4.1 Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1.4.1.1 Lightning protection cabling attachments to roofing systems and accessories.
1.4.1.2 Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
1.4.1.3 Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.
1.4.1.4 Surge Protective Devices (SPD) at the Service Entrance Equipment.

1.4.2 Qualification Data: For Installer.

1.4.3 Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

1.4.4 Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

1.5.1 Maintenance Data: For lightning protection system to include in maintenance manuals.

1.5.1.1 In addition to items specified in Section 01 77 00 "Project Closeout," include the following:

1.5.1.1.1 Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations.
1.5.1.1.2 A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

1.5.2 Completion Certificate:

1.5.2.1 UL Master Label Certificate / LPI Limited Scope Certification.

1.6 QUALITY ASSURANCE

1.6.1 Installer Qualifications: UL-listed installer, category OWAY or LPI Master Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.1.1.1 Advanced Lightning Technology, Ltd.
2.1.1.2 East Coast Lightning Equipment Inc.
2.1.1.3 ERICO; a brand of nVent.
2.1.1.4 Heary Bros. Lightning Protection Co. Inc.
2.1.1.5 National Lightning Protection.

2.1.1.6 Robbins Lightning, Inc.
2.1.1.7 Thompson Lightning Protection, Inc.

2.2 PERFORMANCE REQUIREMENTS

2.2.1 NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I buildings.

2.2.2 UL Lightning Protection Standard: Comply with UL 96A requirements for Class I buildings.

2.2.3 Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.3 MATERIALS

2.3.1 Air Terminals:

2.3.1.1 Copper or Aluminum unless otherwise indicated.
2.3.1.2 5/8-inch diameter by 24 inches long.
2.3.1.3 Pointed tip.
2.3.1.4 Integral base support.

2.3.2 Air Terminal Bracing:

2.3.2.1 Aluminum / Copper / Galvanized steel.
2.3.2.2 1/4-inch diameter rod.

2.3.3 Class 1 Main Conductors:

2.3.3.1 Stranded Copper: 57,400 circular mils in diameter.

2.3.4 Class II Main Conductors:

2.3.4.1 Stranded Copper: 115,000 circular mils in diameter.

2.3.5 Secondary Conductors:

2.3.5.1 Stranded Copper: 26,240 circular mils in diameter.

2.3.6 Ground Loop Conductor: Tinned copper.

2.3.7 Ground Rods:

2.3.7.1 Material: Copper-clad steel.
2.3.7.2 Diameter: 5/8 inch.
2.3.7.3 Rods shall be not less than 120 inches long.
2.3.7.4 Sectional type, with integral threads.

2.3.8 Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Install lightning protection components and systems according to UL 96A & NFPA 780 for satisfactory installation of Lightning Protection Systems (LPS).

3.1.2 Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.

3.1.3 Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed installations in UL 96A / concealed systems in NFPA 780.

3.1.3.1 Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.

3.1.3.2 Install conduit where necessary to comply with conductor concealment requirements.

3.1.3.3 Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

3.1.4 Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

3.2.1 Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

3.2.2 Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: exothermic weld.

3.2.3 Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

3.2.3.1 Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

3.2.3.2 Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

3.3.1 Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

3.3.2 Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

3.4.1 Special Inspections: Engage a qualified special inspector to perform the following special inspections:

3.4.1.1 Perform inspections as required to obtain a UL Master Label for system.
3.4.1.2 Perform inspections to obtain an LPI certification.

3.4.2 Prepare test and inspection reports and certificates.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Protecting existing vegetation to remain.
1.2.1.2 Removing existing vegetation.
1.2.1.3 Clearing and grubbing.
1.2.1.4 Stripping and stockpiling topsoil.
1.2.1.5 Stripping and stockpiling rock.
1.2.1.6 Removing above- and below-grade site improvements.
1.2.1.7 Disconnecting, capping or sealing, and removing site utilities.
1.2.1.8 Temporary erosion and sedimentation control.

1.2.2 Related Requirements:

1.2.2.1 Section 01 50 00 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

1.2.3 Related Requirements:

1.2.3.1 Section 01 50 00 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

1.3.1 Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

1.3.2 Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3.3 Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

1.3.4 Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

1.3.5 Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

1.3.6 Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings

1.3.7 Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PREINSTALLATION MEETINGS

1.4.1 Preinstallation Conference: Conduct conference at Project site.

1.5 MATERIAL OWNERSHIP

1.5.1 Except for materials indicated to be stockpiled or otherwise remain Navy's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.6 INFORMATIONAL SUBMITTALS

1.6.1 Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1.6.1.1 Use sufficiently detailed photographs or video recordings.
1.6.1.2 Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

1.6.2 Topsoil stripping and stockpiling program.

1.6.3 Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.7 QUALITY ASSURANCE

1.7.1 Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

1.8 FIELD CONDITIONS

1.8.1 Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1.8.1.1 Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Navy and authorities having jurisdiction.

1.8.1.2 Provide alternate routes around closed or obstructed trafficways if required by Navy or authorities having jurisdiction.

1.8.2 Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Navy's property will be obtained by Navy before award of Contract Task Order.

1.8.2.1 Do not proceed with work on adjoining property until directed by Engineer.

1.8.3 Utility Locator Service: Notify Call Before You Dig for area where Project is located before site clearing.

1.8.4 Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

1.8.5 Tree- and Plant-Protection Zones: If needed, protect according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

1.8.6 Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving."

2.1.1.1 Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 Protect and maintain benchmarks and survey control points from disturbance during construction.

3.1.2 Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

3.1.3 Protect existing site improvements to remain from damage during construction.

3.1.3.1 Restore damaged improvements to their original condition, as acceptable to Navy.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

3.2.1 Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

3.2.2 Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

3.2.3 Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

3.2.4 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

3.3.1 Protect trees and plants remaining on-site according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

3.3.2 Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

3.4 EXISTING UTILITIES

3.4.1 Locate, identify, disconnect, and seal or cap utilities indicated to be removed

3.4.1.1 Arrange with utility companies to shut off indicated utilities.
3.4.1.2 Navy will arrange to shut off indicated utilities when requested by Contractor.

3.4.2 Locate, identify, and relocate utilities in conflict with new building construction. The existing ground water treatment facility is to remain in operation during construction.

3.4.3 Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Navy or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

3.4.3.1 Notify Engineer not less than three days in advance of proposed utility interruptions.
3.4.3.2 Do not proceed with utility interruptions without Engineer's written permission.

3.4.4 Excavate for and remove underground utilities indicated to be removed.

3.4.5 Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 02 41 16 "Structure Demolition" and Section 02 41 19 "Selective Demolition."

3.5 CLEARING AND GRUBBING

3.5.1 Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

3.5.1.1 Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
3.5.1.2 Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3.5.1.3 Use only hand methods or air spade for grubbing within protection zones.
3.5.1.4 Chip removed tree branches and dispose of off-site.

3.5.2 Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

3.5.2.1 Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

3.6.1 Remove sod and grass before stripping topsoil.

3.6.2 Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

3.6.2.1 Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

3.6.3 Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.6.3.1 Limit height of topsoil stockpiles to 72 inches.
3.6.3.2 Do not stockpile topsoil within protection zones.
3.6.3.3 Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
3.6.3.4 Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

3.7.1 Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.7.2 Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

3.7.2.1 Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
3.7.2.2 Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

3.8.1 Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Navy's property.

3.8.2 Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

SECTION 31 20 00

EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement (PWS), including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Excavating and filling for rough grading the Site.
1.2.1.2 Preparing subgrades for walks pavements turf and grasses.
1.2.1.3 Excavating and backfilling for buildings and structures.
1.2.1.4 Drainage course for concrete slabs-on-grade.
1.2.1.5 Subbase course for concrete walks pavements.
1.2.1.6 Subbase course and base course for asphalt paving.
1.2.1.7 Subsurface drainage backfills for walls and trenches.
1.2.1.8 Excavating and backfilling trenches for utilities and pits for buried utility structures.
1.2.1.9 Excavating well hole to accommodate elevator-cylinder assembly.

1.2.2 Related Requirements:

1.2.2.1 Section 31 10 00 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
1.2.2.2 Section 31 50 00 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.

1.3 DEFINITIONS

1.3.1 Backfill: Soil material or controlled low-strength material used to fill an excavation.

1.3.1.1 Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
1.3.1.2 Final Backfill: Backfill placed over initial backfill to fill a trench.

1.3.2 Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

1.3.3 Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

1.3.4 Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

1.3.5 Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

1.3.6 Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1.3.6.1 Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer of Record (EOR). Authorized additional excavation and replacement material will be paid for according to PWS provisions for changes in the Work.

1.3.6.2 Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.

1.3.6.3 Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by EOR. Unauthorized excavation, as well as remedial work directed by EOR, shall be without additional compensation.

1.3.7 Fill: Soil materials used to raise existing grades.

1.3.8 Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1.3.8.1 Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.

1.3.8.2 Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket.

1.3.9 Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D1586.

1.3.10 Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

1.3.11 Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

1.3.12 Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

1.3.13 Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 PREINSTALLATION MEETINGS

1.4.1 Preinstallation Conference: Conduct preexcavation conference at Project site.

1.4.1.1 Review methods and procedures related to earthmoving, including, but not limited to, the following:

1.4.1.1.1 Personnel and equipment needed to make progress and avoid delays.

1.4.1.1.2 Coordination of Work with utility locator service.
1.4.1.1.3 Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
1.4.1.1.4 Extent of trenching by hand or with air spade.
1.4.1.1.5 Field quality control.

1.5 ACTION SUBMITTALS

1.5.1 Product Data: For each type of the following manufactured products required:

1.5.1.1 Geotextiles.
1.5.1.2 Controlled low-strength material, including design mixture.
1.5.1.3 Warning tapes.

1.5.2 Samples for Verification: For the following products, in sizes indicated below:

1.5.2.1 Geotextile: 12 by 12 inches.
1.5.2.2 Warning Tape: 12 inches long; of each color.

1.6 INFORMATIONAL SUBMITTALS

1.6.1 Qualification Data: For qualified testing agency.

1.6.2 Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1.6.2.1 Classification according to ASTM D2487.
1.6.2.2 Laboratory compaction curve according to ASTM D698 or ASTM D1557 as noted.

1.6.3 Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.7 QUALITY ASSURANCE

1.7.1 Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.8 FIELD CONDITIONS

1.8.1 Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1.8.1.1 Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Navy and authorities having jurisdiction.
1.8.1.2 Provide alternate routes around closed or obstructed traffic ways if required by Navy or authorities having jurisdiction.

1.8.2 Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Navy's property will be obtained by Navy before award of Contract Task Order.

1.8.2.1 Do not proceed with work on adjoining property until directed by EOR.

1.8.3 Utility Locator Service: Notify "Call Before You Dig" for area where Project is located before beginning earth-moving operations.

1.8.4 Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 31 10 00 "Site Clearing" are in place.

1.8.5 Do not commence earth-moving operations until plant-protection measures specified in Section 01 56 39 "Temporary Tree and Plant Protection" are in place.

1.8.6 The following practices are prohibited within protection zones:

1.8.6.1 Storage of construction materials, debris, or excavated material.
1.8.6.2 Parking vehicles or equipment.
1.8.6.3 Foot traffic.
1.8.6.4 Erection of sheds or structures.
1.8.6.5 Impoundment of water.
1.8.6.6 Excavation or other digging unless otherwise indicated.
1.8.6.7 Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

1.8.7 Do not direct vehicle or equipment exhaust towards protection zones.

1.8.8 Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

2.1.1 General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

2.1.2 Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487 Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

2.1.2.1 Liquid Limit: to be determined during Geotechnical Evaluation.
2.1.2.2 Plasticity Index: to be determined during Geotechnical Evaluation.

2.1.3 Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487 Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.

2.1.3.1 Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

2.1.4 Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

2.1.5 Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

2.1.6 Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

2.1.7 Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

2.1.8 Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.

2.1.9 Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.

2.1.10 Sand: ASTM C33/C33M; fine aggregate.

2.1.11 Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

2.2.1 Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

2.2.1.1 Survivability: Class 2; AASHTO M 288.
2.2.1.2 Survivability: As follows:

2.2.1.2.1 Grab Tensile Strength: 157 lbf; ASTM D4632.
2.2.1.2.2 Sewn Seam Strength: 142 lbf; ASTM D4632.
2.2.1.2.3 Tear Strength: 56 lbf; ASTM D4533.
2.2.1.2.4 Puncture Strength: 56 lbf; ASTM D4833.

2.2.1.3 Apparent Opening Size: No. 40 sieve, maximum; ASTM D4751.
2.2.1.4 Permittivity: 0.5 per second, minimum; ASTM D4491.
2.2.1.5 UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.2.2 Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

2.2.2.1 Survivability: Class 2; AASHTO M 288.
2.2.2.2 Survivability: As follows:

2.2.2.2.1 Grab Tensile Strength: 247 lbf; ASTM D4632.
2.2.2.2.2 Sewn Seam Strength: 222 lbf; ASTM D4632.
2.2.2.2.3 Tear Strength: 90 lbf; ASTM D4533.
2.2.2.2.4 Puncture Strength: 90 lbf; ASTM D4833.

2.2.2.3 Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.
2.2.2.4 Permittivity: 0.02 per second, minimum; ASTM D4491.
2.2.2.5 UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

2.3.1 Controlled Low-Strength Material: Self-compacting, low-density, flowable concrete material produced from the following:

2.3.1.1 Portland Cement: ASTM C150/C150M, Type I Type II or Type III.
2.3.1.2 Fly Ash: ASTM C618, Class C or F.
2.3.1.3 Normal-Weight Aggregate: ASTM C33/C33M, 3/4-inch nominal maximum aggregate size.
2.3.1.4 Foaming Agent: ASTM C869/C869M.
2.3.1.5 Water: ASTM C94/C94M.
2.3.1.6 Air-Entraining Admixture: ASTM C260/C260M.

2.3.2 Produce conventional-weight, controlled low-strength material with 80-psi compressive strength when tested according to ASTM C495/C495M.

PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

3.1.2 Protect and maintain erosion and sedimentation controls during earth-moving operations.

3.1.3 Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

3.2.1 Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

3.2.2 Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

3.2.3 Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

3.2.3.1 Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.2.4 Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.3 EXPLOSIVES

3.3.1 Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

3.4.1 Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the PWS Sum or the PWS Time will be authorized for rock excavation or removal of obstructions.

3.4.1.1 If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.4.1.2 Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

3.4.1.2.1 24 inches outside of concrete forms other than at footings.
3.4.1.2.2 12 inches outside of concrete forms at footings.
3.4.1.2.3 6 inches outside of minimum required dimensions of concrete cast against grade.
3.4.1.2.4 Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
3.4.1.2.5 6 inches beneath bottom of concrete slabs-on-grade.
3.4.1.2.6 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

3.4.2 Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by EOR. The PWS Sum will be adjusted for rock excavation according to unit prices included in the PWS Documents. Changes in the PWS Time may be authorized for rock excavation.

3.4.2.1 Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

3.4.2.1.1 Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

3.4.2.2 Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

3.4.2.2.1 24 inches outside of concrete forms other than at footings.
3.4.2.2.2 12 inches outside of concrete forms at footings.
3.4.2.2.3 6 inches outside of minimum required dimensions of concrete cast against grade.
3.4.2.2.4 Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
3.4.2.2.5 6 inches beneath bottom of concrete slabs-on-grade.
3.4.2.2.6 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

3.5.1 Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

3.5.1.1 Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.5.1.2 Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.5.2 Excavations at Edges of Tree- and Plant-Protection Zones:

3.5.2.1 Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

3.5.2.2 Cut and protect roots according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

3.6.1 Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

3.7.1 Excavate trenches to indicated gradients, lines, depths, and elevations.

3.7.1.1 Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

3.7.2 Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

3.7.2.1 Clearance: 12 inches each side of pipe or conduit.

3.7.3 Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

3.7.3.1 For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.

3.7.3.2 For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.

3.7.3.3 For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.

3.7.3.4 Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7.4 Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

3.7.4.1 Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7.5 Trenches in Tree- and Plant-Protection Zones:

3.7.5.1 Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

3.7.5.2 Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.7.5.3 Cut and protect roots according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

3.8 SUBGRADE INSPECTION

3.8.1 Notify EOR when excavations have reached required subgrade.

3.8.2 If EOR determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

3.8.3 Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

3.8.3.1 Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

3.8.3.2 Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by EOR, and replace with compacted backfill or fill as directed.

3.8.4 Authorized additional excavation and replacement material will be paid for according to PWS provisions for changes in the Work.

3.8.5 Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by EOR, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

3.9.1 Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by EOR.

3.9.1.1 Fill unauthorized excavations under other construction, pipe, or conduit as directed by EOR.

3.10 STORAGE OF SOIL MATERIALS

3.10.1 Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3.10.1.1 Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

3.11.1 Place and compact backfill in excavations promptly, but not before completing the following:

3.11.1.1 Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
3.11.1.2 Surveying locations of underground utilities for Record Documents.
3.11.1.3 Testing and inspecting underground utilities.
3.11.1.4 Removing concrete formwork.
3.11.1.5 Removing trash and debris.
3.11.1.6 Removing temporary shoring, bracing, and sheeting.
3.11.1.7 Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.11.2 Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

3.12.1 Place backfill on subgrades free of mud, frost, snow, or ice.

3.12.2 Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

3.12.3 Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."

3.12.4 Trenches under Roadways: Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."

3.12.5 Backfill voids with satisfactory soil while removing shoring and bracing.

3.12.6 Initial Backfill:

3.12.6.1 Soil Backfill: Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

3.12.6.1.1 Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

3.12.6.2 Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

3.12.7 Final Backfill:

3.12.7.1 Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
3.12.7.2 Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

3.12.8 Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

3.13.1 Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

3.13.2 Place and compact fill material in layers to required elevations as follows:

3.13.2.1 Under grass and planted areas, use satisfactory soil material.
3.13.2.2 Under walks and pavements, use satisfactory soil material.
3.13.2.3 Under steps and ramps, use engineered fill.
3.13.2.4 Under building slabs, use engineered fill.
3.13.2.5 Under footings and foundations, use engineered fill.

3.13.3 Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

3.14.1 Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

3.14.1.1 Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
3.14.1.2 Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

3.15.1 Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

3.15.2 Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

3.15.3 Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698 or ASTM D1557 as indicated:

3.15.3.1 Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
3.15.3.2 Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.

3.15.3.3 Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
3.15.3.4 For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.16 GRADING

3.16.1 General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

3.16.1.1 Provide a smooth transition between adjacent existing grades and new grades.
3.16.1.2 Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

3.16.2 Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

3.16.2.1 Turf or Unpaved Areas: Plus or minus 1 inch.
3.16.2.2 Walks: Plus or minus 1 inch.
3.16.2.3 Pavements: Plus or minus 1/2 inch.

3.16.3 Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

3.17.1 Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

3.17.1.1 Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698.

3.17.2 Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

3.17.2.1 Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698.
3.17.2.2 Place and compact impervious fill over drainage backfill in 6-inch-thick compacted layers to final subgrade.

3.18 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

3.18.1 Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

3.18.2 On prepared subgrade, place subbase course and base course under pavements and walks as follows:

3.18.2.1 Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
3.18.2.2 Place base course material over subbase course under hot-mix asphalt pavement.

3.18.2.3 Shape subbase course and base course to required crown elevations and cross-slope grades.

3.18.2.4 Place subbase course and base course 6 inches or less in compacted thickness in a single layer.

3.18.2.5 Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

3.18.2.6 Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

3.19 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

3.19.1 Place drainage course on subgrades free of mud, frost, snow, or ice.

3.19.2 On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

3.19.2.1 Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.

3.19.2.2 Place drainage course 6 inches or less in compacted thickness in a single layer.

3.19.2.3 Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

3.19.2.4 Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.20 FIELD QUALITY CONTROL

3.20.1 Special Inspections: Navy will engage a qualified special inspector to perform the following special inspections:

3.20.1.1 Determine prior to placement of fill that site has been prepared in compliance with requirements.

3.20.1.2 Determine that fill material classification and maximum lift thickness comply with requirements.

3.20.1.3 Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.

3.20.2 Testing Agency: Navy will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

3.20.3 Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

3.20.4 Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by EOR.

3.20.5 Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:

3.20.5.1 Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.

3.20.5.2 Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.

3.20.5.3 Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.

3.20.6 When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.21 PROTECTION

3.21.1 Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

3.21.2 Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

3.21.2.1 Scarify or remove and replace soil material to depth as directed by EOR; reshape and recompact.

3.21.3 Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

3.21.3.1 Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

3.22.1 Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Navy's property.

3.22.2 Transport surplus satisfactory soil to designated storage areas on Navy's property. Stockpile or spread soil as directed by EOR.

3.22.2.1 Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Navy's property.

END OF SECTION

SECTION 31 50 00

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section includes temporary excavation support and protection systems.

1.2.2 Related Requirements:

1.2.2.1 Section 01 33 00 "Submittals" for recording preexisting conditions and excavation support and protection system progress.
1.2.2.2 Section 31 20 00 "Earth Moving" for excavating and backfilling, for controlling surface-water runoff and ponding, and for dewatering excavations.

1.3 PREINSTALLATION MEETINGS

1.3.1 Preinstallation Conference: Conduct conference at Project site.

1.3.1.1 Review geotechnical report.
1.3.1.2 Review existing utilities and subsurface conditions.
1.3.1.3 Review coordination for interruption, shutoff, capping, and continuation of utility services.
1.3.1.4 Review proposed excavations.
1.3.1.5 Review proposed equipment.
1.3.1.6 Review monitoring of excavation support and protection system.
1.3.1.7 Review coordination with waterproofing.
1.3.1.8 Review abandonment or removal of excavation support and protection system.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of product.

1.4.1.1 Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

1.4.2 Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.

1.4.2.1 Include plans, elevations, sections, and details.

1.4.2.2 Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
1.4.2.3 Indicate type and location of waterproofing.
1.4.2.4 Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

1.4.3 Delegated-Design Submittal: For excavation support and protection systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Qualification Data: For the following:

1.5.1.1 Land surveyor.
1.5.1.2 Professional Engineer: Experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in New York.

1.5.2 Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5.3 Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.6 CLOSEOUT SUBMITTALS

1.6.1 Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.7 FIELD CONDITIONS

1.7.1 Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Navy or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1.7.1.1 Notify Engineer of Record (EOR) and Navy no fewer than three days in advance of proposed interruption of utility.
1.7.1.2 Do not proceed with interruption of utility without EOR's written permission.

1.7.2 Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks, and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design excavation support and protection systems to resist all lateral loading and surcharge, including but not limited to, retained soil, groundwater pressure, adjacent building loads, adjacent traffic loads, construction traffic loads, material stockpile loads, and seismic loads, based on the following:

2.1.1.1 Compliance with OSHA Standards and interpretations, 29 CFR 1926, Subpart P.
2.1.1.2 Compliance with AASHTO Standard Specification for Highway Bridges or AASHTO LRFD Bridge Design Specification, Customary U.S. Units.
2.1.1.3 Compliance with requirements of authorities having jurisdiction.
2.1.1.4 Compliance with utility company requirements.
2.1.1.5 Compliance with railroad requirements.

2.2 MATERIALS

2.2.1 Provide materials that are either new or in serviceable condition.

2.2.2 Structural Steel: ASTM A36/A36M, ASTM A690/A690M, or ASTM A992/A992M.

2.2.3 Steel Sheet Piling: ASTM A328/A328M, ASTM A572/A572M, or ASTM A690/A690M; with continuous interlocks.

2.2.3.1 Corners: Site-fabricated mechanical interlock

2.2.4 Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application,

2.2.5 Shotcrete: Comply with Section 03 37 13 "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.

2.2.6 Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

2.2.7 Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

2.2.8 Tiebacks: Steel bars, ASTM A722/A722M.

2.2.9 Tiebacks: Steel strand, ASTM A416/A416M.

PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

3.1.1.1 Shore, support, and protect utilities encountered.

3.2 INSTALLATION - GENERAL

3.2.1 Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.

3.2.2 Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

3.2.2.1 Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Navy and authorities having jurisdiction.
3.2.2.2 Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2.3 Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

3.3 SOLDIER PILES AND LAGGING

3.3.1 Install steel soldier piles before starting excavation.

3.3.1.1 Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement.
3.3.1.2 Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging.
3.3.1.3 Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

3.3.2 Install wood lagging within flanges of soldier piles as excavation proceeds.

3.3.2.1 Trim excavation as required to install lagging.
3.3.2.2 Fill voids behind lagging with soil, and compact.

3.3.3 Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.4 SHEET PILING

3.4.1 Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

3.4.2 Accurately place the piling using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer.

3.4.2.1 Limit vertical offset of adjacent sheet piling to 60 inches.
3.4.2.2 Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

3.4.3 Cut tops of sheet piling to uniform elevation at top of excavation.

3.5 TIEBACKS

3.5.1 Drill, install, grout, and tension tiebacks.

3.5.2 Test load-carrying capacity of each tieback, and replace and retest deficient tiebacks.

3.5.2.1 Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

3.5.3 Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 BRACING

3.6.1 Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

3.6.1.1 Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by EOR.
3.6.1.2 Install internal bracing if required to prevent spreading or distortion of braced frames.
3.6.1.3 Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.7 MAINTENANCE

3.7.1 Monitor and maintain excavation support and protection system.

3.7.2 Prevent surface water from entering excavations by grading, dikes, or other means.

3.7.3 Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.8 FIELD QUALITY CONTROL

3.8.1 Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.

3.8.1.1 Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
3.8.1.2 Promptly notify EOR if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

3.8.2 Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

3.8.3 Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.9 REMOVAL AND REPAIRS

3.9.1 Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.

3.9.1.1 Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
3.9.1.2 Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction, and abandon remainder.
3.9.1.3 Fill voids immediately with approved backfill compacted to density specified in Section 31 20 00 "Earth Moving."

3.9.1.4 Repair or replace, as approved by EOR, adjacent work damaged or displaced by removing excavation support and protection systems.

3.9.2 Leave excavation support and protection systems permanently in place.

END OF SECTION

SECTION 32 13 73

CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

- 1.2.1.1 Cold-applied joint sealants.
- 1.2.1.2 Hot-applied joint sealants.
- 1.2.1.3 Cold-applied, fuel-resistant joint sealants.
- 1.2.1.4 Hot-applied, fuel-resistant joint sealants.
- 1.2.1.5 Joint-sealant backer materials.
- 1.2.1.6 Primers.

1.3 PREINSTALLATION MEETINGS

1.3.1 Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of product.

1.4.2 Paving-Joint-Sealant Schedule: Include the following information:

- 1.4.2.1 Joint-sealant application, joint location, and designation.
- 1.4.2.2 Joint-sealant manufacturer and product name.
- 1.4.2.3 Joint-sealant formulation.
- 1.4.2.4 Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Qualification Data: For Installer testing agency.

1.5.2 Product Certificates: For each type of joint sealant and accessory.

1.6 QUALITY ASSURANCE

1.6.1 Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.6.2 Product Testing: Test joint sealants using a qualified testing agency.

1.7 FIELD CONDITIONS

1.7.1 Do not proceed with installation of joint sealants under the following conditions:

1.7.1.1 When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
1.7.1.2 When joint substrates are wet.
1.7.1.3 Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
1.7.1.4 Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

2.1.1 Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANTS

2.2.1 Single-Component, Nonsag, Silicone Joint Sealant: ASTM D5893/D5893M, Type NS.

2.2.2 Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D5893/D5893M, Type SL.

2.2.3 Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade NS, Class 25, for Use T.

2.2.4 Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.

2.2.5 Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 25, for Use T.

2.3 HOT-APPLIED JOINT SEALANTS

2.3.1 Hot-Applied, Single-Component Joint Sealant: ASTM D6690, Type I.

2.3.2 Hot-Applied, Single-Component Joint Sealant: ASTM D6690, Type I or Type II.

2.3.3 Hot-Applied, Single-Component Joint Sealant: ASTM D6690, Type I, II, or III.

2.3.4 Hot-Applied, Single-Component Joint Sealant: ASTM D6690, Type IV.

2.4 COLD-APPLIED, FUEL-RESISTANT JOINT SEALANTS

2.4.1 Fuel-Resistant, Single-Component, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.

2.4.2 Fuel-Resistant, Multicomponent, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 12-1/2 or 25, for Use T.

2.5 HOT-APPLIED, FUEL-RESISTANT JOINT SEALANTS

2.5.1 Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants: ASTM D7116, Type I or Type II.

2.5.2 Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants: ASTM D7116, Type III.

2.6 JOINT-SEALANT BACKER MATERIALS

2.6.1 Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

2.6.2 Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.6.3 Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

2.6.4 Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.7 PRIMERS

2.7.1 Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

3.2.1 Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

3.2.1.1 Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

3.2.2 Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience.

Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

3.3.1 Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

3.3.2 Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.

3.3.3 Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

3.3.3.1 Do not leave gaps between ends of joint-sealant backings.
3.3.3.2 Do not stretch, twist, puncture, or tear joint-sealant backings.
3.3.3.3 Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

3.3.4 Install joint sealants immediately following backing installation, using proven techniques that comply with the following:

3.3.4.1 Place joint sealants so they fully contact joint substrates.
3.3.4.2 Completely fill recesses in each joint configuration.
3.3.4.3 Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

3.3.5 Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

3.3.5.1 Remove excess joint sealant from surfaces adjacent to joints.
3.3.5.2 Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3.3.6 Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

3.4.1 Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

3.4.2 Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.5 PAVING-JOINT-SEALANT SCHEDULE

3.5.1 Joint-Sealant Application: Joints within concrete paving

3.5.1.1 Joint Location:

3.5.1.1.1 Expansion and isolation joints in concrete paving.
3.5.1.1.2 Contraction joints in concrete paving.
3.5.1.1.3 Other joints as indicated.

3.5.1.2 Joint Sealant: Single-component, self-leveling, silicone joint sealant.
3.5.1.3 Joint-Sealant Color: White.

3.5.2 Joint-Sealant Application: Joints within concrete paving and between concrete and asphalt paving

3.5.2.1 Joint Location:

3.5.2.1.1 Joints between concrete and asphalt paving.
3.5.2.1.2 Joints between concrete curbs and asphalt paving.
3.5.2.1.3 Other joints as indicated.

3.5.2.2 Joint Sealant: Hot-applied, single-component joint sealant.

3.5.3 Joint-Sealant Application: Fuel-resistant joints within concrete paving

3.5.3.1 Joint Location:

3.5.3.1.1 Expansion and isolation joints in concrete paving.
3.5.3.1.2 Contraction joints in concrete paving.
3.5.3.1.3 Other joints as indicated.

3.5.3.2 Joint Sealant: Fuel-resistant, multicomponent, pourable, modified-urethane, elastomeric joint sealant Retain "Joint-Sealant Color" Subparagraph below if joint sealants specified are offered in a range of colors and colors are not indicated on Drawings. Typically, color choice is unavailable for paving joint sealants.

END OF SECTION

SECTION 32 31 13

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Performance Work Statement, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Chain-link fences.
1.2.1.2 Swing gates.

1.2.2 Related Requirements:

1.2.2.1 Section 03 30 00 "Cast-in-Place Concrete" for cast-in-place concrete and post footings.

1.3 PREINSTALLATION MEETINGS

1.3.1 Preinstallation Conference: Conduct conference at Project site.

1.3.1.1 Inspect and discuss equipment bases, and other preparatory work specified elsewhere.
1.3.1.2 Review coordination of interlocked equipment specified in this Section and elsewhere.
1.3.1.3 Review required testing, inspecting, and certifying procedures.

1.4 ACTION SUBMITTALS

1.4.1 Product Data: For each type of product.

1.4.1.1 Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

1.4.1.1.1 Fence and gate posts, rails, and fittings.
1.4.1.1.2 Chain-link fabric, reinforcements, and attachments.
1.4.1.1.3 Gates and hardware.

1.4.2 Shop Drawings: For each type of fence and gate assembly.

1.4.2.1 Include plans, elevations, sections, details, and attachments to other work.
1.4.2.2 Include accessories, hardware, and operational clearances.

1.4.3 Samples for Initial Selection: For each type of factory-applied finish.

1.4.4 Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:

1.5 INFORMATIONAL SUBMITTALS

1.5.1 Qualification Data: For factory-authorized service representative.

1.5.2 Product Certificates: For each type of chain-link fence and gate.

1.5.3 Product Test Reports: For framework strength according to ASTM F1043, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5.4 Field quality-control reports.

1.5.5 Sample Warranty: For special warranty.

1.6 QUALITY ASSURANCE

1.6.1 Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1.6.1.1 Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 FIELD CONDITIONS

1.7.1 Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

1.8.1 Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1.8.1.1 Failures include, but are not limited to, the following:

1.8.1.1.1 Failure to comply with performance requirements.
1.8.1.1.2 Deterioration of metals, metal finishes, and other materials beyond normal weathering.

1.8.1.2 Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.1.1 Delegated Design: Engage a qualified professional engineer to design chain-link fence and gate frameworks.

2.1.2 Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.

2.1.3 Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 CHAIN-LINK FENCE FABRIC

2.2.1 General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

2.2.1.1 Fabric Height: 10 feet
2.2.1.2 Steel Wire for Fabric: Wire diameter of 9 Gage

2.2.1.2.1 Mesh Size: 2 inches.

2.2.1.2.2 Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

2.3 FENCE FRAMEWORK

2.3.1 Posts and Rails: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 based on the following:

2.3.1.1 Fence Height: 120 inches.
2.3.1.2 Light-Industrial-Strength Material: roll-formed-steel C-section shapes

2.3.1.2.1 Line Post: 2.375 inches in diameter.
2.3.1.2.2 End, Corner, and Pull Posts: 2.875 inches.

2.3.1.3 Horizontal Framework Members: Intermediate, top and bottom rails according to ASTM F1043.

2.3.1.3.1 Top Rail: 1.66 inches in diameter.

2.3.1.4 Brace Rails: ASTM F1043.
2.3.1.5 Metallic Coating for Steel Framework:

2.3.1.5.1 Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A123/A123M or 4.0-oz./sq. ft. zinc coating according to ASTM A653/A653M.
2.3.1.5.2 Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
2.3.1.5.3 External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil-thick, zinc-pigmented coating.
2.3.1.5.4 Type C: Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. coating.

2.4 SWING GATES

2.4.1 General: ASTM F900 for gate posts and double swing gate types.

2.4.1.1 Gate Leaf Width: 48 inches.
2.4.1.2 Framework Member Sizes and Strength: Based on gate fabric height.

2.4.2 Pipe and Tubing:

2.4.2.1 Zinc-Coated Steel: ASTM F1043 and ASTM F1083; manufacturer's standard protective coating and finish
2.4.2.2 Aluminum: ASTM B429/B429M; manufacturer's standard finish.
2.4.2.3 Gate Posts: Round tubular steel
2.4.2.4 Gate Frames and Bracing: Round tubular steel

2.4.3 Frame Corner Construction: Welded.

2.4.4 Hardware:

2.4.4.1 Hinges: 180-degree outward swing.
2.4.4.2 Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
2.4.4.3 Lock: Manufacturer's standard internal device.
2.4.4.4 Closer: Manufacturer's standard

2.5 FITTINGS

2.5.1 Provide fittings according to ASTM F626.

2.5.2 Post Caps: Provide for each post.

2.5.2.1 Provide line post caps with loop to receive tension wire or top rail.

2.5.3 Rail and Brace Ends: For each gate, corner, pull, and end post.

2.5.4 Rail Fittings: Provide the following:

2.5.4.1 Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
2.5.4.2 Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails to posts.

2.5.5 Tension and Brace Bands: Pressed steel.

2.5.6 Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

2.5.7 Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

2.5.8 Tie Wires, Clips, and Fasteners: According to ASTM F626.

2.5.8.1 Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:

2.5.8.1.1 Hot-Dip Galvanized Steel: 0.148-inch diameter wire galvanized coating thickness matching coating thickness of chain-link fence fabric.

2.5.9 Finish:

2.5.9.1 Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.

2.5.9.1.1 Polymer coating over metallic coating.

2.6 GROUT AND ANCHORING CEMENT

2.6.1 Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

2.6.2 Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.7 GROUNDING MATERIALS

2.7.1 Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

2.7.2 Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

2.7.2.1 Connectors for Below-Grade Use: Exothermic welded type.
2.7.2.2 Grounding Rods: Copper-clad steel, 5/8 by 96 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine areas and conditions, with Installer present, for compliance with requirements for a certified survey of property lines and legal boundaries site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

3.1.1.1 Do not begin installation before final grading is completed unless otherwise permitted by Engineer of Record.

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

3.2 PREPARATION

3.2.1 Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

3.3.1 Install chain-link fencing according to ASTM F567 and more stringent requirements specified.

3.3.1.1 Install fencing on established boundary lines inside property line.

3.3.2 Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

3.3.3 Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

3.3.3.1 Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.

3.3.3.2 Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

3.3.3.2.1 Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.

3.3.3.2.2 Concealed Concrete: Place top of concrete 2 inches below grade to allow covering with surface material.

3.3.3.2.3 Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

3.3.3.2.4 Posts Set into Holes in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

3.3.4 Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.

3.3.5 Line Posts: Space line posts uniformly at 96 inches o.c.

3.3.6 Post Bracing and Intermediate Rails: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

3.3.6.1 Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

3.3.7 Top Rail: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

3.3.8 Intermediate and Bottom Rails: Secure to posts with fittings.

3.3.9 Chain-Link Fabric: Apply fabric to outside of enclosing framework. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

3.3.10 Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.

3.3.11 Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F626. Bend ends of wire to minimize hazard to individuals and clothing.

3.3.11.1 Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

3.3.12 Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side.

3.4 GATE INSTALLATION

3.4.1 Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 GROUNDING AND BONDING

3.5.1 Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.5.2 Fence and Gate Grounding:

3.5.2.1 Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
3.5.2.2 Install ground rods and connections at maximum intervals of 1500 feet.
3.5.2.3 Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet
3.5.2.4 Ground fence on each side of gates and other fence openings.

3.5.2.4.1 Bond metal gates to gate posts.
3.5.2.4.2 Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

3.5.3 Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of 150 feet on each side of crossing.

3.5.4 Fences Enclosing Electrical Power Distribution Equipment: Ground according to IEEE C2 unless otherwise indicated.

3.5.5 Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

3.5.5.1 Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
3.5.5.2 Make grounding connections to each barbed tape coil with connectors designed for this purpose.

3.5.6 Connections:

3.5.6.1 Make connections with clean, bare metal at points of contact.
3.5.6.2 Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
3.5.6.3 Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
3.5.6.4 Make above-grade ground connections with mechanical fasteners.
3.5.6.5 Make below-grade ground connections with exothermic welds.
3.5.6.6 Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.5.7 Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.

3.5.8 Comply with requirements in Section 26 41 13 "Lightning Protection for Structures."

3.6 ADJUSTING

3.6.1 Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.6.2 Lubricate hardware and other moving parts.

3.7 DEMONSTRATION

3.7.1 Engage a factory-authorized service representative to train Navy’s maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION

SECTION 33 30 00

STORM SEWERS

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 Provide storm sewer gravity pipeline laterals of polyvinyl chloride (PVC) plastic pipe from the truck unloading sump to the existing roof drain to drywell sewer line.

1.2 RELATED SECTIONS

1.2.1 Section Includes:

1.2.1.1 01 33 00 Submittals
1.2.1.2 31 20 00 Earth Moving

1.3 REFERENCES

1.3.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA M23	(2002; 2nd Ed) Manual: PVC Pipe - Design and Installation

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)

ASTM INTERNATIONAL (ASTM)

ASTM C 443	(2005ae1) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C 923	(2008) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C 94/C 94M	(2009a) Standard Specification for Ready-Mixed Concrete
ASTM D 1784	(2008) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2235	(2004) Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings

ASTM D 2321	(2009) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2464	(2006) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2467	(2006) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 3212	(2007) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F 477	(2010) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 794	(2003; R 2010) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1998) Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

1.4 SUBMITTALS

1.4.1 The following shall be submitted in accordance with Section 01 33 00 “Submittals”:

1.4.1.1 Product Data: Pipeline materials including any special connectors or branches, gaskets, resins, mastic.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage:

1.5.1.1 Piping: Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping, jointing materials, and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

1.5.2 Handling: Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs. Carry, do not drag, pipe to trench.

PART 2 - PRODUCTS

2.1 PIPELINE MATERIALS

2.1.1 All sanitary sewer is “PVC Plastic Gravity Pipe”. Pipe shall be of the sizes indicated on the Construction Documents.

2.1.1.1 PVC Plastic Gravity Pipe and Fittings: ASTM D 3034, SDR 80, with ends suitable for elastomeric gasket joints

2.1.1.2 PVC Plastic Gravity Joints and Jointing Material: Joints shall conform to ASTM D 3212. Gaskets shall be watertight and shall conform to ASTM F 477

2.1.1.3 Compaction and density test shall be in accordance with Section 31 00 00 “Excavation, Backfill, and Compaction”.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

3.1.1 Installation of Pipelines

3.1.1.1 Location:

3.1.1.1.1 The work covered by this section shall connect the Truck Unloading Sump drain to the existing roof drain line.

3.1.1.2 Earthwork:

3.1.1.2.1 Perform earthwork operations in accordance with Section 31 00 00 “Excavation, Backfill, and Compaction”. This includes trenching excavation, bedding, placing pipe, backfill, compaction, and the restoration of ground cover. Do not under-excavate or over-excavate the trench. Use excavation support when trenches are deeper than 3.5 feet. The Contractor shall remove unstable material and replace it with a stable material. Take care not to damage the pipe if covering the pipe in a fill or daylight area.

3.1.1.2.2 Bedding for PVC pipe shall meet the requirements of ASTM D 2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

3.1.1.3 Pipe Laying and Jointing:

3.1.1.3.1 Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches.

3.1.1.3.2 Install PVC pipe per ASTM D 2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D 2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.1.1.3.3 Max allowable deflection for PVC pipe is 5%. Pipe slope shall be uniform except as directed on the Construction Drawings. Pipe slope should always be negative, meaning there shall be no low spots or flat spots where standing water or sediment build up will occur.

3.1.1.4 Connections to Existing Lines or Manholes:

3.1.1.4.1 Obtain approval from the Navy before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

3.1.1.4.2 Pipe connections to existing manholes shall be made so that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

3.1.1.5 Cutting Pipe, in general:

3.1.1.5.1 Cutting into piping for connections shall not be done except as approved/overseen by the Navy. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete backfill or supported on a concrete cradle as directed. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer.

3.2 FIELD QUALITY CONTROL

3.2.1 Replace damaged material and redo unacceptable work at no additional cost to the Government. Backfilling shall be accomplished after inspection by the Navy. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Navy. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe shall be stored in accordance with the manufacturer's recommendation and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

3.2.1.1 The Navy will conduct field inspections and witness field tests specified in this section. Perform field tests and provide labor, equipment, and incidentals required for testing. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

3.2.2 Tests for Non-pressure Lines

3.2.2.1 Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; it shall show a practically full circle of light through the pipeline when viewed from the adjoining end of line. When pressure piping is used in a non-pressure line for non-pressure use, test this piping as specified for non-pressure pipe.

3.2.2.2 Leakage Tests

3.2.2.2.1 Test lines for leakage by either infiltration tests or exfiltration tests, or by low-pressure air tests. Prior to testing for leakage, backfill trench up to at least lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

3.2.2.2.1.1 Infiltration tests and exfiltration tests: Perform these tests for storm and sewer lines made of the specified materials in accordance with ASTM C 969. Make calculations in accordance with the Appendix to ASTM C 969.

3.2.2.3 Deflection Testing

3.2.2.3.1 Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D 2412. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

END OF SECTION

SECTION 40 41 95

PROCESS CONTROL DESCRIPTION AND OPERATION

PART 1 - GENERAL

1.1 DESCRIPTION

1.1.1 This Section covers the operating functions and controls of equipment for the AOP / Hydrogen Peroxide additions to the existing Groundwater Treatment Plant (GWTP). Control descriptions for these processes are described herein.

1.1.1.1 Advance Oxidation Process (AOP) reactor
1.1.1.2 Motor Operated Valves
1.1.1.3 Hydrogen Peroxide Tank T-3
1.1.1.4 Chemical Feed System – Metering Pumps
1.1.1.5 Chemical Dosing System

1.1.2 CONTRACTOR shall be responsible for ensuring that all control loops operate properly and safely, regardless of equipment supplier, vendor, or subcontractor. CONTRACTOR shall coordinate repair or replacement of any faulty process equipment, control equipment, wiring, or other system components.

1.1.3 The Drawings and Specifications are provided as a reference only. CONTRACTOR is responsible for determining the final configuration, design, layout, and details of all instrumentation, control system and control loops, which will require final approval by engineer.

1.2 DEFINITIONS

1.2.1 Soft Controls: Software, or Soft controls are programmed controls available to the operator through the existing SCADA workstation.

1.2.2 Hard Controls: Hard controls refer to devices such as pushbuttons, hand switches, and potentiometers.

1.3 ABBREVIATIONS

1.3.1 PLC – Programmable Logic Controller

1.3.2 SCADA – Supervisory Control and Data Acquisition

1.4 SUBMITTALS

1.4.1 Reference Section 01 33 00 Submittals.

PART 2 - PRODUCTS

2.1 GENERAL OPERATING DESCRIPTION

2.1.1 General:

2.1.1.1 Contractor shall coordinate networking requirements with the AOP manufacturer to ensure existing PLC / SCADA equipment and new manufacturer equipment communicate.

2.1.1.2 Contractor to ensure AOP manufacturer PLC memory map locations are clearly documented and communicated to allow for existing PLC / SCADA access to manufacturer PLC data.

2.1.2 Supervisory Control and Data Acquisition (SCADA) System:

2.1.2.1 Contractor to provide required configuration of existing SCADA to communicate directly with the manufacturer's PLC and monitor the following AOP data –

2.1.2.1.1 AOP Operating Status – On/Off
2.1.2.1.2 AOP Alarms and Interlocks as defined in 43 31 03.
2.1.2.1.3 Hydrogen Peroxide tank monitoring as described herein and 43 31 03.
2.1.2.1.4 Hydrogen Peroxide pump monitoring as described herein and 43 31 03.
2.1.2.1.5 AOP outlet Motor Operated Valve (MOV) position as described herein and 43 31 03.

2.1.3 PLC Communication:

2.1.3.1 Contractor to provide programming between existing plant PLC and manufacturer's PLC as required.

2.2 ADVANCE OXIDATION PROCESS (AOP) REACTOR

2.2.1 The advance oxidation system will have continuous monitoring and control using the manufacturer's package self-contained control center (SCC) and as per requirements of 43 31 03.

2.3 MOTOR OPERATED VALVES

2.3.1 Process water flow from the AOP outlet to the Equalization Tank / LGAC units shall be controlled using motor operated valves (MOV's). The actuators shall include a chain wheel operator.

2.3.2 Monitoring and control of the MOV's shall be provided by the manufacturer's package self-contained control center (SCC).

2.3.3 Process water from AOP outlet to Equalization Tank will operate during an AOP "warm up / start up" period, or if the AOP is experiencing a Shutdown Alarm. In this scenario, AOP outlet to the Equalization Tank valve will be OPEN and AOP outlet valve to GAC will be CLOSED.

2.3.4 Process water from AOP outlet to the GAC will operate when the treated flow from AOP needs to be sent to GAC downstream. In this scenario, AOP outlet valve to the GAC will be OPEN and AOP outlet valve to the Equalization Tank will be CLOSED.

2.3.5 Manual Operation: Under normal circumstances, no manual operation is required. The valves are automated but will have the option to operate manually using a chair wheel operator.

2.3.6 Automatic Operation: Automated valves. Position of valves will depend on the operating scenario. Valves will OPEN and CLOSE based on the status of the AOP system.

2.3.7 Interlocks: The MOV's shall be interlocked to allow only one valve to be open at a given time.

2.3.8 Alarms: The MOV's shall be programmed with a "Failure Alarm" to alert an operator if a valve has not travelled to a fully Opened or Closed position after 30 seconds of an Open/Close command.

2.4 HYDROGEN PEROXIDE STORAGE TANK (T-3)

2.4.1 The hydrogen peroxide storage tank will be monitored and controlled using the manufacturer's package self - contained control center (SCC).

2.4.2 Chemical level will be monitored by utilizing an ultrasonic level transmitter with a 4-20mA output to the manufacturer's PLC. The PLC will monitor overall chemical usage and generate both High- and Low-level alarms based on operator entered setpoints.

2.4.3 A backup, dual stage mechanical level switch will be used to monitor the Low-Low and High-High chemical levels in the tank both with a discrete 120VAC output to the manufacturer's PLC.

2.4.4 The hydrogen peroxide tank will utilize a leak detection system to monitor the double wall containment. The leak detection system will utilize a fail-safe 120VAC discrete output to the manufacturer's PLC.

2.4.5 Alarms: Chemical level Low-Low and High-High alarm. Leak Detection alarm.

2.5 CHEMICAL FEED SYSTEM – METERING PUMPS

2.5.1 The chemical feed metering pumps for the advance oxidation process (AOP) will be monitored and controlled using the manufacturer's package self - contained control center (SCC).

2.5.2 The chemical feed metering pumps will have a supplemental flow switch to prevent operation in the event of zero or low flow through the AOP system.

2.6 CHEMICAL DOSING SYSTEM

2.6.1 The hydrogen peroxide dosing control system will be monitored and controlled using the manufacturer's package self - contained control center (SCC).

PART 3 - EXECUTION (NOT APPLICABLE)

SECTION 40 91 00

PRIMARY PROCESS MEASUREMENT DEVICES

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 Furnish Primary Process Measurement Devices throughout the facility as defined within this specification and the sections listed below.

1.1.1.1 01 33 00 Submittals
1.1.1.2 01 78 00 Operation and Maintenance Data
1.1.1.3 01 91 13 Equipment Testing and Startup
1.1.1.4 40 41 95 Process Control Description & Operation
1.1.1.5 40 96 15 I/O List

1.2 REFERENCES

1.2.1 The organizations and standards listed below form a part of this specification to the extent that all equipment and labor services provided shall conform to their corresponding reference.

1.2.1.1 IEEE-Institute of Electrical and Electronic Engineering
1.2.1.2 ISA-Instrumentation Society of America
1.2.1.3 ANSI-American National Standards Institute
1.2.1.4 JIC-Joint Industrial Council
1.2.1.5 OSHA-Occupational Safety and Health Act
1.2.1.6 NEC-National Electrical Code
1.2.1.7 UL-Underwriter Laboratories

1.3 SUBMITTAL

1.3.1 Refer to Section 01 33 00 Submittals. In addition, the following Submittals and Requirements shall be considered part of the contract documents.

1.3.2 General Requirements

1.3.2.1 Submit, within 45 calendar days after Notice to Proceed, the following with regard to Primary Process Measurement Devices:

1.3.2.1.1 Product Data: Manufacturer's descriptive and technical literature with all model numbers and related data highlighted.
1.3.2.1.2 Specification Sheets, performance charts and installation instructions.
1.3.2.1.3 Product specific catalog cuts shall be in booklet form, indexed to the unique identifiers, and shall consist of Specification Sheets that document compliance with the specification. Where multiple components are shown on a catalog cut, the application specific component shall be marked in a clear fashion.

1.3.2.2 Operation and Maintenance Data

1.3.2.2.1 Reference to Section 01 78 00 for specific Operations and Maintenance Data.

1.3.2.3 Equipment Testing and Startup

1.3.2.3.1 Refer to Section 01 91 13 for specific Equipment Testing and Startup requirements.

PART 2 - PRODUCTS

2.1 GENERAL

2.1.1 All instrumentation and electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and epoxy or equal coating to prevent contamination by dust, moisture and fungus. The field mounted equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.

2.1.2 All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks unless otherwise noted. Fasteners for securing control panels and enclosures to walls and floors shall be either hot-dipped galvanized after fabrication or stainless steel. Provide stainless steel fasteners only in corrosive areas rated NEMA 4X. Provide minimum size anchor of 3/8-inch.

2.1.3 All indicators shall be linear in process units, unless otherwise noted. All transmitters shall be provided with indicators in process units, accurate to two percent or better.

2.1.4 All equipment, cabinets and devices furnished shall be heavy-duty type, designed for continuous industrial service. The system shall contain similar products of a single manufacturer, and shall consist of equipment models, which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.

2.1.5 All analog transmitter and controller outputs shall be 4-20 mA into a load of 0 to 750 ohms, unless specifically noted otherwise.

2.1.6 All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall incorporate a mechanism to resume normal operation when power is restored, without the need for a manual reset.

2.1.7 All Instrument Datasheets and PLC Control Panel drawings have been provided as a reference only. It is the final responsibility of the CONTRACTOR to review all documents and ensure selected equipment and instrumentation is suitable for its intended use. Alternate equipment will be considered during the final Submittal process and review by the Engineer.

2.1.7.1 Example – Instrument Data Sheet 40 91 23.2B Ultrasonic Level Transmitter lists Rosemount as the Basis of Design. Also contained in the document are two acceptable alternatives, Siemens and Magnetrol.

2.1.8 Nomenclature and Identification

2.1.8.1 All field instrumentation shall have an attached stainless-steel tag indicating instrument tag number. (Example: FIT-100).

2.1.9 Electrical

2.1.9.1 Equipment shall operate on a 60 Hertz alternating current power source at either a nominal 480 volts or 120 volts AC, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

2.1.9.2 With the exception for field device network connected devices, all electronic instrumentation shall utilize linear transmission signals of isolated 4 to 20 mA DC (milliampere direct current) capable of driving a load up to 750 ohms, unless specified otherwise. However, signals between instruments within the same panel or cabinet may be 1-5 VDC (volts direct current). All field instrumentation shall be HART compatible where available.

2.1.9.3 Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero-based signals will be allowed.

2.1.9.4 All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA where available.

2.1.9.5 Switches and/or signals indicating an alarm, failure or upset condition shall be wired in a fail-safe manner. A fail-safe condition is an open circuit when in an alarm state.

2.1.9.6 Materials and equipment shall be UL approved whenever such approved equipment and materials are available.

2.2 ELECTRICAL SURGE PROTECTION

2.2.1 Provide Surge protection of all 120 VAC power feeds into control panels, instruments, and control room equipment to protect downstream equipment from induced surges caused by lightning, utility surges or the plant electrical system.

2.2.2 Non-Fiber Based Data Highway or Communications Circuits – Provide protection on all communication and data highway circuits that leave a building or are routed external to a building. Circuit protection shall be provided at both ends of the line.

2.2.3 Inductive Loads – Provide coil surge suppression devices, such as varistors or interposing relays, on all process controller outputs or switches rated 120 VA or less that drive solenoid, coil, or motor loads.

2.3 SPARE PARTS

2.3.1 Provide instrumentation as specified below.

Specification Sheet No.	Type	Device
40 91 23.2B	Hydrogen Peroxide Tank Level Measurement Device Provide one spare level transmitter calibrated per the Spec Sheet.	Ultrasonic Level Transmitter
40 91 23.2E	Hydrogen Peroxide Tank Level Switch Provide one spare dual stage, backup level switch for Low-Low and High-High level detection calibrated per Spec Sheet.	Mechanical Displacement Level Switch
40 91 23.2F	Hydrogen Peroxide Tank Leak Detection Switch Provide on spare leak detection switch calibrated per Spec Sheet.	Capacitance Level Switch

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

3.1.1 Instrumentation and accessory equipment shall be installed in accordance with manufacturer installation instructions. This includes local wiring, connections to process pipe, and other accessories required for the instrumentation and controls to safely and accurately operate. If provided as part of the reference documents, all indicated locations of equipment, transmitters, alarms and similar devices indicated are approximate only. Exact locations of all devices shall be as approved by the Engineer during construction. Obtain in the field, all information relevant to the placing of process control equipment and in case of interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner at no additional cost to the Navy.

3.1.2 Provide brackets and hangers required for mounting of equipment.

3.1.3 The shield on each process instrumentation cable shall be continuous from source to destination and be grounded at only one ground point for each shield.

3.1.4 Investigate each space in the building through which equipment must pass to reach its final location. If necessary, ship material in sections sized to permit passing through restricted areas in the building. Provide on-site service to oversee the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the Engineer’s approval. Certify that field wiring associated with the equipment is installed in accordance with best industry practice.

3.1.5 Provide sunshades for equipment mounted outdoors in direct sunlight. Sunshades shall include standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face to the North or as required to minimize the impact of glare and ultraviolet exposure on digital readouts.

END OF SECTION

TETRA TECH	Ultrasonic Level Transmitter Specification Sheet	REV.	DATE
	40 91 23.2B	A	05/24/2019

Customer	GM-38	Project	Groundwater Treatment Facility
Project No.	112G08005-WE24	Location	Bethpage, NY

PROCESS CONDITIONS:

Fluid	Hydrogen Peroxide	Pressure Range	Atm (psig)
Surface Agitation Type	None	Temperature Range	60 (°F)

ELEMENT:

Measurement Type	Ultrasonic	Wetted Parts Material	PVDF
Sensor Beam Width	6° Beam Half Angle	Distance From Sidewall	Minimum 12 (inches)
Connection Size & Type	2” NPT		

TRANSMITTER:

Type	Integral	Output Signal	4 – 20 mA
Power Supply	24VDC Loop Powered	Indicator Scale	N/A
Accuracy	+/- 0.25% Measured Range		

HOUSING:

Material	Aluminum	Finish	Polyurethane
Mounting Hardware	N/A	Conduit Connections	2 @ 1/2"

ELECTRICAL:

Area Classification Class _______ Division _______ Group _______

Non-hazardous X

ACCESSORIES:

Cable Length	N/A (ft.)	Flange Mount	03100-1001-0002 Tank nozzles to be elevated 6” Max. 2” NPT To 3” PVC Flange

MANUFACTURER BASIS OF DESIGN:

Manufacturer	Rosemount	Model No.	3102HA1FRCNAQ4ST

ACCEPTABLE MANUFACTURERS:

Manufacturer Siemens
Magnetrol

TAG INFORMATION:

Tag Number	Service	Tank Height	Calib. Range (inches)	Process Fluid
LT-3	Hydrogen Peroxide Storage Tank T-3	108"	0 -102"	Hydrogen Peroxide

SPECIAL INSTRUCTIONS OR FEATURES:

1. Stainless Steel Tag inscribed with tag number permanently attached to device. All instruments listed shall be from the same manufacturer.
   Note: Reference Mounting Instructions to ensure Equalization Tank Nozzles are fabricated correctly.

THE END

	Mechanical Displacement Level Switch Specification Sheet	REV.	DATE
TETRA TECH	40 91 23.2E	A	05/24/2019

Customer	GM-38	Project	Groundwater Treatment Facility
Project No.	112G08005-WE24	Location	Bethpage, NY

ELEMENT:

Measurement Type	Level	Float and Trim	316 SS
Sensor Type	Mechanical Displacement	Process Connection	2 ½" NPT on 3" 150# RF
Orientation	Top Mount	Max. Press. / Temp.	720 PSIG @ 100 Deg. F

SWITCH:

Type	Series B Snap Switch	Max. Temp.	250 Deg. F
Current Rating	15 Amp @ 120VAC	Switch Enclosure	NEMA 4X
Quantity & Form	2 – DPDT Standard Contact	Power Supply	120VAC

HOUSING:

Material	NEMA 4X	Conduit Connection	1" NPT

ELECTRICAL:

Area Classification Class ______ Division ______ Group ______

Non-Hazardous X

MANUFACTURER BASIS OF DESIGN:

Manufacturer	Magnetrol	Model No.	B15-4G3B-BOB

ACCEPTABLE MANUFACTURERS:

Manufacturer Drexelbrook
Siemens

TAG INFORMATION:

Tag Number	Service	Orientation	Process Media
LSLL / LSHH-T3	Hydrogen Peroxide T-3 Low-Low / High-High Level	Top	Hydrogen Peroxide Chemical

SPECIAL INSTRUCTIONS OR FEATURES:

1. Stainless Steel Tag inscribed with tag number permanently attached to device. All instruments listed shall be from the same manufacturer.

NOTES: Flange Mounting Location must be taken into consideration to ensure proper operation.
Unit ships with a 20' cable, Displacer elements are field adjustable as necessary.

THE END

TETRA TECH	Capacitance Level Switch Specification Sheet	REV.	DATE
	40 91 23.2F	A	05/24/2019

Customer	GM-38	Project	Groundwater Treatment Facility
Project No.	112G08005-WE24	Location	Bethpage, NY

SENSING PROBE:

Measurement Type	Interstitial Leak Detection	Probe Material	316 SS / Teflon
Sensor Type	Capacitance	Probe Type	Rigid
Orientation	Vertical	Process Connection	¾' NPT

SWITCH:

Type	Dry Contact	Quantity & Form	2 SPDT – Form C (Failsafe)
Current Consumption	3A 250VAC Max	Indicator Scale	N/A

CONTROL UNIT:

Material	Blue Painted Steel	Display	Two Line LCD & Keypad
Protection Degree	Type 4 / IP65	Accuracy	0.2% of Full Scale
Power Supply	120VAC	Options	Strobe / Beacon

ELECTRICAL:

Area Classification Class ________ Division ________ Group ________

Non-hazardous X

MANUFACTURER BASIS OF DESIGN:

Manufacturer	Arjay Engineering	Model No.	2852T-ILA-1

ACCEPTABLE MANUFACTURERS:

Manufacturer Gems

TAG INFORMATION:

Tag Number	Service	Orientation	Process Media
LSH-T3	Hydrogen Peroxide Storage Tank T-3 Leak Detection	Vertical	Hydrogen Peroxide

SPECIAL INSTRUCTIONS OR FEATURES:

1. Stainless Steel Tag inscribed with tag number, service description, and calibrated range permanently attached to device. All instruments listed shall be from the same manufacturer.

SECTION 41 10 02

PROCESS PIPING

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 Furnish all labor, materials, equipment and incidentals required to install all Process Piping and Appurtenances as shown on the drawings and specified herein. This specification covers the requirements for process water pipe, piping, pipe supports, valves, fittings, and accessories only. For other civil, mechanical and plumbing related piping specifications Contractor shall refer to other piping specifications. The Contractor shall procure, install, support and test all process piping shown on the Performance Work Statement (PWS) Drawings and described in these specifications.

1.1.2 All piping within the GWTP from the AOP reactor to the existing piping shall be Schedule-80 PVC piping as shown on drawings.

1.1.3 All the piping and connections on the AOP reactor shall be 316 stainless steel, except small bore piping (1” and below) for connecting to pressure gauges, instruments, sample ports, pipe drains, and pipe vents, which shall be 316L stainless steel as shown on drawings.

1.1.4 All chemical feed piping and tubing are specified in Section 43 32 69, Chemical Feed System - Metering Pumps.

1.2 RELATED SECTIONS

1.2.1 Sections Include:

1.2.1.1 Section 01 33 00 Submittals and Substitutions
1.2.1.2 Section 22 11 13 Facility Water Distribution Piping
1.2.1.3 Section 22 13 16 Sanitary Waste and Vent Piping
1.2.1.4 Section 22 42 13 Plumbing Fixtures
1.2.1.5 Section 31 00 00 Excavation, Backfill & Compaction
1.2.1.6 Section 43 32 69 Chemical Metering Systems

1.3 REFERENCES

1.3.1 The publications listed below form a part of this specification to the extent referenced.

1.3.1.1 American Society of Mechanical Engineers International (ASME)

1.3.1.1.1 B1.1: Unified Inch Screw Threads (UN and UNR Thread Form)
1.3.1.1.2 B1.20.1: Pipe Threads, General Purpose (Inch)
1.3.1.1.3 B1.20.7: Standard for Hose Coupling Screw Threads (Inch)
1.3.1.1.4 B16.11: Forged Fittings, Socket-Welding and Threaded
1.3.1.1.5 B16.21: Nonmetallic Flat Gaskets for Pipe Flanges
1.3.1.1.6 B16.3: Malleable Iron Threaded Fittings, Classes 150 and 300

1.3.1.1.7 B16.39: Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
1.3.1.1.8 B16.5: Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
1.3.1.1.9 B16.9: Standard for Factory-Made Wrought Steel Butt-welding Fittings
1.3.1.1.10 B18.2.1: Square and Hex Bolts and Screws (Inch Series)
1.3.1.1.11 B18.2.2: Standard for Square and Hex Nuts
1.3.1.1.12 B31.3: Process Piping
1.3.1.1.13 B36.19M: Stainless Steel Pipe
1.3.1.1.14 BPVC SEC VIII D1: BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

1.3.1.2 American Society for Testing and Materials (ASTM)

1.3.1.2.1 A181/A181M: Standard Specification for Carbon Steel Forgings, for General-Purpose Piping
1.3.1.2.2 D1784: Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds
1.3.1.2.3 D1785: Standard Specification for Poly (Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
1.3.1.2.4 D2105: Standard Test for Longitudinal Tensile Properties of Reinforced Thermosetting Plastic Pipe and Tube
1.3.1.2.5 D2122: Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
1.3.1.2.6 D 2241: Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
1.3.1.2.7 D2412: Standard Test for External Loading Properties of Plastic Pipe by Parallel-Plate Loading
1.3.1.2.8 D2464: Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
1.3.1.2.9 D2467: Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
1.3.1.2.10 D2564: Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
1.3.1.2.11 D2855: Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
1.3.1.2.12 F2164: Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
1.3.1.2.13 F2620: Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
1.3.1.2.14 F477: Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
1.3.1.2.15 F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
1.3.1.2.16 F656: Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

1.3.1.3 American Welding Society (AWS):

1.3.1.3.1 B3.0: Welding Procedure and Performance Qualification
1.3.1.3.2 A5.11/A5.11M: Specification for Nickel and Nickel Alloy Welding Electrodes for Shielded Metal Arc Welding
1.3.1.3.3 A5.14/A5.14M: Specification for Nickel and Nickel Alloy Bare Welding Electrodes and Rods
1.3.1.3.4 D1.1/D1.1M: Structural Welding Code – Steel

1.3.1.4 Manufacturers Standardization Society (MSS)

1.3.1.4.1 SP-25: Standard Marking System for Valves, Fittings, Flanges and Unions
1.3.1.4.2 SP-58: Standard for Pipe Hangers and Supports - Materials, Design and Manufacture
1.3.1.4.3 SP-69: Standard for Pipe Hangers and Supports - Selection and Application
1.3.1.4.4 SP-80: Bronze Gate, Globe, Angle, and Check Valves
1.3.1.4.5 SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices

1.3.1.5 Plastics Pipe Institute (PPI)

1.3.1.5.1 TR-21: Thermal Expansion and Contraction in Plastic Piping Systems

1.3.1.6 Rubber Manufacturers Association (RMA)

1.3.1.6.1 IP-2: Hose Handbook

1.4 SUBMITTALS

1.4.1 The following shall be submitted in accordance with Section 01 33 00 Submittals:

1.4.1.1 Shop Drawings: Shop drawings and support system detail drawings showing piping and appurtenances including mechanical joints, valves, hangers, and pipe supports. Include a complete list of equipment and materials on the drawings.
1.4.1.2 Product Data: Manufacturer's descriptive and technical literature for each piping system, including design recommendations; pressure and temperature ratings; dimensions, type, grade and strength of pipe and fittings and chemical resistance.
1.4.1.3 Material safety data sheet in conformance with 29 CFR 1910 Section 1200(g) for each chemical (solvents, solvent cements, and glues) delivered for use in pipe installation.
1.4.1.4 Pipe Schedule: Provide a list of piping systems, pressure ratings and source of supply for each piping system broken out by material, size and application as indicated on the PWS Drawings. Provide a list of any special tools necessary for each piping system and appurtenance furnished for adjustment, operation, maintenance and disassembly of the system.
1.4.1.5 Valve and Valve Operator Schedule: Provide a list of valve materials, pressure ratings, and valve operator materials and reference identification as indicated in the PWS Drawings. Provide a list of any special tools necessary for each valve type and appurtenances furnished for adjustment, operation, maintenance and disassembly.
1.4.1.6 Test Reports: Submit Pipe Leakage Tests, Hydrostatic Tests, Valve Testing; copies of all field test reports including Pipe Leakage Tests and Hydrostatic Tests.
1.4.1.7 As-built drawings: Show pipe anchors and guides, and layout of piping systems relative to other parts of the work including clearances for maintenance and operation. Submit as-built piping and instrumentation diagrams (P&IDs) identifying and labeling equipment, instrumentation, valves, vents, drains, and all other inline devices. The P&IDs found in the PWS Drawings shall be revised by the Contractor to reflect the constructed process system.
1.4.1.8 Instruction Manuals: Submit sufficient detail in the Operation Manuals to demonstrate the step-by-step procedures required for startup, operation and shutdown of piping systems, and include the manufacturer's name, model number, parts list and brief description of piping components such as valves, fittings, and other appurtenances and their basic operating features. List in the Maintenance Manuals routine maintenance procedures and troubleshooting guides for the piping system and include piping layout and valve locations.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged shall be replaced at the Contractor's expense. During installation, piping shall be capped to keep out dirt and other foreign matter. A material safety data sheet in conformance with 29 CFR 1910 Section 1200(g) shall accompany each chemical delivered for use in pipe installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling shall be in accordance with ASTM F 402. Storage facilities shall be classified and marked in accordance with NFPA 704. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendation. Plastic pipe shall be packed, packaged and marked in accordance with ASTM D 3892. No piping shall be stored directly on bare ground. Valves and fittings shall be stored in their shipping crates or boxes until time of installation and be protected from the weather at all times.

1.6 ABOVE GRADE PIPING SYSTEMS (WITHIN GWTP)

1.6.1 Above ground piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure, and installation factors such as insulation, support spans, and ambient temperatures. Consideration shall be given to all operating and service conditions including forces both internal and external to the piping systems.

1.7 SEQUENCING AND SCHEDULING

1.7.1 For wall, and roof penetrations, keep on site pertinent wall pipes and sleeves before they are required for placement in concrete forms. Verify and coordinate the size and location of building pipe penetrations before forming and placing concrete.

1.8 MAINTENANCE

1.8.1 Service

1.8.1.1 A manufacturer’s representative who is experienced in the installation, adjustment and operation of the valves specified shall provide inspection services for automatic valve systems. The representative shall inspect the installation and supervise the adjustment and testing of the valves.

1.8.2 Extra Materials

1.8.2.1 Contractor shall provide the manufacturer’s recommended spare parts that are expected to be replaced within the first 3 years of service of the piping system.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Provide piping materials and appurtenances as specified and as shown on the Drawings. Piping materials, valves, and appurtenances supplied as part of this PWS shall be of equal material and ratings as the connecting pipe, new and unused except for testing equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer. The general materials to be used for the piping systems shall be in accordance with the PWS Drawings. Pipe fittings shall be compatible with the applicable pipe materials.

2.1.2 Piping systems shall be rated for at least 1.5 times the deadhead pressure of the pump feeding the piping.

2.1.3 Standard Products: Provide material which are the standard products of a manufacturer regularly engaged in the manufacturing of the products and that essentially duplicate items that have been in satisfactory use for at least 10 years prior to bid opening. Nominal sizes for standardized products shall be used.

2.1.4 Identification and Tagging: Each piece of pipe shall bear the ASTM designation and all other markings required for that designation. The service, valve identification number shown on the PWS Drawings, the manufacturer's name, and the valve model number shall be displayed. Valves shall be marked an shall bear an identification tag securely attached using plastic straps designed for that purpose. Identification tags shall be 1.375-inch minimum diameter, made of engraved laminated plastic. Major process piping shall be labeled with the fluid service name and flow direction arrow (for example, Raw Groundwater, Treated Water, etc.). Letters for labeling pipes shall be easily readable from 10 feet away and shall be no smaller in height than 1 inch for pipes less than 2 inches in diameter and no smaller in height than 2 inches for all other size piping.

2.1.5 Pipe Supports: Pipe shall be provided with supports spaced not farther than the manufacturer’s recommended spacing for 70°F service. For PVC pipe 2” or smaller, supports shall be every 5’ or less; for 3” pipe every 6’; for 4” pipe every 8’, and for pipe, 6” and larger supports shall be every 10’ or less. Provide pipe flanges of the same material as shown on the drawings to be able to dismantle sections of PVC pipe for maintenance. Piping shall be pitched to drain.

2.1.6 The Contractor shall provide slip-type PVC expansion joints with joint material as recommended by the manufacturer for the type of service. Joints shall be installed not more than 100 feet apart only on all straight runs of pipe that exceed 100 feet.

2.2 PLASTIC AND DUCTILE IRON PIPING AND FITTING FOR WATER PROCESS SERVICE

2.2.1 PVC Pipe: PVC pipe shall be Schedule 80, seamless, unplasticized polyvinyl chloride normal impact type, conforming to ASTM D-1784, Class 12454-B and D-1785, PVC 1120, for Type I, Grade 1. PVC pipe system shall be as manufactured by CertainTeed Corp, JM Eagle, North American Pipe, Harvel Pipe, or approved equal.

2.2.2 PVC Joints: The piping system shall be joined by flanged or mechanical connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Connections at those points shall be threaded.

2.2.3 PVC Fittings: The schedule rating for the fittings shall not be less than that for the associated pipe. All pipe and fittings shall conform to ASTM D2467 and joints shall be solvent socket welded where threaded or flanged fittings are not used.

2.2.4 Flanged Fittings: Flanges shall be used at all valves, pumps, equipment, tanks, and vessels. Flanges will be of the same material as the piping. Flanges shall be the Van-Stone type complete with gaskets, bolts, and nuts. Flanges will be flat face to match the flanges of the valves, pumps, equipment and vessels. Flanges will be drilled to ANSI B16.1, class 150 conforming to ASTM A182 and ANSI B16.5. Gaskets for flanged joints shall be Viton. Flange bolts shall be of the number and size in accordance with ANSI B16.1. All bolts, nuts and washers shall be Type 316 stainless steel.

2.2.5 PVC Solvent Cement: Joints shall be assembled using approved solvent cement in accordance with the manufacturer's recommendations and ASTM D2564 and ASTM D2855. No cementing shall be done in the rain or when the air temperature is below 40°F or above 90°F.

2.2.6 The Contractor is cautioned to exercise care in handling, loading, unloading, and storing plastic pipe, valves, and fittings. All plastic pipe, valves, and fittings shall be stored under cover before using and shall be transported in a vehicle with a bed long enough to allow the length of pipe to lay flat so as not to be subject to undue bending or concentrated external load at any point. Any section of pipe that has been dented or damaged shall be discarded.

2.2.7 All PVC piping, fittings, and valves shall not be painted.

2.3 VALVES AND SPECIALTIES (PVC PROCESS SERVICE)

2.3.1 General. The Contractor shall furnish and install all valves and specialties as specified herein and shown on the Drawings. In addition, valve-operator and other accessories shall be furnished and installed by the Contractor where specified for various system packages. All valves shall be new and of current manufacture. All valves, specialties, etc. shall be installed with sufficient unions and/or flange joints to permit replacement without the need to cut the pipes. Valves and fittings 2 inch and smaller shall have union joints. Valves shall include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and all other accessories required for a complete operation. The valves shall be suitable for the intended service. Valves shall be the same size as adjoining pipe. Valve ends shall be compatible with the adjacent piping system. An operator shall be sized to operate the associated valve for the full range of pressures and velocities. Valves will open by turning counterclockwise. Operators, actuators, and accessories shall be factory mounted. Check Valves. Check valves larger than 2 inches for liquid service shall be Schedule 80 PVC, wafer-type with spring-loaded flappers manufactured by Hayward, Asahi-America, George Fisher, or approved equal. Check valves shall be capable of operating in either the horizontal or the vertical position.

2.3.2 Check valves 2 inches and smaller for liquid service shall be Schedule 80 double-union ball check as manufactured by Nibco, Hayward, Chemline, or approved equal. Check valves shall be capable of operating in either the horizontal or the vertical position.

2.3.3 Ball Valves (General Purpose). Ball valves upto 4 inch, shall be Schedule 80 PVC double-union ball valves with handle as manufactured by Nibco, Hayward, Chemline, or approved equal.

2.3.3.1 All sampling valves and drain a valves shall be 316 SS, provided with a spring return handle with a locking device similar to manufactured J Flow Controls LLC or equal.

2.3.4 Butterfly Valves. Butterfly valves, 3 inch and larger, shall be Schedule 80 PVC with lugs for flanged service. Butterfly valves shall have hand wheel or chain wheel operators. Butterfly valves shall be as manufactured by Nibco, Hayward, Chemline, or approved equal. Where shown on drawings, provide pneumatic actuator with electric solenoid valve to control air (fail-safe) with both

OPEN and CLOSED limit switches. Pneumatic actuator shall be Hayward 4” PCD25-A8 with PHSA8 120VAC solenoid valve or approved equal.

2.3.5 Pressure/Vacuum Relief Valve: Two pressure/vacuum pressure/vacuum breather valves shall be provided (one of which will be a backup). The valves shall be of stainless-steel construction and shall be rated for atmospheric pressure (14.7 psi) and zero vacuum.

2.3.6 Air/Vacuum release valves (vent valves)

2.3.6.1 Air/Vacuum release valves up to 3 inches, shall be combination air/vacuum release automatic PVC valves and provided as shown on the drawings. The valves shall have flanged ends and manufactured by Nibco, Hayward, Chemline or approved equal. The valves shall have full port liquid capacities and high discharge capacities. The valves shall have excellent corrosion resistance material. The seal material of the valves shall be EPDM or Viton. The valves shall be rated for the maximum operating and test pressures of the system.

2.4 DRAINS AND VENT VALVES

2.4.1 All drain and vent valves may not be shown on the detailed drawings for individual pipelines; their absence will not relieve the Contractor of the responsibility for providing and installing them to complete the piping system for the use intended. Drain valve material shall match adjacent pipe.

2.4.1.1 Locations

2.4.1.1.1 All pipeline shall have a drain valve at low point.
2.4.1.1.2 All pressured pipeline shall have a vent valve at high point.

2.4.1.2 Sizes

2.4.1.2.1 For pipelines 2.5 inch and larger, drains shall be 0.75 inch and equipped with ball valves. For pipelines 2 inch and smaller, drains shall be 1/2 inch and equipped with ball valves.

2.5 SAMPLE PORTS

2.5.1 Sample ports, shown on the piping and instrument diagrams of the PWS Drawings, may not be shown on the detailed drawings of the individual pipelines; their absence shall not relieve the Contractor of the responsibility for providing them. Sample ports shall be provided as indicated in the piping and instrument diagrams to complete the piping systems for the use intended. The sample ports shall be located in easily accessible locations, no higher than five feet off the floor, and shall avoid potential stagnant points and/or areas where material could collect. Sample ports shall be ½” 316L SS ball valves with threaded ends and a PVC threaded barb.

2.6 MISCELLANEOUS PIPING COMPONENTS

2.6.1 Air Release Valves

2.6.1.1 Air release vents shall be located, and vented, such that a hazardous atmosphere will not be created upon operation. Air release shall be located as indicated on the PWS Drawings and at all high points.

2.6.2 Expansion Joints

2.6.2.1 Provide all structural work and equipment required to control expansion and contraction of piping. Verify that the anchors, guides, and expansion joints provided, adequately protect the piping systems. Provide rubber expansion joints for piping at connections to equipment as shown on the drawings. The expansion joints shall be flanged with a maximum working pressure range of 100 – 150 psi. The joints shall provide an axial movement from 1/2 to 3/4 inches, axial extension of 1/4 inches and transverse deflection of up to 1/2 inch. The materials shall meet requirements of ANSI/ASTM D1418-77 and the Elastomer type shall be EPDM or AFMU Elastomer (PTFE/TFE/FEP) with temperature rating of greater than 250^0F. The expansion joints shall be manufactured by UIP International or approved equal.

2.6.3 Pipe Insulation Material

2.6.3.1 All exposed process piping shall have foam insulation and PVC jacketing as shown on the Drawings. Insulation shall be per Section 22 09 19.

2.6.4 Pipe Heat Tracing

2.6.4.1 All exterior exposed process piping shall have heat tracing per the details shown on Drawings.

2.7 PIPE SUPPORTS AND PENETRATIONS

2.7.1 Provide auxiliary steel where the support of piping systems and equipment is required between building structural elements. Light gauge and structural steel shapes shall conform to the requirements of ASTM A 36/A 36M. The Contractor has the option to use pre-engineered support systems of electrogalvanized steel products from one manufacturer such as Cooper B-line or approved equal. Where auxiliary steel is indicated as stainless steel, provide TP304 stainless steel conforming to ASTM A 167, No. 1 Finish.

2.7.1.1 Pipe Supports

2.7.1.1.1 Pipe supports shall conform to the requirements of MSS SP-58, MSS SP-69, and MSS SP-89. Where pipe supports contact bare piping or in-line devices, provide supports of compatible material (or dielectric separation) so that neither shall have a deteriorating action on the other. Refer to the Drawings for pipe support details. The absence of pipe supports and details on the drawings does not relieve the Contractor of the responsibility for sizing and providing adequate supports throughout the facility.

2.7.1.1.1.1 Beam Clamps

2.7.1.1.1.1.1 For upper attachments on structural steel, provide beam clamps of stainless steel and MSS SP-58 Types 19 through 23, 25 or 27 through 30. Holes drilled in structural steel for hanger support rods shall not be permitted. Clamps shall be provided with hardened steel cup-point set screws and lock-nuts for anchoring in place. Clamp size selection shall only be based on the support of the required load.

2.7.1.1.1.2 Riser Clamps

2.7.1.1.1.2.1 Vertical runs of piping shall be supported on the floor, or closer where required, with stainless steel clamps bolted around pipes and attached to the building construction. Two bolt-type clamps designed for installation under insulation shall be used on insulated pipe runs.

2.7.1.1.1.3 Brackets

2.7.1.1.1.3.1 Where piping is run adjacent to walls or steel columns, provide welded stainless-steel brackets, pre-punched with a minimum of two fastener holes.

2.7.1.1.1.4 Offset Pipe Clamp

2.7.1.1.1.4.1 Where pipes are indicated as offset from wall surfaces, supply a double-leg design two-piece stainless steel pipe clamp.

2.7.1.1.1.5 Racks

2.7.1.1.1.5.1 Multiple pipe racks or trapeze hangers shall be fabricated from stainless steel and designed to suit the conditions at the points of installation. Pipes shall be kept in their relative positions to each other using clamps or clips. Pipelines subject to thermal expansion must be free to slide or roll.

2.7.1.1.1.6 Hangers

2.7.1.1.1.6.1 Hangers shall be fabricated of stainless steel. All hangers shall be of a uniform type and material for a given pipe run and application. Coated or plated hangers shall be used to isolate steel hangers from dissimilar metal tube or pipe. Hangers for pipe sizes 2.5 inches or larger shall incorporate a means of vertical adjustment after erection while supporting the load.

2.7.1.1.1.7 Hanger Rods

2.7.1.1.1.7.1 Hanger rods shall be stainless steel. The diameter of the rods for the piping system support shall conform to ASME B31.1.

2.7.2 Wall Penetrations

2.7.2.1 Above Grade Wall Penetrations

2.7.2.1.1 Plastic pipe penetrations shall be fitted with galvanized steel collars that have intumescent inlays.

2.7.2.2 Below-Grade Wall Penetrations

2.7.2.2.1 Below-grade wall penetrations shall be provided with seals manufactured by Link Seal or approved equal. The locations where this will be used are:

2.7.2.2.1.1 Groundwater conveyance pipe entering the building.
2.7.2.2.1.2 Potable water line entering the building.
2.7.2.2.1.3 Electrical and instrumentation lines entering the building.

2.7.2.3 Galvanizing

2.7.2.3.1 Galvanizing shall be hot-dip applied and meet the requirements of ASTM A 153/A 153M. Stainless steel components may be substituted where galvanizing is specified.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 After becoming familiar with all details of the work, verify all dimensions in the field, and advise Navy's Representative of any discrepancy before performing the work.

3.2 PREPARATION

3.2.1 Pipe and equipment openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage. Pipe and fittings shall be inspected before piping is installed. Clean the ends of pipes thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after laying.

3.3 EXPOSED PIPING INSULATION

3.3.1 Exposed piping shall be run as straight as practical along the alignment shown on the PWS Drawings and with a minimum number of joints. Piping and appurtenances shall be installed in conformance with approved shop drawings, manufacturer's instructions and ASME B31.3. Piping shall be installed without springing or forcing the pipe.

3.3.1.1 FIELD Piping Flexibility Provisions

3.3.1.1.1 Thrust protection shall be provided as required. Additional pipe anchors and flexible couplings beyond those shown on the PWS Drawings shall be provided to facilitate piping installation, in accordance with approved shop drawings.

3.3.1.2 Couplings, Adapters and Service Saddles

3.3.1.2.1 Pipes shall be thoroughly cleaned of oil, scale, rust, and dirt in order to provide a clean seat for gaskets. Gaskets shall be wiped clean prior to installation. Flexible couplings and flanged coupling adapter gaskets shall be lubricated with the manufacturer's standard lubricant before installation on the pipe ends. Couplings, service saddles, and anchor studs shall be installed in accordance with manufacturer's instructions. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Torque-limiting wrenches shall be used to tighten bolts.

3.3.1.3 Piping Equipment/Component Installation

3.3.1.3.1 Piping components and instrumentation shall be installed in accordance with manufacturer's instructions. Required upstream and downstream clearances, isolation valves, and miscellaneous devices shall be provided for an operable and serviceable installation. The upstream and downstream lengths of undisturbed piping shall be in accordance with the flow element manufacturer's recommendations and at a minimum shall be at least 5 pipe diameters of straight run pipe upstream and at least 2 pipe diameters of straight run pipe downstream of the edge of the flow tube.

3.3.1.3.2 Local Instrumentation: All direct-reading instrumentation and pressure gauges shall be installed so that they can be easily read from floor level, and are readily accessible for maintenance and service. Pressure gauges shall be installed where indicated on the PWS Drawings. Differential pressure gauges shall be installed across the process equipment indicated on the PWS Drawings, in accordance with the manufacturer's recommendations, and arranged for easy observation at eye level.

3.3.1.4 Pipe Flanges

3.3.1.4.1 Pipe flanges shall be set level, plumb, and aligned. Flanged fittings shall be installed true and perpendicular to the axis of the pipe. The bolt holes shall be concentric to the centerline of the pipe and shall straddle the vertical centerline of the pipe.

3.3.1.5 Valve Locations

3.3.1.5.1 Valves shall be located in accordance with the PWS Drawings where actuators are shown. Where actuators are not shown, valves shall be located and oriented to permit easy access to the valve operator, and to avoid interferences. Valves shall be installed so that they can be fully opened and closed without interferences.

3.3.1.6 PVC Pipe Installation

3.3.1.6.1 All PVC pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations. Solvent-cemented joints shall be constructed in accordance with ASTM D 2855. Pipe shall not be laid in the rain and when the air temperature is below 40 deg F. All PVC piping installed above grade shall be ultraviolet (UV) resistant. The pipe ends that are to be joined shall be shielded from direct sunlight prior to and during installation. Adequate ventilation shall be provided when working with pipe joint solvent cement and the handling of solvent cement. Provide and install supports and hangers in accordance with the manufacturer's recommendations. All non-gravity lines shall be hydrostatically tested to at least 1.5 times the upstream pump dead head pressure.

3.4 CONNECTING DISSIMLAR PIPE

3.4.1 Flexible transition couplings, dielectric fittings and isolation joints shall be installed in accordance with the manufacturer's instructions.

3.5 VALVE INSTALLATION

3.5.1 Flanged valve bolt holes shall be installed so as to straddle the vertical centerline of pipe. Flanged faces shall be cleaned prior to inserting the gasket and bolts, and then the nuts shall be tightened progressively and uniformly. Threaded ends shall have the threads cleaned by wire brushing or swabbing prior to installation.

3.5.1.1 Valve Orientation

3.5.1.1.1 The operating stem of a manual valve shall be installed in a vertical position when the valve is installed in horizontal runs of pipe having centerline elevations 4.5 feet or less above finished floor, unless otherwise shown on PWS Drawings. The operating stem of a manual valve shall be installed in a horizontal position in horizontal runs of pipe having centerline elevations between 4.5 feet and 6.75 feet above finish floor, unless otherwise shown on the PWS Drawings. Automatic valves shall be installed in accordance with the manufacturer's instructions. Chain wheels and chains shall be provided if valves are located five feet above the floor.

3.6 PIPING SUPPORT SYSTEMS INSTALLATION

3.6.1 The absence of pipe supports and details on the PWS Drawings shall not relieve the Contractor of the responsibility for sizing and providing adequate supports throughout the plant.

3.6.1.1 General Support Requirements

3.6.1.1.1 Large or heavy valves, fittings, and/or equipment shall be supported independently of associated piping. Pipes shall not be supported off other pipes, equipment, or tanks. Pipes shall be supported by engineered supports independent of equipment and tanks. Supports shall be provided at piping changes in direction or in elevation, adjacent to flexible joints and couplings, and where otherwise shown on the PWS Drawings. Pipe supports and hangers shall not be installed in equipment access areas. Hanging pipes shall be braced against horizontal movement by both longitudinal and lateral sway bracing. Installed support systems may be used to support additional new piping only if the Contractor can demonstrate that the existing support systems are adequate for the additional loads, or if the existing systems are strengthened to support the additional loads. Pedestal type pipe supports shall be provided under base flanges adjacent to rotating equipment and where required to isolate vibration. All piping shall be supported by engineered supports and not by equipment or tanks.

3.6.1.2 Support Methods

3.6.1.3 Piping support and spacing shall be provided as specified and as shown in the PWS Drawings, in addition to supplemental support as needed in the field. Adjustable swivel-ring hangers shall support single horizontal suspended piping. Trapeze hangers shall support multiple horizontal suspended piping with channel type supports. Horizontal pedestal mounted piping shall have saddle type supports. Horizontal wall mounted piping shall have wall brackets. Vertical piping shall be supported by wall brackets, base elbows, or riser clamps on floor penetrations. All metal supports shall be stainless steel and all nuts, bolts and fasteners shall be 316 SS. Refer to the Drawings for pipe support details.

3.6.1.4 Pipe support locations shown on the drawings are the minimum requirements and does not relieve the Contractor from providing adequate support and meeting the intent of this specification.

3.7 FIELD QUALITY CONTROL

3.7.1 Exposed Piping

3.7.1.1 Hydrostatic testing shall be conducted in accordance with ASME B31.3. Piping systems shall be tested under normal service conditions to demonstrate compliance. Potable water shall be used as the hydrostatic test fluid. Provide clean test water of such quality to prevent corrosion of the piping system materials. Air release vents shall be opened at all high points of the piping system in order to purge air pockets while the piping system is filling. Contractor shall provide all test water and testing equipment.

3.7.1.2 Tests for above ground pressure piping shall be conducted after the piping has been completely installed, including all supports, hangers, and anchors, and inspected for proper installation but prior to installation of insulation.

3.7.1.3 Drain lines shall not be pressure tested.

3.7.1.4 The test pressure shall be 1.5 times the maximum operating pressure. The test will be considered acceptable if the pressure does not drop more than 5% of the initial value.

3.7.2 Pipe Leakage Tests

3.7.2.1 Should leakage be observed during testing, the leaks should be located and repaired at no cost to the Navy.

3.7.3 Leak Testing Vent Piping

3.7.3.1 PVC piping for tank atmospheric vents shall not be pressure tested.

3.7.4 Valve Testing

3.7.4.1 Valves may be tested while testing pipelines. It shall be demonstrated to the Navy's Representative that valves open and close smoothly and fully under operating pressure.

3.8 FINAL CLEANING

3.8.1 Following assembly and testing, and prior to final acceptance, liquid piping systems shall be flushed with water to remove accumulated construction debris and other foreign matter. The piping shall be flushed until all foreign matter is removed from the pipeline. Provide all hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water. The minimum flushing velocity shall be 2.5 fps. Accumulated debris shall be removed through drains, or by removing spools or valves. Provide potable water for pipe flushing and cleaning.

3.9 WASTE WATER DISPOSAL

3.9.1 All water generated during the flushing, and pressure testing of pipes shall be collected, stored temporarily onsite, tested, and disposed off-site in accordance with all Local, State, and Federal regulations and at a facility that appears on the Navy's list of approved disposal facilities.

END OF SECTION

SECTION 43 29 06

DUAL CONTAINMENT CHEMICAL STORAGE TANK

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Contractor shall supply and install all materials, equipment, appurtenances, specialty items, and services required to provide an upright, double wall, flat bottom, closed top, one (1) 3000 gallon polyethylene storage tank for storage of the chemical application described in Table I. Thank will be capable of storing the chemical application at atmospheric pressure.

B. The supplier work shall include the supply and installation of a double wall, flat bottom storage tank with all assemblies. The assembly shall consist of one cylindrical inner primary tank and one blended form octagonal outer secondary tank. The tank will be designed for above-ground, vertical installation and capable of containing chemicals at atmospheric pressure. The assembly shall be designed to prevent rainwater from entering the containment tank. The design shall allow direct primary tank base retention for up to seismic conditions per IBC code requirements.

1.2 REFERENCES

A. ASTM (American Society for Testing and Materials) Standards:

1. D618 Conditioning Plastics and Electrical Insulating Materials for Testing
2. D638 Tensile Properties of Plastics
3. D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
4. D883 Definitions of Terms Relating to Plastics
5. D1505 Density of Plastics by the Density-Gradient Technique
6. D1525 Test Method for Vicat Softening Temperature of Plastics
7. D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics
8. D1998 Standard Specification for Polyethylene Upright Storage Tank
9. D2765 Degree of Crosslinking in Crosslinked Ethylene Plastics as Determined by Solvent Extraction
10. D2837 Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
11. D3892 Practice for Packaging/Packing of Plastics
12. F412 Definitions of Terms Relating to Plastic Piping Systems

B. ARM (Association of Rotational Molders) Standards: Low Temperature Impact Resistance (Falling Dart Test Procedure)

C. ANSI Standards: B-16.5 Pipe Flanges and Flanged Fittings

D. OSHA Standards: 29 CFR 1910.106 Occupational Safety and Health Administration, Flammable and Combustible Liquids

E. UBC CODE: Uniform Building Code 2006 Edition

F. IBC CODE: International Building Code 2015 Edition

G. CBC Code: California Building Code 2016 Edition

H. 40 CFR-264.193

1.3 QUALITY ASSURANCE AND TEST METHODS

A. Tank furnished under this Section shall be supplied by a manufacturer who has been regularly engaged in the design and manufacturing of polyethylene chemical storage tank using cross-linked and high-density linear polyethylene tank for over ten years.

B. Dimensions and Tolerances

1. All dimensions will be taken with the tank in the vertical position, unfilled. Tank dimensions will represent the exterior measurements.
2. The tolerance for the outside diameter, including out of roundness, shall be per ASTM D1998.
3. The tolerance for fitting placements shall be +/- 0.5 in. in elevation and 2 degrees radial at ambient temperature.

C. Low Temperature Impact Test

1. Test specimens shall be taken from fitting location areas.
2. Test specimens shall be conditioned at (- 40) degrees Fahrenheit for a minimum of 2 hours.
3. The test specimens shall be impacted in accordance with the standard testing methods as found in ASTM D1998. Test specimens < $^1/_2$” thickness shall be tested at 100 ft. lb. Test specimens > $^1/_2$” thickness shall be tested at 200 ft. lb.

D. The percent gel level for tank on the inside 1/8 in. of the wall shall be a minimum of 65%.

E. Ultrasonic Tank Thickness Test

Tank shall be measured for tank wall thickness at 6”, 1ft., 2ft. and 3ft. on the tank sidewall height at 0° and 180° around the tank circumference with 0° being the tank manway and going counter-clockwise per ANSI standard drafting specifications. Tank shall meet design thickness requirements and tolerances.

F. Hydrostatic Water Test

The hydrostatic water test shall consist of filling the tank to brim full capacity for a minimum of four hours and conducting a visual inspection for leaks.

G. Workmanship

1. The finished tank wall shall be free, as commercially practicable, of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, crazing, cracking and delaminations that will impair the serviceability of the vessel.
2. All cut edges where openings are cut into the tank shall be trimmed smooth.

Fitting and Accessory Schedule

Tank Number	Tank-1
Quantity/Capacity	**One (1)/ 3000 gallon**
Inlet / Fill	2-inch, 316 SS
Outlet	1 inch threaded
Drain	2 inches threaded
Overflow Pipe	2 inches
Vent	Two (2)- 2 inches
Surge Protection Lid	
Manway	18” PE Threaded/Vented Manway w/15” Access
Access Ladder	FRP
Lifting Lugs	68” lifting lug assembly, U-Bolt, 6” x 5/8” threads, SS

1.4 SUBMITTALS

A. Drawings and Data: The manufacturer’s shop drawings shall be approved by the engineer or contractor prior to the manufacturing of the tank. Data and specifications for the equipment shall include but shall not be limited to the following submittals.

B. Contractor shall submit for review sufficient literature, detailed specifications, and drawings to show dimensions, materials used, design features, internal construction, weights and any other information required by the ENGINEER for review of storage tank and accessories.

C. Information to be included with the submittals is specified below:

1. Shop drawings for the tank shall include as a minimum the following:

   a. Service Conditions: Chemical environment and temperature.

   b. Statement that fabrication shall be in accordance with ASTM D 1998, where applicable.

   c. Sizing and description of the fittings and accessories for tank that are to be supplied by the tank manufacturer.

   d. Layouts and assembly schedules for tank identifying the location and elevation from the bottom of the tank for all connections and appurtenances supplied by the tank manufacturer.

2. Wall thickness - Prior to the manufacture of the tank the designed wall thickness audit is to be supplied based upon 600 psi hoop stress (ASTM D 1998) @ 100 degrees F.

3. Tank restraint – The drawings and calculations for the system are to be provided.

4. Supporting information on fittings and accessories to be supplied; heat system, insulation, mastic coating, etc.

5. Technical Manuals: The tank manufacturer’s “Guideline for Use & Installation” is to be submitted for review.

6. Installation certificate: Once installed the installer is to certify that the tank system has been installed according to the tank manufacturer’s Guidelines for Use & Installation.

7. Manufacturer’s warranty

8. Manufacturer Qualifications: The manufacturer is to have polyethylene tank based upon ASTM standards utilizing resins for the last 10 years.

9. Factory Test Report: Upon completion of the tank the manufacturer's inspection report is to be supplied for each tank.

a. Verification of wall thickness (See 1.3 E.)
b. Impact test (See 1.3 C.)
c. Hydrostatic test (See 1.3 F.)
d. Verification of fitting placement (See 1.3 B.)
e. Visual inspection (See 1.3 G.)
f. Verification of materials

1.5 SHIPPING, DELIVERY AND STORAGE

A. Since there are variations in methods of shipping, SII's instructions shall be followed in all cases.

B. Transportation, handling, storage of the tank, and installation shall be in accordance with the manufacturer's printed instructions.

C. Upon receipt of the tank and accessories the purchaser and/or his agent shall be responsible for inspection for damage and to verify that the system is complete. If damage has occurred, a claim should be filed with the carrier by the purchaser, and the manufacturer should be notified prior to the tank being put into service. All fittings and accessories need to be installed and adjusted in the field according to the manufacturer's Guidelines for use and installation.

D. Consult the manufacturer's "Guideline for Use and Installation" booklet. Use shipping cables to secure the tank together and for assembly. Once the tank is in position, the shipping cables shall be removed from the tank.

E. If tank shall be stored for over one month before being put into service, it should be stored in an upright vertical position. If outdoors it shall be secured to prevent movement or overturn during high wind situations.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Tank shall be manufactured by USP Technologies or Approved Equal.

2.2 DESIGN REQUIREMENTS

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

T = P x O.D./2 SD = 0.433 x S.G. x H x O.D./2 SD

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

1. The hydrostatic design stress shall be determined by multiplying the hydrostatic design basis, with a service factor selected for the application. The hydrostatic design stress would be ≤ 660 PSI at 73 degrees Fahrenheit. In accordance with the formula in 2.2 A., the tank shall have a stratiform (tapered wall thickness) wall. In no case shall the wall thickness be less than the minimum allowed per calculation of ASTM D1998.

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

3. The standard design specific gravity shall be 1.5 or 1.9.

B. The minimum required wall thickness for the cylinder straight shell must be sufficient to support its own weight in an upright position without any external support. Secondary containment tank shall be designed per the manufacturer's standard containment thickness requirements. The secondary containment shall be configured to allow shipment of the primary tank inside of the secondary tank. The shipment shall be done without the aid of additional spacer blocks which can be lost during shipment causing tank damage.

C. The top cover of the tank shall be a cylinder shell. The primary tank top shall be configured to prevent rain water from entering the secondary containment tank. The primary tank shall be keyed to the secondary tank preventing primary tank rotation. The secondary containment shall have 115% of the normal fill capacity of the primary tank.

D. Tank shall have lifting lugs into the top shell. The lifting lugs shall be designed to allow erection of empty primary and secondary tank. Tank shall be capable of being lifted into position as a unit (primary and secondary tank).

Tank Schedule

Tank Reference #	1
Quantity/Capacity	One (1)/ 3000 gallons
Outside Diameter (Nominal)	102 inches
Inside Diameter (Nominal)	95 inches
Height maximum	107.5 inches
Maximum Usable Volume Height	94 inches
Secondary Tank Height	89.8 inches
Color	White
Manway Type	18" PE Threaded/Vented Manway w/15" Access
Fitting Material	PVC
Gasket Material	Viton
Bolt Material	316 SS

2.3 SERVICE CONDITIONS

Table I – Service Conditions

Tank #	Chemical Stored	Concentration / Density/	Tank Location Inside/Outside	Operating Temperature Range	Fitting Material	Gasket Material	Bolt Material
1	Hydrogen Peroxide	27% by weight/ 9.2 lbs/gal	Outside	-4^0F to110^0F	PVC	Viton	316 SS

2.4 CHEMICAL COMPATIBILITY

A. Chemical compatibility shall be according to the following chemical resistance guides:

Compass Publications -
Pruett, Kenneth M., “Chemical Resistance Guide for Plastics”
Pruett, Kenneth M., “Chemical Resistance Guide for Metals and Alloys”
Pruett, Kenneth M., “Chemical Resistance Guide for Elastomers III”

These references shall be considered as general guidelines only.

Chemical	Concentration	Tank Resin	Tank Design Info	Fitting Material	Gasket Material	Bolt Material
Hydrogen Peroxide	27%	HDLPE	1.9/ASTM	PVC	Viton	316SS

2.5 TANK FITTINGS AND ACCESSORIES

A. Fittings – Threaded Bulkhead

1. Threaded bulkhead fittings are available for above liquid installation depending on the tank diameter and the placement of the fitting in the tank. Fittings must be placed away from tank knuckle radius' and flange lines. The maximum allowable size for bulkhead fittings placed on a curved cylindrical section of tank 48 in. to 142 in. in diameter is 2 inch. Tank wall thickness must be considered for bulkhead fitting placement. The maximum wall thickness for each fitting size is shown below.

Fitting Size	Maximum Wall Thickness
1/2 in.	2 in.
3/4 in.	2 in.
1 in.	2 in.
1 1/4 in.	2 in.
1 1/2 in.	2 in.
2 in.	2 in.
3 in.	2.125 in. (Flat Surface Only)

2. The bulkhead fittings shall be constructed of PVC, PP, or other specified material. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton, or other specified material.

B. Fittings - Bolted Stainless Steel Fittings

1. Bolted stainless steel fittings are available for below liquid level installation depending on the tank diameter and the placement of the fitting in the tank. Fittings must be placed away from tank knuckle radius' and flange lines. Consult SII for placement questions. Allowable fittings sizes based on tank diameter for curved surfaces are shown below.

Tank Diameter	Maximum Bolted Fitting Size Allowable
48 in.	3 in.
64 in. - 142 in.	4 in.

The bolted stainless-steel fittings shall allow tank wall thickness up to 2 1/2 in.

2. The bolted stainless-steel fittings shall be constructed with a minimum of 4 fully threaded 3/8 in. studs. Each fitting shall have two gaskets and two flanges. One gasket shall be compressed between the inside of the tank wall surface and the inside flange of the fitting. The other gasket shall be compressed between the outside tank wall surface and the outside flange of the fitting. The fittings shall be constructed of Type 316 stainless steel. Gaskets shall be a minimum of $^1/_4$" thickness and constructed of 4050 durometer EPDM, 60-70 durometer Viton or other specified material.

C. Vents

1. Each tank must be properly vented for the type of material and flow rates expected. Vents must comply with OSHA 1910.106 (f) (2) (iii) or other accepted standard. All tank must be vented for atmospheric pressure as well as any pressure created by filling and emptying the tank. Some applications may require a sealed tank with a vent line going to a scrubber system for proper chemical safety. Venting equipment should be sized to limit pressure or vacuum in the tank to a maximum of 1/2" of water column (0.02 psi). U-Vents are offered in sizes from 1 in. to 6 in. with or without mesh insect screening. U-Vents with mesh screening may require additional sizing due to reduced air-flow rates. Consult the manufacturer for necessary venting and placement information.

2. All u-vents shall be constructed of PVC or other specified materials.

3. When a tank is being filled from a pressurized tanker truck or rail car steps need to be taken to avoid pressurizing the tank. The tank may require a secondary surge protection lid to avoid any pressure build up. The surge protection lid is to be a 14" or 18" hinged and be design that it is self-closing.

4.. To avoid the air surge and over-pressurization from a tank being filled from a pressurized tanker truck or rail car, the 18" (26" x 11.7") polyethylene mushroom vent could be used. The vent is to be attached to the tank with (8) screws and a bead of silicone sealant. The underside of the vent has 1/8" poly mesh insect screen. The mushroom vent requires a 19" diameter flat surface on the tank for installation.

D. Flexible Connections

1. All tank fitting attachments shall be equipped with flexible couplers or other movement provisions provided by the tank customer. The tank will deflect based upon tank loading, chemical temperature and storage time duration. Tank piping flexible couplers shall be designed to allow 4% tank design movement. Movement shall be considered to occur both outward in tank radius and downward in fitting elevation from the neutral tank fitting placement.

2. The flexible connection is to be manufactured of the same material as the tank or a compatible material approved by the project engineer. If an elastomer flexible connection is used control bolts are required if recommended by the manufacturer. The flexible connection is to be designed for a minimum of 4% tank movement. The flexible connection is to be designed with 150# flange connections to allow for attachment to the tank and the piping system. The flexible connection is to be attached as close as possible to the tank to reduce stress.

2.7 TANK ATTACHMENTS

A. Level Indication

1.Sight Level Gage

a. The sight level gage shall be constructed of flexible PVC tubing to allow for tank contraction and expansion due to loading and temperature changes. The level gage shall be connected to the tank at the top of the tank with 1ea. appropriate 3/4" fitting and to a tee off of the drain / transition fitting. Each fitting can have valves installed for isolation or drainage purposes.

2. Reverse Float Level Gage

a. The float level gage shall be constructed of a guided float on the inside of the tank connected to a weight indicator on the exterior of the tank with a 1/4" rope. The weighted indicator shall move along inside a clear guide pipe and may be equipped with an optional gallonage indicator board. The gallonage indicator board shall be made of PVC material and may be attached to the clear guide pipe. The board shall be stenciled with one hundred-gallon marks and labeled every five hundred gallons. The level gage shall be connected to the tank at an appropriate tank flat on the tank dome with 3" threaded bulkhead fittings and held along the tank sidewall with appropriate 1" fittings and stand-off connections.

b. The float level gage rigid components shall be constructed of PVC. The rope shall be constructed of polypropylene or other specified material. Gaskets shall be constructed of EPDM or Viton.

3. Ultrasonic Level Indicator

a. The ultrasonic enclosure is to be an all plastic design with a NEMA 4X rating. The ultrasonic transducer is to have a 12" dead band and beam with a 20 ft range. The supply voltage can be 110, 220 VAC or 24 VDC. The connection to the tank is to be 2" NPT.

b. The ultrasonic level indicator shall provide a visual display of liquid level in the tank showing gallonage in measurement of hundreds of gallons along with 4-20 mA output for other alarm or control systems as well as four independent contacts capable of handling 10 amps each. Each contact can be programmed to operate in different opening and closing methods (7 modes). Contacts can be used to control pumps, valves, alarms.

B. Leak Detector Unit

1. The leak detector unit shall consist of a proximity sensor, a welded 2 in. FPT connection, a 2 in. bung plug with 3/4 inch strain relief, and an indicator box. The sensor is placed in the interstitial space between the primary and secondary tank approximately 1 in. above the tank bottom. The indicator box shall be NEMA 4 rated and factory pre-wired for 110 VAC power. All connections shall be labeled to prevent errors in field installation. The indicator box will show a green light when power is on and the sensor is not detecting a liquid. The light is a push to test light allowing the operator to test for power outage or malfunction. If the green light goes out there are two possibilities. The green light does not come on when the button is pushed. This would indicate a lack of power to the unit or the light bulb is burned out. If the green light comes on when pushed, then a possible leak condition is indicated.

C. Threaded Manways and Fill Caps

1. Manways shall be 18 in. vented or non-vented threaded design or hinged style (minimum opening diameter of 15 in.) and a 24 in. vented or non-vented threaded or hinged style (minimum opening diameter of 22 in.)
2. All caps and manways shall be constructed of polyethylene material.

D. Down Pipes and Fill Pipes

1. External Fill / Down Pipe

a. External fill pipes shall be approved drawings and specifications. All external fill pipes shall be supported at 3 ft. maximum intervals with a support structure independent of the tank (ground supported).

b. All external fill pipes shall be constructed of PVC or other specified materials.

E. Ladders

1. Ladders shall be constructed of galvanized mild steel or FRP.

2. Safety cages shall be provided with ladders per OSHA standards.

3. All ladders shall be designed to meet applicable OSHA standards. Reference: OSHA 2206; 1910.27; fixed ladders.

4. Ladders must be mounted to the tank to allow for tank expansion and contraction due to temperature and loading changes. All top ladder mounts shall be connected to integrally molded-in attachment lugs that allow for tank movement due to temperature and loading changes.

5. Mild steel parts shall be deburred and galvanized.

F. Base Angles

1. The tie down system shall consist of built in base angles around the perimeter of the tank base. Expansion or chemical anchors shall be used to connect to base slab through holes in these angles. The base angles shall be designed to withstand wind loads. The base angles must meet seismic requirements per IBC 2015 / CBC 2016 code with seismic loads ≤ .445g (Seismic Design Category "D" - Fa=1.0, Fv=1.5, Ss=1.4, S1=0.5). The contractor shall provide the calculations that meet these requirements. A registered engineer's wet stamped calculations and or drawings shall be submitted for review and approval prior to installation.

2. The base angle system shall be offered in either galvanized steel, 304 or 316 stainless steel.

G. Signs

1. Signs shall be provided in accordance with NYSDEC 6CRR – NY598 and 599 requirements, as well as other specific sign requirements that may result during the bulk tank permit. The signs shall as a minimum state the contents, (Hydrogen Peroxide, 27 Percent), volume of the tank (3,000 gallons), and potential hazards associated with the tank contents.

2.8 MARKING AND PACKAGING

A. The tank shall be marked to identify the product, date (month and year) of manufacture, capacity, and serial number. The tank shall be shipped with a 3 of 9, HRI bar code label containing tank description, manufacturing order number, part number, serial number, manufacturer, and date.

B. The proper caution or warning signs as prescribed by OSHA standard 29 CFR 1910.106 shall be customer determined and supplied.

C. The proper hazardous chemical warning Placards as prescribed by OSHA standard 49 CFR, Part 172, Subpart F shall be supplied and installed at locations that is clearly visible at both sides of the tank. The placard shall have the regulated background color based on the chemical hazard class. The placard shall display the applicable hazard class or division number of the 27% Hydrogen Peroxide oxidizer stored in the tank as well as the applicable identification number displays per 49 CFR, Part 172, Subpart F. The placard size shall meet regulations and made of plastic, metal or other material capable of withstanding open weather conditions.

D. All packing, packaging, and marking provisions of ASTM Practice D3892 shall apply to this standard.

E. All fittings that do not interfere with tank shipment shall be installed unless otherwise specified. Fittings and accessories that interfere with tank shipment or could be broken during shipment are shipped separately.

F. Permanent Labels:
1. Engraved stainless steel identification plate.

2. National Fire Protection Association label specifically coded for the tank contents in accordance with NFPA 30. to be supplied by the contractor.
3. Stencil the chemical label on to the tank wall to be clearly visible from outside the tank enclosure. Must be ordered by customer. (remove if not required)

PART 3 - EXECUTION

3.1 INSTALLATION AND FIELD TESTING

A. Install the tank in strict accordance with manufacturer's Guidelines for Use and Installation and shop drawings.

B. Hydro-test (water test) for 24 hours before introduction of chemical. Once completed, if necessary, remove all test water to prevent any possible reaction with chemical to be stored.

C. All tank fitting attachments shall be equipped with flexible couplers or other movement provisions provided by the tank customer. The tank will deflect based upon tank loading, chemical temperature and storage time duration. Tank piping flexible couplers shall be designed to allow 4 percent tank design movement. Movement shall be considered to occur both outward in tank radius and downward in fitting elevation from the neutral tank fitting placement.

D. The installer is to certify in writing that the tank system has been installed according to the tank manufacturer's Guidelines for Use & Installation.

3.2 WARRANTY

A. The tank shall be warranted for three years in regard to defects in materials and workmanship. The warranty on fittings and accessories supplied by the tank manufacturer will be for one year. The warranty will begin at time of shipment.

B. Manufacturer shall be able to offer extended warranties on tank (up to a maximum of 5 years) in regard to defects in materials and workmanship in certain applications or as a purchased option.

3.3 O&M MANUAL

1.1.1 The tank supplier is to supply an electronic copy of the Operation & Maintenance manual for all components. Separate sections include, but not limited to the following: fittings, controls, and mechanical components.

1.1.2 O&M manuals to include all submittal documentation modified, if required, to reflect the as-built condition along with parts lists, maintenance manuals, and electrical schematics.

END OF SECTION

SECTION 43 31 03

ADVANCED OXIDATION SYSTEM (UV-HYDROGEN PEROXIDE)

PART 1. GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to install the Advanced Oxidation Process (AOP) Systems as specified herein and shown on the Drawings.

B. This specification covers the equipment and installation requirements for one (1) AOP system, dual chamber with independent operation, and a total of approximately 144 lamps and rated at approximately 36 kW. This UV/Oxidation system shall include factory assembled reactor, two (2) power distribution center (PDC) panels, process system one (1) self-contained control panel (SCC) and one (1) chemical feed system with two (2) pumps and a chemical dosing system. Alternative UV/Oxidation systems that provide similar performance can be proposed, but will require documentation on water characteristics and volume similar to this project and will need to operate and be maintained within the area available.

C. The units shall be furnished and installed with all necessary equipment including the UV reactor, UV lamp assemblies, automatic wipers, power distribution center (PDC), process system control center (SCC), on-line continuous UVT and hydrogen peroxide monitors, automatic quartz sleeve cleaning system, ballast cooling system, chemical dosing/injection system and any other auxiliaries for a complete and operable system.

D. The UV/Oxidation system shall be designed to provide treatment of 1,4-dioxane in the groundwater stream to the treatment objectives specified in attached Table 1 – GM38 Design Basis and Objectives.

E. All process piping on the skid shall be 316L stainless steel along with all 316L stainless steel valves as shown on the P&IDs and Performance Work Statement (PWS) drawings. The size of the process piping and fittings will be as shown the P&IDs and PWS drawings. Butterfly valves shall be supplied by the Contractor.

1.2 RELATED SECTIONS

A. Section 01 01 00 Scope of Work
B. Section 01 33 00 Submittals and Substitutions
C. Section 01 77 00 Project Closeout Procedures
D. Section 01 78 23 Operation and Maintenance (O&M) Data
E. Section 41 10 02 Process Piping
F. Section 26 05 26 Grounding and Bonding
G. Section 40 41 95 Process Control Description
H. Section 43 32 69 Chemical Feed Systems

1.3 REFERENCES

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

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1/B2.1M (2009) Specification for Welding Procedure and Performance Qualification
AWS D1.1/D1.1M (2010) Structural Welding Code – Steel

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) INTERNATIONAL

ASME B16.5 (2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9 (2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B40.100 (2005) Pressure Gauges and Gauge Attachments
ASME BPVC SEC VIII D1 (2007; Addenda 2008; Addenda 2009) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

AMERICAN SOCIETY FOR TESTING MATERIALS (ASTM) INTERNATIONAL

ASTM A182/A182M (2010a) Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A269(2010) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A276 (2010) Standard Specification for Stainless Steel Bars and Shapes
ASTM A312/A312M (2011) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM F 593 (2002; R 2008) Stainless Steel Bolts, Hex Cap Screws, and Studs

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ANSI/ISA 5.1 (2009) Instrumentation Symbols and Identification

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 6 (1993; R 2006) Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2011; TIA 11-1; Errata 2011) National Electrical Code

1.4 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 Submittals:

1. Pre-construction submittal:

2. Product Data: Manufacturer's descriptive data and technical literature and engineering data sheets for the equipment. Product data shall include selected model number, rated flow capacity, dimensions, and weights (dry and operating).

3. Process flow diagrams and instrumentation diagrams(s) showing all major pieces of process equipment with valves and other necessary appurtenances.

4. Shop Drawings, including:

   a. Complete wiring and schematic diagrams and any other details required to demonstrate that the system has been fully integrated and will properly function as a unit.

   b. General arrangement drawings and manufacturer's data covering installation instructions, dimensions, weight, detailed specifications, materials of construction, parts, devices and other information required to verify compliance with these specifications.

   c. Proposed layout, location of valves and interface points, and anchorage requirements.

   d. Clearances for maintenance and operation.

5. Instrumentation & Controls: Contractor shall submit a description of the control system including, but not limited to, the following items:

   a. Product information for all skid mounted instruments.

   b. Panels, Consoles, and Cabinets Information

      I. Panel layout drawings including location of panel relative to the skid.
      II. Panel schematic and internal point-to-point wiring interconnect diagrams.
      III. Specific electrical control schematics in accordance with NFPA and NEC standards for all circuits indicated in the specifications or on the PWS Drawings. No "typical" wiring diagrams will be acceptable and no tables or charts to describe wire numbers will be acceptable. Wires shall be labeled and shown on the submittal drawings.
      IV. Stock lists or Bill of Materials for each panel including, manufacturer's name, manufacturer's model number, and quantity for components mounted in and on the panel, console, or cabinet.

   c. Instrument loop diagrams for analog display, control and Input/Output (I/O) loops prepared using ISA standard symbols.

   d. Instrument list and I/O list outlining all anticipated equipment and spare parts.

   e. A process controls listing shall be provided outlining anticipated Programmable Logic Controller(s) (PLC), I/O modules and Human Machine Interface (HMI).

   f. Description of control logic.

6. Calculations:

   a. Structural and anchorage calculations. Contractor shall submit detailed calculations illustrating the seismic characteristics and anchorage of the proposed reactor assembly. Calculations shall be signed and sealed by a professional engineer licensed to practice in the State of New York.

7. Manufacturer's certificates including process guarantee, including the name and address of the production facility. Provide manufacturer’s certification in writing, that the equipment and materials of construction will meet or exceed minimum requirements as specified and will meet process water treatment requirements.

B. Informational Submittal

1. Manufacturer’s hydrostatic test report at manufacturing facility.

2. Recommended spare parts list.

C. Contractor shall submit a Test Report describing the findings of the field inspection of the installed equipment and the results of the functional testing, hydrostatic testing, and performance testing.

D. Operation and Maintenance Manual

1. Submit the required number of copies of operation and maintenance (O&M) manuals in accordance with the PWS Documents.

2. Comprehensive instrument and I/O list, associated datasheets/ installation and maintenance manuals, I/O drawings detailing wiring between field instruments and the vendor supplied PLC along with a spare parts list.

3. The O&M Manual shall be submitted prior to startup. O&M Manual shall cover, as a minimum, instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the instructions the manufacturer's name, model number, serial number, service manual, parts list, and brief description of all equipment and their basic operating features. Submit complete copies of maintenance instructions including routine maintenance procedures, possible breakdowns and repairs, and trouble-shooting guides.

1.5 SEISMIC LOADS

A. The structural aspects of the AOP system shall be sufficient to meet the current editions of the NYC Construction Code and the International Building Code requirements for Seismic Design Category = B.

1.6 DELIVERY AND STORAGE

A. Protect all equipment, delivered and designated for storage, from the weather, humidity and temperature variations, dirt and dust, and other contaminants.

1.7 WARRANTY

A. The UV system shall be designed to provide adequate treatment throughout the guaranteed life of the lamps and sleeves. The average UV output from the lamps after 12,000 hours of operation shall be 98% of the output from a new lamp.

PART 2. PRODUCTS

2.1 MATERIALS & EQUIPMENT

A. Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of AOP systems, and is similar to items that have been in satisfactory use at other locations for at least 5 years.

B. The entire AOP reactor assembly shall be mounted on a mid-mount cradle frame as shown on drawings and be tested in the shop prior to shipment.

C. The manufacturer shall furnish all tools, materials, labor, and appurtenances necessary for the complete fabrication, testing and shipment of the UV/Oxidation system.

D. All process piping and fittings shall be 316L stainless steel. All valves shall be 316L stainless steel.

2.2 AOP SYSTEM REQUIREMENTS

A. One (1) dual chamber, advanced oxidation process (AOP) system with 144 lamps and rated at 36 kW shall be provided.

B. The Contractor shall provide a guarantee that the installed system shall continuously meet the specified performance requirements under the following conditions:

1. Design Flow rate (gpm)	1000
2. Minimum Flow Rate (gpm)	100
3. Maximum Hydraulic Flow Rate (gpm)	1400
4. Design UV Transmittance at 254nm (%)	97
5. Maximum Process Water Temperature (deg F/C)	104/40
6. Maximum Operating Pressure (psig)	65

C. Process Treatment Guarantee Parameters for 1,4-Dioxane - see table attached to this section.

2.3 EQUIPMENT DESCRIPTION

A. The UV/Oxidation system shall consist of reactor assemblies mounted on a cradle along with the power distribution center (PDC) panels that would be floor mounted as shown on drawings. The system control center (SCC) for process control and the reagent delivery and mixing equipment shall be an independent unit. The reactor assembly shall be factory assembled and tested and ready for installation.

B. One (1) reactor assembly shall be supplied, consisting of horizontal reactor with 36 kW UV lamp. Each lamp shall be protected from the water stream by a quartz cylinder. Water shall enter the reactor from the side with the flange orientation at 9 o'clock and be discharged from the top with the flange orientation at 12 o'clock. The reactors shall be designed to provide turbulent plug flow to ensure axial mixing for optimum UV light absorption and at the same time eliminating short circuiting.

C. Each UV/Oxidation cradle assembly shall be capable of complete, independent operation from other skids.

D. The UV lamps used in the UV/ Oxidation reactor shall be specifically designed to provide a wavelength of 254 nanometers (nm). The lamps shall be capable of providing 12,000 hours of operation with no more than a 2% decrease in emissions. Lamp ends shall be cooled by the process water within the unit and the driver will be cooled by an air conditioner on the power distribution center.

E. A cleaning mechanism shall be provided for each quartz tube to maintain efficient transmittance of UV light. The mechanism shall be constructed of materials which are not affected by high intensity UV radiation. The cleaning system shall operate automatically with an adjustable time interval or can be operated manually. The wiper assembly shall be hydraulically driven providing positive action. Limit switches shall be provided at both ends of wiper travel for fail-safe indication of proper operation. Operation of the cleaning mechanism shall not divert or otherwise disrupt water flow to the reactor or reduce the effectiveness of the treatment.

F. Contractor shall be responsible for providing sample valves at the end of the reactor.

G. All materials exposed to UV light shall be unaffected by prolonged UV exposure.

H. The reactor piping shall be 316L SS and as shown on the PWS drawings.

I. The reactor shall be designed in such a way that when installed and operated according to manufacturer's instructions, there is no possibility of direct operator exposure to UV light from the lamps.

J. The reactor shall shutdown at low flow condition. The plant's system shall also include an over temperature sensor/ interlock that shuts down the system in the event of a high temperature alarm. The plant's system shall be setup to receive a signal in the event of low process water flow for an extended period of time, such a signal should shut down the AOP system.

K. The reactor shall include at least one manual drain plug.

L. The electromagnetic ballast shall withstand voltage sags of -40% and surges of +25% without extinguishing the lamps. System lamp driver shall be capable of working nominally from 208 to 277 V +/- 10% (187 V to 305 V).

2.4 POWER DISTRIBUTION CENTER (PDC)

A. One PDC shall be provide power supply for each UV Chamber. The power supply shall be installed in a NEMA 4X enclosure that is air conditioned, and all internal wiring shall comply with NEC and be certified by a US OSHA accredited Nationally Recognized Testing Laboratory (NRTL) including Underwriters Laboratories Inc. (UL). The PDC unit shall be a stand-alone panel that shall be mounted on concrete pad as shown on drawings.

B. The power supply system shall be provided with cooling fans, thermal protection, safety access interlock, lamp run meters, lamp ammeters, lamp voltmeters, and main power disconnect.

C. The power supply shall be equipped with transformers isolated from ground to provide inherent safety from electrical shock.

D. System shall be wired for 480 V AC, 3 phase power drop. Contractor shall provide a 480 V AC/120 V AC transformer to supply low voltage control devices. All control and interlocking circuitry shall be a maximum of 24 V DC.

E. Contractor shall provide surge protection device that shall protect the AOP system from induced surges propagating along the signal and power supply lines from lightning, utility, or the plant electrical system. The protection systems shall be such that the protective level shall not interfere with normal operation but shall be lower than the system components surge withstand level. Devices shall have a response time of less than 50 nanoseconds and be capable of handling a discharge surge current (at an 8x20μs impulse waveform) of at least 8 kA. Ground wires for all instrumentation device surge protectors shall be connected to a low resistance ground in accordance with Section 26 05 26 Grounding and Bonding.

F. Contractor shall provide all power panels with the appropriate Arc Flash Hazard rating label to meet NFPA and OSHA requirements.

2.5 UV/OXIDATION SYSTEM CONTROL CENTER (SCC)

A. The UV/Oxidation system shall be controlled by a reliable programmable logic device. The programmable logic controller (PLC) shall be factory programmed and tested prior to shipment.

B. The control panel(s) housing the PLC(s) shall be a NEMA 4X enclosure(s).

C. The system shall be capable of operation from a main control console with system status and operational data shown on an interface display with touch screen. Data entry shall be made from a touchscreen. The operator interface shall be programmed with test and diagnostic functions to permit testing of all equipment while the system is off line for maintenance. This should include, but not be limited to, all cooling fans, operation of quartz wiper mechanisms and interlocks, and hydrogen peroxide reagent pumps.

D. The PLC shall have sufficient capacity and contacts for control and interface with all standard optional features and equipment provided with the UV/ Oxidation system. PLC memory shall be protected by a continuously charged lithium battery in case of power outage. The PLC I/O shall be designed with a minimum of 20% spare I/O, internally wired and delivered in a manner ready to accept field wiring without any additional internal wiring required.

E. Interlocks will be programmed to alarm and/ or shutdown the UV/ Oxidation system under the following conditions:

1. High temperature in lamp drive enclosure – Alarm
2. Low process water flowrate – Alarm and System Shutdown
3. High temperature in the UV/ Oxidation reactor - Alarm
4. Total Lamp failure – Alarm and System Shutdown.
5. High voltage cabinet door open - Alarm
6. Reactor access covers open – Alarm and Shutdown
7. Low peroxide concentration – Alarm and System Shutdown
8. Transmittance controller failure – Alarm

F. Instrumentation & Controls

1. Vendor instrumentation shall be purchased as new (unused), readily available and of a reliable quality. At a minimum, all instrumentation shall have a NEMA 4X rating.

2. Vendor control system(s) shall be Allen-Bradley 1769 series Compact Logix PLC. Vendor shall provide an Ethernet switch allowing end user access to required data points. Local Human Machine Interface (HMI) shall be Allen-Bradley PanelView Plus, touch capable, color, minimum 6-inch flat panel display.

3. Vendor shall be provided a range of IP addresses to assign their equipment.

G. Contractor shall coordinate networking requirements with the SCC. This will include ensuring all equipment provided is properly configured and available to the existing with regard to IP address.

H. Contractor to coordinate PLC memory map locations with the PCSS. The Treatment Plant SCADA system shall have access to the contractor supplied PLC via Ethernet in order to monitor operational data (Temperature, Pressure, Alarms, etc).

I. Manufacturer to provide control for automated motorized operating valves shown on PWS drawings. The automated motor operated valve I/O shall be wired to indicate position of the valves, and operating status of the AOP reactor. The automatic valves shall actuate based on hydrogen peroxide and UV intensity level. The automated motor valves shall be used to direct flow to the Equalization tank or the GAC units. The inlet, outlet and bypass valves of the AOP reactor shall be manually operated.

J. Manufacturer to provide monitoring and display the operating status of the Hydrogen Peroxide storage tank. The Hydrogen Peroxide tank I/O shall be wired to the PLC to monitor the chemical tank's level and leak detection. The PLC shall be capable of communicating with an ultrasonic level transmitter, a dual stage backup level switch for Low-Low and High-High level detection as well a leak detection system to indicate any leaks in the tank containment wall.

K. Manufacturer to provide monitoring and control of the Hydrogen Peroxide dosing pumps.

L. Contractor to provide 10 spare lamps.

2.6 EQUIPMENT APPURTENANCES

A. Supporting Skid: The AOP system and all appurtenances shall be supported on a structural frame and painted to prevent corrosion.

B. Lifting Lugs: Individual equipment and or each field assembled part over 100 pounds in weight shall be provided with lifting lugs for ease of handling.

C. Anchor Bolts: All necessary bolts, nuts, washers, bolt sleeves, and other types of attachments for the installation of the equipment shall be furnished with the equipment. Bolts, nuts, and washers shall be Type 316 stainless steel.

D. Equipment Identification Plate: A stainless steel identification plate shall be securely mounted on the equipment in a location that is visible at eye level. The plate shall bear the Manufacturer's name, address, phone number, equipment model number, serial number, and equipment ID number (to match the P&IDs).

E. Static Mixer: Contractor shall provide hydrogen peroxide injector and static mixer.

F. Hydrogen Peroxide Metering Pump Skid: Manufacturer shall provide a hydrogen peroxide metering pump skid as described in Section 43 32 69 Chemical Metering Systems that includes metering pumps, relief valve, stainless steel tubing, Teflon tubing with secondary containment, pressure gauge, shutoff valve, and all other appurtenances for a fully functioning and flow paced hydrogen peroxide feed system.

G. Control loop instrumentation for the hydrogen peroxide feed system.

2.7 SPARE PARTS & TOOLS

A. Contractor shall provide one set of recommended spare parts for AOP and related accessories supplied.

B. Contractor shall supply one set of any special tools required for assembly, disassembly, or adjustment of the equipment supplied.

PART 3. EXECUTION

3.1 GENERAL

A. The AOP System shall be manufactured in accordance with the best trade practices and in accordance with all applicable codes and regulations.

3.2 FABRICATION & SHIPMENT

A. All open piping, connections, and flanges piping shall be fitted with blank flanges prior to shipment. All UV lamps shall be protected during shipment and any parts or components that break during shipment shall be replaced at no cost to the Navy.

B. Work not required to be performed in the field shall be performed in the factory under controlled conditions. Field assembly of the equipment shall be performed by the Contractor under the supervision of the Manufacturer.

C. The Contractor shall provide all installation documents and O&M Manuals in accordance with the PWS Documents.

3.3 INSTALLATION

A. Verify all dimensions in the field and advise the Navy's Representative of any discrepancy before performing the work.

B. Installation shall be made in accordance with manufacturer's printed instructions and in the presence of the manufacturer's field representative.

C. The Contractor shall provide certification from the manufacturer that the equipment has been properly installed.

3.4 TESTING

A. Functional Testing: Prior to startup, all equipment components shall be inspected by the Contractor for proper alignment, proper connections, and satisfactory installation. All products shall be carefully inspected for defects in workmanship and material; debris and foreign matter shall be cleaned out of valve openings and seats; all operating mechanisms shall be operated to check their proper functioning; and all nuts and bolts shall be checked for tightness. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced.

B. Hydrostatic Testing: After installation, the AOP system shall be tested for water tightness. Testing shall be performed with potable water. Testing plugs or caps, all necessary pressure pumps, pipe connections, gauges, other equipment, potable water, and all labor required shall be included. The Contractor shall ensure all the air is removed from the system prior to pressure testing. Test pressures shall be at the system's maximum operating pressure of 65 psi for 3 hours. No leaks are allowed. A decrease in pressure of no more than 0.5 psi is permissible. System shall be checked for leaks after one hour. Piping systems shall be isolated from the tanks for pressure testing at the specified test pressures. This testing shall also be done at the Manufacturer's facility.

C. Performance Testing: An Operating Performance Test shall be performed to demonstrate that the AOP System conforms to the requirements of this specification.

System throughput will be continuously monitored on the plant flow meters. The performance testing flow generated during the system startup and AOP reactor warm up period shall be recycled back from the AOP to the existing Equalization tank. The flow will be circulated in this loop until the AOP reactors are ready to begin treatment. The design will include capability to send the flow to the Equalization Tank using automated valves with non-modulating actuators based on the operation status of the AOP reactors. Water samples will be collected from the AOP system influent, AOP system effluent, and GAC effluent. The samples will be collected and analyzed by the Contractor. The data will be compared to the influent characteristics and effluent requirements specified to verify that they are within the specified ranges. The system performance will be considered acceptable if the effluent concentration of each of the organic compounds including 1,4-dioxane, is less than the Required Level of Treatment values required.

- Under average flow and initial AOP operating conditions (pristine tubes and new bulbs) during the first month (720 hours of operation), the AOP system shall obtain a 95 percent reduction in 1,4-dioxane concentrations (5 µg/L to less than 0.1 µg/L).

- Under variable conditions such as the maximum hydraulic flow rate, scaling of the UV tubes, and aging lamps and higher flowrates (1,400 gpm), the AOP system shall achieve a 90 percent reduction in 1,4-dioxane concentrations (consistently less than 0.5 µg/L) during the first year (8,600 hours of operation).

- Compliance testing will be weekly for the first three months, biweekly (every two weeks) for three to nine months, and monthly thereafter. In addition, the testing over the first three months shall address any variation in the system operation that may effect performance (e.g., flow rate).

3.5 **REMEDY**

A. If the tests specified above reveals deficiencies, corrective measures shall be taken by the Contractor until the System satisfies all of the specified requirements. Remedies shall be completed at no additional cost to the Navy.

3.6 **FIELD PAINTING**

A. Do not paint stainless steel, galvanized steel, and nonferrous surfaces.

B. Touch-Up Painting

1. Factory painted items requiring touching up in the field shall be thoroughly cleaned, and wire brushed of all foreign material, and shall be sanded, primed and top coated with the manufacturer's standard factory finish.

TABLE 1 - GM38 DESIGN BASIS AND OBJECTIVES

Paramater	Units	Current GM38 Area Hotspot	Planned Future GM38 Area Hotspot	Design Basis[3]	Treatment Goals[5]
Flow[1]	gpm	1,000	1,000	1,000 / 1,400	-
Tetrachloroethene	ug/L	24	16	0.20[4]	< 0.5
Trichloroethene	ug/L	110	1,293	19[4]	< 0.5
cis-1,2-Dichloroethene	ug/L	8	7.2	0.27[4]	< 0.5
trans-1,2-Dichloroethene	ug/L	ND	1	< 0.2	< 0.5
1,1-Dichloroethene	ug/L	1.4	3.5	< 0.2	< 0.5
Vinyl Chloride	ug/L	0.41	0.9	< 0.2	< 0.5
1,1,1-Trichloroethane	ug/L	0.97	1.1	< 0.2	< 0.5
Freon 113	ug/L	ND	6.6	< 0.2	< 0.5
1,1-Dichloroethane	ug/L	2	2.2	< 0.2	< 0.5
1,1,2-Trichloroethane	ug/L	ND	1.7	< 0.2	< 0.5
1,4-Dioxane	ug/L	2.5	5	5	50/< 0.5
Nitrate/Nitrite[2]	mg/L	-	-	3.2 / 4	-
Total Organic Carbon[2]	mg/L	-	-	0.15 / 0.49	-
Iron[2]	ug/L	-	-	0.8 / 19	-
Manganese[2]	ug/L	-	-	1.28 / 19	-
pH[2]		5 to 6	6.5 to 7.5	6.5 to 7.5	-

GWTS - Groundwater Treatment System.
VOC - Volatile Organic Compound.
1 - Average / Maximum.
2 - Minimum / Maximum.
3 - Post air stripper.
4- Calculated based on current air stripper performance.
5 - The New York State Department of Health (NYSDOH) Maximum Contaminant Level (MCL) for each of these VOCs is 5 ug/L. The current NYSDOH MCL for 1,4-dioxane is 50 ug/L. The anticipated future NSYDOH MCL for 1,4-dioxane is 1 ug/L. The treatment goals presented above are anticipated typical concentrations to be achieved by the treatment system. The actual treatment requirements are based on the MCLs.

gpm - Gallons per minute.
ug/L - Micrograms per liter.
mg/L - Milligrams per liter.

END OF SECTION

SECTION 43 32 69

CHEMICAL FEED SYSTEM – METERING PUMPS

PART 1 - GENERAL

1.1 SCOPE OF WORK

1.1.1 Provide the following chemical feed system consisting of chemical feed pumps on skid and chemical dosing control:

1.1.1.1 Two (2) peristaltic metering pumps with the entire pump skid assembly including the flow meters, inlet and outlet connections, panel and electrical enclosure, calibration cylinder and tubing, valves, pressure gauges and steel enclosure. All fittings and connections shall be 316 stainless steel.

1.1.1.2 One (1) Chemical dosing control system capable of delivery in real time. The dosing system shall be capable of interacting with the AOP reactor to collect data on flow rate, chemical dosing concentration, UV transmittance, contaminant concentration and other data.

1.1.2 Pump shall be mounted inside the steel enclosure. Capacity and design of the chemical feed systems and accessories shall be suitable for full load service in ambient, nonfreezing conditions. All feed pumps shall be consistent and work in the chemical dosing control system.

1.2 REFERENCES

1.2.1 The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z400.1	(2004) Hazardous Industrial Chemicals - Safety Data Sheets - Preparation

1.3 SUBMITTALS

1.3.1 The following shall be submitted in accordance with Section 01 33 00 Submittals:

1.3.1.1 Product Data: Submit product data describing equipment features, materials, of construction, general dimensions, and operational parameters. Include detail specifications, available test data and instructions for installation and maintenance.

1.3.1.1.1 Submit manufacturer's descriptive and technical literature, catalog cuts, performance charts, and engineering data sheets. List of materials, list of equipment, including a complete list of spare parts. List of special tools for necessary for adjustment, operation, maintenance, and disassembly.

1.3.1.2 Shop Drawings: Submit shop drawings for approval if the Contractor’s proposed equipment and layout deviates from the system shown on the Construction Drawings.

1.3.1.3 Material Safety Data Sheets: For the specified chemicals

1.3.1.4 O&M Data: System Operating & Maintenance Manual shall be provided prior to startup of the system

1.3.2 Complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the instructions the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features.

1.3.3 Complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble-shooting guides. Include spare parts list,

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Protect material and equipment delivered and placed in storage from the weather, excessive humidity and excessive temperature variation, dirt, dust, or other contaminants. Replace damaged items that cannot be restored to their original condition. Store items subject to deterioration by exposure to elements, in a well-drained location, protected from weather, and accessible for inspection and handling.

PART 2 - PRODUCTS

2.1 MANUFACTURER

2.1.1 Pumps shall be manufactured by Watson Marlow Pumps (Qdos Peristaltic Metering) or Approved Equal.

2.2 MATERIALS AND EQUIPMENT

2.2.1 2.1.1 Standard Products

2.2.1.1 Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products.

2.2.2 Nameplates

2.2.2.1 Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.3 CHEMICAL STORAGE TANK

2.3.1 Upon completion of installation and testing for the chemical storage tank for any leakage, the contractor shall fill the chemical tanks with the required chemicals prior to system startup.

2.4 CHEMICAL FEED PUMPS

2.4.1 Each Metering pump shall be capable of delivering chemical solution at any rate from the minimum flow rate to the maximum flow rate and shall be capable of continuous operation at rated capacity. Accuracy shall be plus or minus 3 percent of maximum capacity. Construction shall be as simple as practicable to provide equipment isolation, bypass and reliable service and to be readily accessible for inspection, cleaning, adjustment, repairs, and replacements.

2.4.2 Chemical metering pumps and entire skid assembly shall be provided by USP Technologies or Approved Equal.

2.4.3 The following shall be provided for agent solution delivery.

2.4.3.1 Number of pumps: 2 (one installed and one spare)
2.4.3.2 Pump Details: Chemical metering pump with a design flow capacity of 0.6 GPH to 4.0 GPH with a pressure rating of 100 PSI.
2.4.3.3 Pump Drive: IP66 (NEMA 4X) for industrial environment.
2.4.3.4 Display: 3.5” TFT color display.
2.4.3.5 Pump Head: Sealed pump head with integral leak detection.
2.4.3.6 Pump Mounting: Pumps shall be mounted inside a steel enclosure having a pump skid and pump mount at the location shown on contract drawings.
2.4.3.7 Valves: Valve shall be constructed from 316 SS. The pressure range on the valve shall be with a design pressure range of 0-50 PSI.

2.5 CHEMICAL DOSING CONTROL SYSTEM

2.5.1 The chemical dosing control system shall be based on the design minimum flow rate of 0.6 GPH to maximum 4.0 GPH. The chemical dosing system flow rate will be manually set by the operator. Operation of the pumps shall be interlocked with the flow switch to ensure that the pumps are not discharging hydrogen peroxide when there is no flow through the system.

2.6 CALIBRATION STANDPIPES

2.6.1 Chemical metering equipment shall be provided with a calibration cylinder 1000 ml with 1/2” FNPT connection for measuring pump output. The calibration cylinder shall allow convenient observation of the change of fluid level for at least 1/2 minute at maximum speed settings, and shall be Schedule 80, clear PVC pipe conforming to ASTM D 1785. The standpipe shall have a clear, observable length of at least 12 inches and shall be permanently calibrated in gallons and fractions thereof, to allow reading of the fluid contents with an accuracy of 1 percent.

2.7 PRESSURE GAUGES

2.7.1 Gauges shall be diaphragm type with Bourdon tube and diaphragm compartments filled completely with oil and shall be made of materials suitable for the application. Diaphragm seals shall be installed at each gauge connection to isolate gauges from corrosion, sludge or other hazards of the process fluid. Seal material shall be compatible with the oil in the gauge and the process fluid.

2.8 INJECTORS

2.8.1 Injectors for chemical solution shall be provided on process piping by means of a plastic injection nozzle, or by means of a suitable diffuser tube inserted through a corporation cock. The device for introducing the solution into a pressure main shall be constructed in such a way that accidental breakage of discharge hose or tubing will not cause water to escape from the pipeline and will allow disassembling of the unit without leakage.

2.9 PIPING

2.9.1 Chemical Solution Piping

2.9.1.1 Chemical solution piping shall be 1/2" ID 316 stainless steel tubing on the suction side and ½" ID tubing housed in 2" CPVC pipe conforming to ASTM F441 on the discharge side. The CPVC piping will act as secondary containment and shall be compatible with the chemical conveyed within the tubing. Provisions shall be incorporated to allow solution piping to be conveniently and safely bled of trapped air and minimize infiltration of air bubbles. All stainless steel piping, valves, and fittings used for the hydrogen peroxide feed system shall be passivated prior to placing in service.

2.10 EQUIPMENT APPURTENANCES

2.10.1 Bolts, nuts, anchors, washers and all other types of supports necessary for the installation of the equipment shall be Type 316 stainless steel.

PART 3 - EXECUTION

3.1 FIELD MEASUREMENTS

3.1.1 After becoming familiar with details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

3.2.1 Chemical Feeding Equipment

3.2.1.1 Pumps, equipment, and appurtenances shall be installed to provide a complete and integrated system in accordance with the instruction of the manufacturer and under the direct supervision of the manufacturer's representative.

3.2.2 Pipe, Tubing, Hangers and Supports,

3.2.2.1 Chemical feed tubing, secondary containment pipe, hangers and supports shall be installed to provide a complete chemical feed system in accordance with the manufacturer's instructions and as shown on the contract drawings.

3.3 FIELD PAINTING

3.3.1 Factory painted items requiring touching up in the field shall be thoroughly cleaned of all foreign material and shall be primed and top-coated with the manufacturer's standard factory paint.

3.4 FIELD TESTS

3.4.1 After installation of each system, operating tests shall be carried out to assure that the chemical metering installation operates properly. If any deficiencies are revealed during any tests, such deficiencies shall be corrected, and the tests shall be re-conducted. Reports of all tests shall be submitted prior to final acceptance of the installation.

3.4.2 Pumps

3.4.2.1 Pumps shall be tested to demonstrate that the pumps are capable of operating without leakage. Testing shall be performed at the maximum design flow rate and at half the design flow rate.

3.4.3 Time, Volume and Pumping Pressure

3.4.3.1 Pumps shall be tested by filling the calibration cylinder with chemical and measuring the outage, with all other equipment valved off. The time, volume and pumping pressures shall be recorded.

3.4.4 Test Pressure

3.4.4.1 Tests shall be carried out at 50 PSI. Back pressure valves shall be manually controlled for this testing and shall be reset as necessary after testing. The time to deliver a given quantity of chemical at a given stroke and speed setting shall be the same at all pressures.

3.4.5 Flow

3.4.5.1 Pumps shall be tested to demonstrate zero gpm flow at a zero stroke or speed setting. Failure to meet this test will be cause for rejection.

3.4.6 Chemical Waste

3.4.6.1 Chemicals wasted during testing procedures shall be neutralized to achieve a pH value between 6.0 and 9.0 and a hydrogen peroxide concentration of not more than 1 percent (10,000 mg/L). All chemicals wasted during testing procedures shall be routed to the building sump at a rate that the process can assimilate without upset.

3.5 MANUFACTURER’S SERVICES

3.5.1 Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.6 FIELD TRAINING

3.6.1 Conduct a field training course for designated operating, maintenance and supervisory staff members. Training shall be provided for a total period of 4 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the Operating and Maintenance Instructions.

END OF SECTION