Albert Einstein High School
Generator Replacement

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SECTION 23 0101

HVAC GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General provisions and requirements for all HVAC work.

1.2 RELATED SECTIONS

A. Requirements of this section generally supplement requirements of Division 01.

1.3 REFERENCES

A. NFPA 10: Portable Fire Extinguishers.

B. NFPA 241: Safeguarding Construction, Alteration, and Demolition Operations.

1.4 SYSTEM DESCRIPTION

A. The full set of Contract Documents applies to work of Division 23.

B. Visit the site and study all aspects of the project and working conditions, as required by General and Supplementary Conditions, Bidding and Contracting Requirements, Drawings, and Specifications. Verify field dimensions.

C. The work covered in technical sections includes the furnishing of all labor, equipment and materials, and the performance of all operations pertinent to the work described.

D. Except as required otherwise in Division 01, promptly obtain and pay for, including all necessary signatures and paperwork, all permits, fees and inspections required for work of this division by authorities having jurisdiction, including any utility connection or extension charge. No payment will be made until a copy of the permit is forwarded to the Owner. Contractor shall obtain and pay all fees for the mechanical permit.

E. HVAC work of this project includes, as a brief general description, the following:

1. Gas piping for emergency generator replacement.

1.5 PRODUCT OPTIONS

A. Except as modified by provisions of Bidding and Contracting Requirements and Division 01, these options apply to Division 23 specifications.

B. General: Where Contractor is permitted to use a product other than the specified item and model named as the basis of design, Contractor is responsible for all coordination and additional costs as specified in the article “Substitutions,” below for substitutions.

C. Products specified by reference standards or by description only: Any product meeting those standards or description.

D. Products specified by naming one or more manufacturers, or model name or catalog reference number: Products specified establish a standard of quality, options to be included, and performance.

1. Where other acceptable manufacturers are named, Contractor may provide products of those named manufacturers only, which meet the specifications.
2. Where specification permits “equal” products, without naming other acceptable manufacturers, Contractor may use products of any manufacturer, which meet the specifications.

E. Products specified by naming one manufacturer and particular product, with no provision for other options: No options or substitutions allowed.

1.6 SUBSTITUTIONS

A. Substitutions will be considered only as permitted or required by the Bidding and Contracting Requirements and Division 01. Except as modified by those requirements, the requirements below apply to Division 23 specifications.

B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed substitution with contract documents.

D. A request constitutes a representation that the Bidder or Contractor:

1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
2. Will provide the same warranty for the substitution as for the specified product.
3. Will coordinate installation and make changes to other work which may be required for the work to be complete with no additional cost to Owner.
4. Waives claims for additional costs or time extension which may subsequently become apparent.
5. Will reimburse Owner for review or redesign services associated with re-approval by authorities.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

F. Substitution submittal procedure is specified in Bidding and Contracting Requirements and Division 01.

1.7 MATERIALS AND EQUIPMENT

A. All materials and equipment shall be new and the best of their respective kinds, suitable for the conditions and duties imposed on them by the project, and of representative manufacture. The description, characteristics and requirements of the materials to be used shall be in accordance with the specifications.

B. All equipment, construction and installation must meet requirements of local, state and federal governing codes.

C. Singular number: In cases where material, a device, or part of the equipment is referred to in the singular number in the specifications, it is intended that such reference shall apply to as many items of material, devices, or parts of the equipment as are required to complete the installation as shown on the drawings or required for proper operation of the system.

D. Terms have the following meanings:

1. Furnish: Supply item
2. Install: Mount and connect item
3. Provide: Furnish and install.

E. All materials and equipment shall be installed and completed in a first class and workmanlike manner and in accordance with the best modern methods, practice and manufacturers' instructions. Any work which shall not present an orderly and neat or workmanlike appearance shall be removed and replaced with satisfactory work when so directed in writing by the Architect.

F. The specifications and drawings are intended to define the minimum requirements, as to quality of materials, construction, finish and overall workmanship.

G. General Conditions describe the correlation and intent of the Contract Documents. In case of discrepancies between the specifications and drawings, the specifications should be followed as to the general methods and principles and the drawings followed as to sizes, capacities and specifics for corresponding parts. If sizes are omitted, the Architect will determine sizes to be utilized.

H. In all cases of doubt, uncertainty, or conflict as to the true meaning of the specifications or drawings, it is the responsibility of the Contractor to notify the Architect of said uncertainty, doubt, or conflict and obtain a decision as to the intent before starting any work which may be affected by this decision.

1.8 COORDINATION

A. Should a situation develop during construction to prevent the proper installation of any equipment or item where shown on the drawings, call the situation to the attention of the Architect and await a written decision.

B. Plan and coordinate all work to proceed in an orderly and continuous manner without undue delay, and in conformance with project schedule. Submit samples, shop drawings, schedules, insurance policies and certificates, and the like in time to avoid delays in actual construction. Coordinate HVAC work so that work of each trade is completed before other construction begins which would obstruct it.

1. Perform work in compliance with approved coordination drawings specified in "Submittals" below.
2. Install mechanical and plumbing piping as high as possible in mechanical rooms.

C. Coordinate trades to ensure that proper clearances between work of the various trades allow access to items which require operation and maintenance.

D. Coordinate location and elevation of all piping, ductwork, light fixtures, equipment, and appurtenances in such a manner that the finished installation is as indicated on drawings. In the event difficulties are encountered which prevent this, it is the Contractor's responsibility to bring this to the attention of the Architect prior to initiation of work. Correct improperly coordinated installation at no additional cost.

E. The Contractors' assistants shall include a competent foreman, who shall be on the premises at all times to check, lay out, coordinate and superintend the installation of work. The foreman shall establish all grades and lines relative to the work before starting, and be responsible for the accuracy thereof.

F. For HVAC equipment located above ceilings, coordinate installation of all work above that ceiling such that service clearances are maintained. Install HVAC no more than two feet above the finished ceiling.

1.9 SUBMITTALS

A. Manufacturers' and subcontractors' lists:

1. As specified in Division 01, submit a complete list of proposed manufacturers for all equipment, materials and subcontractors used for the work of this division. Lists shall follow the sequence of the specifications. No considerations will be given for partial or incomplete lists. After review of lists, submit shop drawings and product data.

B. Shop drawings and product data:

1. Submit in accordance with the requirements of Division 01 or as established at the preconstruction conference, the required number of copies of shop drawings and product data for every item of equipment. Shop drawings or product data will not be considered until manufacturers' lists have been approved. Shop drawings and product data shall be submitted, as required by the General Conditions, with sufficient time for checking, return to Contractor, and resubmission as required before Contractor shall install any item.
2. Each item submitted shall be properly labeled, indicating the specific service for which the equipment or material is to be used, section and paragraph number of specification or drawing number to which it applies, Contractor's name and project name and number. Data submitted shall be specific and shall include product data and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents. Clearly identify each item within the data. Data of a general nature will not be accepted. Each sheet must clearly show the project name and number.
3. The review of a shop drawing or product data shall not be considered as a guarantee of the measurements or building conditions or that the shop drawings or product data have been checked to see that item submitted properly fits the building conditions. This review shall not relieve the Contractor of the responsibility for furnishing material or performing work as required by the contract documents, for correctness of dimensions and quantities, or for proper coordination of details and interfaces among trades.
4. All exclusively electrical items furnished as items associated with mechanical items but not specifically described in the mechanical item submission, shall be submitted as a separate submittal but shall be clearly marked as associated with the mechanical item by identification specification paragraph.
5. Product data sheets shall be 8.5-inches by 11-inches cut sheets for operating and maintenance manual.
6. Provide submittal compliance cover letter for each project submittal indicating compliance with the contract documents. Sample compliance cover letter is included at the end of this section for reference.

C. Submit at least three copies of the results of every test required under any section in this division.

D. Specialist shall submit a list of at least three projects similar to this project in type, size, and quality, which have been in place and operating satisfactorily for at least five years.

1. Include project name, address, name and phone number of owner's representative, and project type and size.

E. After the work is completed, submit all required certificates of approval from approved inspection agencies and authorities having jurisdiction over work of this division. Certificates of approval must be received by the Architect prior to final acceptance of the work.

1.10 SPECIALIST

A. The term “Specialist” as used in the specification shall mean an individual or firm of established reputation (or, if newly organized, whose personnel have previously established a reputation in the same field,) which is regularly engaged in, and which maintains a regular force of workers skilled in either (as applicable) manufacturing or fabricating items required by the contract, installing items required by the contract, or otherwise performing work required by the contract. Where the specification requires installation by a specialist, the term shall also be deemed to mean the manufacturer of the item, an individual or firm licensed by the manufacturer, or an individual or firm who will perform the work under the manufacturer’s direct supervision.

1.11 CONTRACT CLOSEOUT SUBMITTALS

A. Project record documents:

1. Maintain on site one set of the following record documents; record actual revisions to the work of this division:

    a. Contract drawings.
    b. Specifications.
    c. Addenda.
    d. Change orders and other modifications to the Contract.
    e. Reviewed shop drawings, product data, and samples.

2. Maintain record documents separate from documents used for construction.
3. Record information concurrent with construction progress.
4. Specifications: Legibly mark and record in each section a description of actual products installed, including the following:

    a. Manufacturer’s name and product model and number.
    b. Product options, substitutions, or alternates utilized.
    c. Changes made by addenda and modifications.

5. Record documents and shop drawings: Legibly mark each item to record actual construction, including:

    a. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
    b. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the work.
    c. Field changes of dimension and detail.
    d. Details not on original Contract Drawings.

6. Submit documents as specified in Division 01.

1.12 REGULATORY REQUIREMENTS

A. When these specifications call for materials or construction of a better quality or larger sizes than required by the following codes and standards, the provisions of the specifications shall take precedence.

B. Provide, without extra charge, any additional materials and labor which may be required for compliance with these codes and standards even though the work is not mentioned in these specifications or shown on the contract drawings.

C. Perform the work of this division in strict accordance with the following authorities. The latest revision of these codes accepted by the authority having jurisdiction as of the date of the contract documents shall apply.

1. The plumbing, mechanical, electrical, building, fire, and safety codes of the state and county or city in which the work is being performed.
2. The National Electric Code, NFPA 70 (NEC).
3. The National Fire Protection Association Code. (NFPA).
4. International Energy Conservation, Fire, Fuel Gas, Mechanical, and Plumbing Codes (ICC).

D. All equipment displays shall indicate English units.

1.13 REFERENCE STANDARDS

A. Perform the work of this division using the standards of the following organizations, as referred to in technical sections, as a minimum requirement for construction and testing. Unless specified otherwise in Bidding and Contract Documents or Division 01, the latest revision current as of the date of the contract documents shall apply. Products shall be certified by manufacturers to meet the requirements of referenced standards.

1. Air Conditioning and Refrigeration Institute (ARI)
2. Air Movement and Control Association (AMCA)
3. Associated Air Balance Council (AABC)
4. American Association State Highway and Transportation Officials (AASHTO)
5. American National Standards Institute (ANSI)
6. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
7. ASME International (ASME)
8. American Society for Testing and Materials (ASTM)
9. American Society of Sanitary Engineering (ASSE)
10. American Water Works Association (AWWA)
11. International Code Council (ICC)
12. Manufacturer's Standardization Society of the Valve and Fittings Industry Inc. (MSS)
13. National Electrical Code, NFPA 70 (NEC)
14. National Electrical Manufacturer's Association (NEMA)
15. National Fire Protection Association (NFPA)
16. National Fuel Gas Code, NFPA 54
17. National Sanitary Foundation (NSF)
18. National Standard Plumbing Code (NSPC)
19. The Occupational Safety and Health Act (OSHA)
20. Piping and Drainage Institute (PDI)
21. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
22. Underwriters Laboratory Inc. (UL)
23. Maryland Occupational Safety and Health Act (MOSHA)

1.14 TEMPORARY STORAGE

A. Maintain upon premises, where directed, a storage area, and be responsible for all contents within these areas. Provide all security measures necessary for this area.

B. Area shall be maintained and shall be returned to original condition at the completion of the project.

1.15 PROTECTION

A. Control dust resulting from construction work to prevent its spread beyond the immediate work area, and to avoid creation of a nuisance.

1. Do not use water to control dust. Use drop cloths or other suitable barriers.
2. In areas where dirt or dust is produced as a result of the work, sweep daily, or more often as required.
3. Provide walk-off mats at entries and replace them at regular intervals.
4. Construct dust partitions, where indicated on the drawings or as required.
5. Protect areas occupied by Owner's personnel or equipment.
6. Seal off all return air registers and other mechanical systems to prevent dust from entering.

B. Each trade and subcontractor is responsible for preventing damage and soiling of work performed by other trades or subcontractors. Each trade and subcontractor is responsible for providing temporary protection of its own work.

1. Protect work from spills, splatters, drippings, adhesives, bitumens, mortars, paints, plasters, and damage from welding or burning.
2. Protect finished work from damage, defacement, staining, or scratching.
3. Protect finishes from cleaning agents, or grinding and finishing equipment.
4. Protect adjacent and finished work from damage, using tape, masking, covers or coatings and protective enclosures.
5. Coordinate installations and temporarily remove items to avoid damage from finishing work.

C. Repair all damage or soiling to the complete satisfaction of the Architect; replace any materials or work damaged to such an extent that they cannot be restored to their original condition, all at no addition to the Contract Sum.

D. Protect work stored in place and supplies stored in the building.

E. All equipment shall be covered during shipping and wrapped prior to leaving factory.

F. Use of sidewalk or roadway areas outside of the property lines shall be with permission and approval of the local authorities having jurisdiction.

1.16 FIRE PROTECTION

A. As a minimum, provide hand-carried, portable, UL-rated extinguishers with each work crew working inside the building.

B. Select extinguishers in accordance with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

1.17 PROJECT CONDITIONS

A. Drawings showing utilities in concealed locations are based on the best information available but are not represented as being precisely correct. Work of the contract includes digging, cutting, drilling, using nondestructive methods, and other methods of locating concealed utilities in the field, as well as patching and repairing as specified in “Cutting and Patching” below.

B. If, in the course of the work, workers encounter a material they suspect to present some hazard:

1. Promptly notify the Owner and Architect in writing.
2. Do not perform any work which would disturb the suspected material until written instructions have been received.

1.18 WARRANTY

A. All work and equipment provided as work of this division shall be fully warranted under the general project warranty, which shall include a 2 year/24 hour/7 day full parts and labor warranty for all mechanical work and equipment.

B. During the correction period, the Contractor shall begin correcting any work found to be not in accordance with the requirements of the Contract Documents within 4-hours of receiving written notice from the Owner. Provide detailed schedule for completion of work within 24-hours of receiving written notice from the Owner and revise schedule based on any Owner comments generated. Except as otherwise required in General Conditions and Division 01, the correction period is two years after the date of substantial completion of the work. Work requiring correction shall promptly be repaired or completely replaced at no addition to the Contract Sum.

C. Special warranties are warranties required by individual specification sections, incidental product warranties, manufacturers' standard warranties, installer or subcontractor service agreements, and other individual warranties in addition to the general project warranty.

D. Provide copies of warranties as required for Operation and Maintenance Manual specified above, and by Division 01.

E. For items of work delayed beyond date of substantial completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

B. Cut walls, floors, partitions, roofs, and other appurtenances for the passage or accommodation of pipes, ducts and appurtenances. Close superfluous openings and remove all debris caused by work of this division.

C. No cutting of any structure or finish shall be done until the condition requiring such cutting has been examined and approved by the Architect.

D. New or existing surfaces disturbed as a result of such cutting or otherwise damaged shall be restored to match original work and all materials used for any patching or mending shall conform to the class of materials originally installed.

E. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

3.2 PROGRESS MEETINGS

A. Progress meetings shall be held as specified in Division 01, and also when and if the Contractor or Architect finds them necessary or advantageous to progress of work.

B. Contractor, those subcontractors and those material suppliers concerned with current progress or with the scheduling of future progress, Architect and Owner shall each be represented at these meetings by persons familiar with the details of work and authorized to conclude matters relating to work progress.

END OF SECTION

SECTION 23 0500

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements applicable to more than one section of Division 23.

B. Basic material and equipment required for the HVAC piping work.

C. Identification of HVAC systems.

D. Cleaning and painting.

E. Operating instructions.

F. Piping tests.

1.2 RELATED SECTIONS

A. Project and special warranties: Division 01 and Section 23 0101.

B. Operation and Maintenance Manuals: Division 01 and Section 23 0101.

C. Painting: Division 09.

1.3 REFERENCES

A. American Society of Mechanical Engineers

1. ASME Boiler and Pressure Vessel Code
2. ASME A 13.1: Scheme for the Identification of Piping Systems
3. ASME B 31.1: Power Piping
4. ASME B 31.9: Building Services Piping

B. American Society of Testing and Materials

1. ASTM A 234: Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
2. ASTM B 32: Standard Specification for Solder Metal
3. ASTM B 88: Standard Specification for Seamless Copper Water Tube
4. ASTM B 813: Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
5. ASTM D 635: Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
6. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials
7. ASTM E 548: Standard Guide for General Criteria Used for Evaluating Laboratory Competence
8. ASTM D 2564: Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
9. ASTM F 656: Standard Specification for Primers for use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

C. American Welding Society

1. AWS D1.1: Structural Welding - Steel
2. AWS D10.9: Specification for Qualification of Welding Procedures and Welders for Piping and Tubing
3. AWS QC1: Specification for AWS Certification of Welding Inspectors

1.4 DEFINITIONS

A. Project correction period: A period after Substantial Completion of the work during which the Contractor shall correct every part of the work found to be not in accordance with the requirements of the contract documents, promptly after receipt of written notice.

B. Qualified testing agency: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual sections; and where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

C. DN: Dimension Nominale, nominal pipe size in millimeters, in accordance with the metric system for construction, Systeme Internationale (SI).

D. NPS: Nominal pipe size in inches, in accordance with standard U.S. designations for manufactured pipe. Pipe sizes do not change when projects are designed and built in metric units; each size has a consistent name (nominal dimension) in each system.

1.5 DESIGN REQUIREMENTS

A. The drawings and system performances have been designed based on the use of the particular manufacturer’s products specified and scheduled on the drawings.

B. Products of other manufacturers that are listed under the article "Acceptable Manufacturers," or permitted as "equal," are permitted provided:

1. Product shall meet the specifications.
2. Contractor shall make, without addition to the contract sum, all adjustments for deviations so that the final installation is complete and functions as the design basis product is intended.

C. Do not propose products with dimensions or other characteristics different from the design basis product that render their use impractical, or cause functional fit, access, or connection problems.

1.6 SUBMITTALS

A. Shop drawings:

1. Schedule of welding and brazing procedures proposed for each piping system in the project.
2. Shop drawings of backboards for piping specialties.

B. Certifications: Proof of operator and testing agency personnel qualifications as required for welding and brazing in the article "Quality Assurance" below.

C. Test reports: Field test results for each piping system as specified in Part 3 below.

D. Demonstration and Training Plan: Plan indicating number of hours and topics of discussion for in-classroom and on-site training as specified in Part 3 below.

1.7 QUALITY ASSURANCE

A. Provide materials and perform work in accordance with the plumbing, mechanical, electrical, building, fire, health and safety, and other applicable codes and regulations of the state, county or city in which the work is performed.

B. Welding procedures and operator qualifications for structural welding: AWS D1.1, Structural Welding Code Steel, electric arc process.

C. Welding, brazing, and soldering procedures and operator qualifications for building systems piping:

1. AWS D10.9, Qualification of Welding Procedures and Welders for Piping and Tubing.
2. ASME B31.9, Building Services Piping.
3. Copper Development Association "Copper Tube Handbook."

D. Qualifications of independent testing laboratory personnel:

1. Welding inspectors: AWS QC1, Certification of Welding Inspectors.
2. Nondestructive evaluation personnel: American Society for Nondestructive Testing Recommended Practice.

E. VOC content: Field-applied adhesives and sealants, limits per South Coast Air Quality Management District (SCAQMD), Rule No. 1168.

F. Products shall contain no urea-formaldehyde content.

PART 2 - PRODUCTS

2.1 GENERAL

A. Piping techniques, testing, identification, painting, and operating instructions specified in this section apply to products specified in other sections of Division 23.

B. Equipment that uses or processes date and time data in order to perform its function shall be warranted by the manufacturer to properly function and correctly use or process all time-related data for all dates and times which occur during a reasonable life expectancy of the equipment.

2.2 PIPING MATERIALS

A. Weldolets and thredolets: Fittings designed for installing branches on piping, with either welded or threaded connection to branch; conforming to ASTM A 234.

B. Soldering materials:

1. Solder: Free of lead, antimony, and zinc and meeting the requirements of ASTM B 32. No solder containing lead is permitted.

a. Tin 95.5 percent, copper 4 percent, and silver 0.5 percent; “Silvabrite 100” manufactured by Engelhard Corporation.
b. Tin, copper, bismuth, and silver; "Oatey Silver" manufactured by Oatey.

2. Flux: Meeting the requirements of ASTM B 813 and NSF 61 certified, Oatey H-20^{95}.

C. Threaded pipe joint materials:

1. Pipe joint compound:

a. Pipe joint compound recommended by the manufacturer for use at the temperature and pressure of the system.
b. For gas service: As specified in Section 23 1123, Natural-Gas Piping.

2. Pipe joint tape: Polytetrafluoroethylene (PTFE) pipe thread tape, "Teflon."

2.3 IDENTIFICATION DEVICES AND MATERIALS

A. Stenciling materials:

1. Stencils: Manufactured standard stencils prepared for required applications, conforming to ASME A 13.1 for color and size of legend letters, including arrows showing direction of flow.
2. Paint: Exterior type enamel, colors conforming to ASME A 13.1, or black.

B. Equipment identification tags:

1. Laminated plastic with adhesive back, white core and black outer layers, which, when engraved, will produce white letters and numerals on a black background.
2. Tags installed on curved surfaces shall be aluminum or brass.

C. Valve tags: Brass, 1.5 inch (40 mm) in diameter with black-filled numbers not less than 0.25 inch (6 mm) high, complete with brass attachment chains.

2.4 RUST INHIBITIVE PAINT

A. Rust-inhibitive paint:

1. Alkyd based, white, black, or bronze tone.
2. Applied in a wet film thickness of at least 2.9 mils (0.07 mm).
3. Benjamin Moore Super Spec HP D.T.M. Alkyd Low Lustre P23.

PART 3 - EXECUTION

3.1 GENERAL

A. Manufacturers' instructions: Except as modified by drawings or specifications, install products and equipment in accordance with manufacturers' instructions and recommendations applicable to the project conditions.

1. Immediately notify Architect if a difference or discrepancy is found between manufacturers' instructions and the drawings or specifications.

B. The contract drawings are diagrammatic and do not indicate all fittings or offsets in pipe and ductwork, all access panels, or all specialties required. Provide required fittings, offsets, access panels, and specialties to coordinate the work.

C. No pipe or duct shall be run below the head of a window or door.

D. Equipment, ducts, and pipes installed in areas without a suspended ceiling shall be as tight to structure as possible, but at least above a height of 6'-8", unless otherwise noted.

E. Items which require access for operation or maintenance shall be easily accessible. Do not cut or form hand holes for operation or maintenance of appliances through walls or ceilings.

3.2 PIPE INSTALLATION

A. Install pipe exposed to view parallel to building lines and as close to walls, columns, and ceilings as may be practical, maintaining proper clearances for access at all parts requiring servicing.

B. Install pipe a sufficient distance from other work to permit a clearance of not less than 0.5 inch (15 mm) between its finished covering and adjacent work.

C. Remove burrs resulting from cutting pipe or from any other operation.

D. Thoroughly clean pipe and fittings before they are installed, and keep them clean until the acceptance of the completed work. Cap or plug the ends of the lines so as to prevent earth and other debris from entering during construction.

E. Provide for expansion and contraction of piping and connections so that no breakage or excessive strain will occur. Provide anchors and guides of approved design where shown on drawings and where necessary to allow for proper expansion and contraction. At the time of installation, expansion loops shall be cold sprung to one-half of the calculated expansion.

F. Pipe connection flexibility:

1. Connections shall be arranged so that movement in piping due to expansion and contraction will not transmit excessive force to equipment.

G. Install unions or flanges in the piping at each item of equipment, control valve, and appliance, so as to provide easy removal of the equipment, valve, or appliance, and to provide for easy removal of coils.

H. Interface with other products:

1. Where pipe is provided through walls, provide finished, permanent, waterproof installation complete with inserts, sleeves, supports or hangers, seals, and other appurtenances as required. Do not pierce, cut, or notch any footing or other structural member.
2. Waterproofing and dampproofing of the building shall be unharmed by the installation of the work. Where pipe has to pierce waterproofing or dampproofing, including outside walls, the penetration shall be made watertight. Waterproofing damaged or destroyed shall be repaired or replaced with new waterproofing.

I. Thoroughly clean pipe and fittings before they are installed, and keep them clean until the acceptance of the completed work. Cap or plug the ends of the lines so as to prevent earth and other debris from entering during construction.

J. Use welding fittings, tees, wyes, reducers, eccentric reducers, and caps as required. Branches at least two nominal pipe sizes less than the main may be made with "Weldolets" or "Thredolets" installed with full size opening in larger pipe and in accordance with manufacturer's printed instructions. Flanges shall be welded neck or slip-on pattern of class to suit the valves or equipment connections. Flanges shall have machine bolts with hex nuts and washers.

K. Threaded connections:

1. Cut threads full and clean.
2. Apply specified pipe joint compound or tape on male threads only.

3. Where piping is installed in crawl spaces and tunnels, cover exposed threads with rust-inhibitive paint. Apply after joints have been assembled and tested.

L. Copper tubing installation:

1. Cut pipe with a tubing cutter or fine-tooth saw. Cuts made with a saw shall be true and square, and the end shall be filed smooth with a fine-tooth file. Remove all marks and burrs with sandpaper.
2. Solder joints for copper tubing: Clean ends of tubing and inside of fitting ends thoroughly with emery cloth before applying flux.
3. Provide dielectric fittings between copper and steel piping to prevent electrolysis.
4. Follow the techniques for soldering and brazing pipe, fittings, and valves as recommended by the manufacturer.

3.3 IDENTIFICATION

A. General: Do not apply identification until insulation and finish painting work is complete.

B. Piping:

1. Mark by stenciling.
2. Mark to identify service with arrows showing direction of flow. Apply markings near building walls where pipes enter or leave an accessible space and in intermediate locations so that markings are no more than 30 feet (9 m) apart. They shall be readily visible to a person standing on the floor.
3. Fully identify all piping installed as work of the project.
4. Mark pipe with letters of height and with colors as required by OSHA and conforming to ASME A 13.1.
5. Identify every thermometer, gauge, and control device.
6. Provide valve tags for all valves except shutoff valves on individual fixtures or equipment where their function is obvious, or where the fixture or equipment is immediately adjacent. Numbers shall correspond to those shown on the Valve Chart. Attach tags to valve shaft.

C. Piping paint color legend:

SERVICE	PIPING	STENCIL
Gas	OSHA Yellow	Black

3.4 CLEANING AND PAINTING

A. Cleaning: Clean all piping and equipment. Where items are to be painted, clean ready for painting.

B. Painting: Coordinate painting with requirements of Division 09. Use paint materials and systems specified in Division 09.

C. Items to be painted:

1. Items furnished with manufacturer’s prime coat.
2. Gas piping.

D. Items not to be painted: Copper, stainless steel, flexible connectors, PVC and aluminum piping jackets, and equipment furnished with manufacturer’s finish.

E. Paint systems:

1. Galvanized steel: One coat of primer recommended for galvanized surfaces and one coat of glossy alkyd enamel.
2. Ferrous metal: One coat of primer recommended for ferrous metal and one coat of glossy alkyd enamel.
3. Items protected with rust-inhibitive primer: Finish coat of compatible glossy enamel.

F. Paint identification stenciling using colors in accordance with identification legend above.

3.5 PIPING TESTS

A. Hydrostatic testing:

1. Notify Owner in writing at least 24 hours prior to the test.
2. Test before pipes are concealed or insulated.
3. Piping may be tested in sections as the work progresses.
4. Provide fluid, pumps, valves, and gages required for testing.
5. Where water is used as the test fluid, provide ambient temperature water and provide means to avoid freezing. Drain and dispose of test fluid when testing is concluded.
6. Isolate equipment and expansion tanks during test.
7. Isolate or remove any components with a pressure rating below the required test pressure.
8. Brace and support piping during the test, so that no movement, displacement, or damage results from the application of the test pressure.
9. Provide a pressure relief valve, set at a pressure no more than one-third higher than test pressure, to protect against damage caused by expanding liquid or other source of overpressure during test.
10. Replace piping or fittings found defective with new material.
11. Documentation of tests: Prepare a test report for each portion of piping tested, identified by service, material, location, and pipe size. Include these items:

    a. Date of test.
    b. Starting and completion times.
    c. Initial test pressure.
    d. Final test pressure.
    e. Problems or leaks detected.
    f. Corrective actions taken.
    g. Record of successful completion of testing.
    h. Name, title, and signature of person conducting test.

12. Piping Systems Test Schedule:

System	Test Pressure psig (kPa)	Duration	Allowable Drop	Medium
Fuel gas	100 (690)	4 Hours	None	*Air

* If pressure drops, locate leaks with soap and water solution

END OF SECTION

SECTION 23 0504

HVAC DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Extent and location of demolition are shown on the drawings.

1.2 RELATED SECTIONS

A. Demolition: Division 02.

1.3 QUALITY ASSURANCE

A. Demolition shall be carried out as expeditiously as possible in accordance with accepted practice and applicable building code provisions.

1.4 PROJECT CONDITIONS

A. If, in the course of the work, workers encounter a material they suspect to be asbestos, to contain lead or PCBs, or to present some other hazard:

1. Promptly notify the Owner and Architect in writing.
2. Do not perform any work which would disturb the suspected material until written instructions have been received.

B. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

C. Locate, identify, and protect mechanical and electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 DEMOLITION

A. Comply with demolition and disposal requirements of Division 02.

B. Perform removal work neatly with the least possible disturbance to the building.

C. Provide temporary barriers, danger signals, and appurtenances for protection of personnel and equipment during removal operations.

D. Drain and refill portions of existing piping systems necessary to implement the work of this project.

1. Isolation valves shall be installed, if necessary, to keep systems operational in Owner-occupied portions of the building.
2. Activities for draining systems shall be scheduled and coordinated with the Owner in accordance with Division 01 requirements for system shutdowns.

E. Demolish, remove, demount, and disconnect inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls, fixtures, and insulation.

1. Piping and ducts embedded in floors, walls, and ceilings may be abandoned in place if they do not interfere with new installations. Cut back to at least one inch below finished surface.
2. Remove materials above accessible ceilings.
3. Drain and cap items to remain behind finished surfaces.
4. Patch and repair surface materials as required in Division 01 and Section 23 0101 article, “Cutting and Patching.”

F. Remove anchors, bolts, and fasteners associated with piping and equipment to be removed.

3.2 DISPOSAL

A. Dispose of equipment and materials removed, and rubbish and waste material, as work progresses. Do not allow demolition debris to accumulate on site. Remove products of demolition from the building daily.

3.3 PROTECTION

A. Provide adequate and positive protection to existing building and equipment that is to remain, particularly to prevent entry of either dust or water. Ensure weathertightness at all times. Keep standby patching materials on hand to patch and maintain protection as required.

END OF SECTION

SECTION 23 0513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Unless otherwise specified in a particular section or required for a particular application, motors shall conform to the following requirements, whether factory-installed or field-installed.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Motor capacitors: Section 26 0521, Wiring Connections.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Variable frequency drives: Section 26 2923.

1.4 REFERENCES

A. NEMA MG 1: Motors and Generators.

B. NEMA MG 10: Energy Management Guide for Selection and Use of Polyphase Motors.

C. NEMA MG 11: Energy Management Guide for Selection and Use of Single-Phase Motors.

D. UL 508: Industrial Control Equipment.

1.5 DEFINITIONS

A. Energy efficient motor: Motor meeting the nominal and minimum efficiency levels listed for its horsepower and speed in Table 12-10 of NEMA MG 1.

B. Nominal efficiency: Efficiency as defined in Table 12-8, Efficiency Levels, in NEMA MG 1, and identified on the motor nameplate.

1.6 SUBMITTALS

A. Product data:

1. Motors and drives not provided with equipment: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lugs, and coatings.
2. Motor capacitors.

B. Wiring diagrams required for the proper installation of mechanical equipment.

C. Submit product data which verifies compliance with ASHRAE 90.1 or provide certified performance ratings by a qualified independent testing agency.

D. Certifications:

1. Actual motor power factor for each motor, certified test results for each motor proposed for use on this project.
2. Field test showing corrected power factor, if required.

3. Motors controlled by variable frequency controllers: Certification that motor meets specified requirements.

1.7 QUALITY ASSURANCE

A. Actual motor power factor shall be tested and certified by an independent testing laboratory.

B. Where power factor is field tested as required in “Power Factor” in Part 2 below, specialist performing tests shall be acceptable to the local authorities having jurisdiction.

C. UL label and local testing (if required): As specified in Section 23 0500, Common Work Results for HVAC.

D. HVAC equipment shall meet the energy performance requirements of ASHRAE 90.1.

1.8 REGULATORY REQUIREMENTS

A. Motors shall conform to the requirements of NEMA MG1 and applicable portions of the National Electric Code (NEC, NFPA 70).

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Motors:

1. Baldor Electric Co.
2. Marathon
3. Rockwell
4. Siemens
5. A.O. Smith
6. Toshiba International

B. Motor capacitors:

1. ABB Power Distribution
2. Commonwealth Sprague
3. General Electric

2.2 BASIC MOTOR REQUIREMENTS

A. Capacity: Each motor shall have sufficient capacity and torque to start, accelerate, and operate the machine it drives without exceeding the motor nameplate rating at the speed specified, or at any speed and load which may be obtained by the drive actually furnished.

B. Starting: Each automatically controlled motor shall be capable of starting as frequently as the control sequence may demand. Motors not automatically controlled shall be capable of making no fewer than 4 starts per hour.

C. Loads: Belt-connected motors shall be equipped with shafts and bearings designed to withstand both the normal connected loads of the drive furnished, and momentary loads imposed during acceleration.

D. Ratings: Motors shall be rated for continuous duty at 100 percent of rated capacity, and temperature rise shall be based on ambient temperature of 40 degrees C.

E. Phase: Unless otherwise indicated, motors one-half horsepower and larger shall be polyphase and motors smaller than one-half horsepower shall be single-phase motors.

F. Motor construction:

1. Motors for fans, air handling units, and pumps, unless specified otherwise in the equipment section, shall be open drip-proof NEMA design B construction.

G. Efficiency: The term “energy efficient” is defined in the article “Definitions” in Part 1 above.

1. Single-phase motors, alternating-current fractional horsepower, rated 1/20 to 1 horsepower, 250 volts or less: NEMA MG 11, types and efficiencies selected for their applications.
2. Polyphase motors, medium alternating-current, squirrel-cage, 1 to 500 horsepower, 600 volts or less: NEMA MG 10, energy-efficient types selected for their application. Nominal full-load efficiencies shall meet or exceed ratings of Table 12-10 of NEMA MG 1.
3. Motors for packaged hermetic and semi-hermetic refrigeration compressors need not comply with these efficiency requirements but they shall comply with the requirements indicated for power factor and power consumption.

2.3 SINGLE-PHASE MOTORS

A. Permanent split-capacitor or split-phase type.

B. Bearings: Sealed, prelubricated ball-bearing type.

2.4 POLYPHASE MOTORS

A. NEMA MG1 Design B.

B. Stator: Copper windings.

C. Rotor: Squirrel cage.

D. Bearings: Doubly shielded, prelubricated ball bearings suitable for radial and thrust loading of connected equipment.

E. Temperature rise shall not exceed insulation rating.

F. Insulation: Class F.

G. Motors used with inrush controllers: Match wiring requirements for indicated controller with required motor leads brought to motor terminal box to suit control method.

H. Horsepower/frame relationship: NEMA Standard for T frame motors.

I. Motor frame and endshields: Cast iron.

J. Conduit box: Either steel or aluminum, diagonally split and rotatable in 90-degree increments, with grounding provision.

K. Finishes:

1. External hardware: Plated to resist corrosion.
2. External paint: Industrial enamel.

L. Nameplates: Stainless steel or aluminum, and stamped in accordance with NEMA MG1. Nameplate information shall include the nominal efficiency value in accordance with NEMA MG1 and the manufacturer's minimum guaranteed efficiency value.

M. Multi-phase motors serving mechanical equipment shall be provided with single phase protection. When single phasing is detected, the unit shall deenergize completely. When all power phases are restored, the units shall automatically energize.

1. Provide ICM-450 phase monitor, including all required wiring for final connections between phase monitor and motor. Include automatic restart with a 300 second time delay.

2.5 ELECTRONICALLY COMMUTATED MOTOR (ECM)

A. Brushless direct current (DC) variable speed motor supplied with alternating current, with a permanent magnet with near zero rotor losses, permanently-lubricated ball bearings, electronic commutation, designed for synchronous rotation, and at least 70 percent efficient at all operating speeds.

B. As a minimum, the motor shall include the following features:

1. Integrated controller / invertor that operates the wound stator and senses rotor position to electronically commutate the stator.
2. Thermal overload protection.
3. Built-in soft start and soft speed change ramps.
4. Inductors to minimize harmonic distortion and line noise.
5. Designed to overcome reverse rotation without affecting life expectancy.
6. Motor speed shall be controllable down to 20 percent of full speed. Speed shall be controlled by either a potentiometer with manual adjustment on the motor or by a 0-10Vdc analog signal from a remote source, as required by other sections of Division 23 specifications.
7. Software for motor control shall be as indicated or described in other Division 23 specifications.

2.6 TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS

A. Polyphase motors with the following additional requirements:

1. TEFC construction for severe environment.
2. Ventilating fans: Made of corrosion-resistant, non-sparking material.
3. Conduit box: Heavy-wall cast construction, gasketed with a lead gasket between box and motor frame.
4. Motor shaft shall be provided with an external slinger on the drive end.
5. Rotor and stator air-gap surfaces coated to prevent corrosion.
6. Finish: At least two coats of catalyzed epoxy enamel.

B. Explosion-proof motors: TEFC NEMA Type K and NFPA hazardous Class I or Class II as required.

2.7 MOTORS CONTROLLED BY VARIABLE FREQUENCY DRIVES

A. Specifically constructed and warranted by the manufacturer to meet the voltage requirements of NEMA MG 1, Part 31.4.4.2.

B. Temperature rise: Match rating for Class B insulation.

C. Insulation: Class B or F (TEFC), or Class F (ODP).

D. Provide ICM-450 phase monitor, including all required wiring for final connections between phase monitor and motor/VFD. Include automatic restart with a 300 second time delay.

E. Bearing protection: Conductive shaft grounding ring, equal to Aegis SGR by Electro Static Technology, to transmit induced current from shaft to motor frame without harming bearings.

2.8 POWER FACTOR

A. Power factor for three-phase motors 10 HP and larger and packaged equipment systems totaling 10 HP and larger as noted below shall be not less than 90 percent at full rated load. Test, certify, and submit certified reports for each motor as required in “Submittals” and “Quality Assurance” in Part 1 above.

1. Should the Contractor propose to provide motors with less than 90 percent power factor, provide power-factor-correcting, automatically discharging type motor capacitors. The corrected power factor of the motor-capacitor combination shall be equal to or greater than 90 percent. Submit certified test results.
2. Motor capacitor: Designed for installation at the load side of motor starters; insulated, impregnated component unit completely enclosed in a grounded steel case with welded and ground seams. Where installed on outdoor equipment, case shall be weatherproof. Provide each unit with a flexible cable for connection to the starter or motor terminals. The capacitor shall be suitable for use in areas with ambient temperatures ranging from minus 10 degrees F to 115 degrees F.

B. Where motors totaling 10 HP and larger are part of packaged equipment system, such as packaged air-conditioning unit or air-conditioning condensing unit, the overall power factor for the entire system package shall be no less than 90 percent. Provide capacitors and appurtenances required to accomplish this power factor as part of the packaged equipment, or furnish separately and wire as work of equipment installation. Capacitors shall be stepped, deenergized, or cycled when the unit is deenergized or the load is varied, to maintain 90 percent power factor.

1. Capacitors provided as part of packaged equipment: If the installation of the capacitors voids the UL label, unit shall be tested. Actual power factor shall be factory-tested and certified test results included in submittals.
2. Capacitors provided separately and wired as work of equipment installation: Unit shall then be field tested to verify actual power factor. Submit field test reports.
3. Tests shall be performed by an electrical testing specialist and in accordance with NFPA 70 (NEC) testing brochure.

C. Motors and packaged equipment systems equipped with variable frequency drives shall not receive power factor correcting capacitors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount direct-connected motors securely and in accurate alignment. The drive shall be free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

B. Mount capacitors shipped separately beside motor connection box as required. Connect in accordance with the requirements of Division 26, Electrical.

1. Test units at full rated load after the installation of the motor capacitors, and submit reports.

C. Provide wiring required from phase monitor to motor. Ensure automatic restart time delay is adjusted to 300 seconds.

3.2 OPERATING INSTRUCTIONS

A. As specified in Section 23 0500, provide operating instructions.

END OF SECTION

SECTION 23 0529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe hangers and supports.

B. Fasteners.

1.2 REFERENCES

A. American Society of Mechanical Engineers

1. ASME B31.1: Power Piping.
2. ASME B31.9: Building Services Piping.

B. ASTM International

1. ASTM A 36: Standard Specification for Carbon Structural Steel
2. ASTM A 53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
3. ASTM A 307: Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
4. ASTM A 563: Standard Specification for Carbon and Alloy Steel Nuts ASTM A 1064: Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
5. ASTM C 533: Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
6. ASTM C 552: Standard Specification for Cellular Glass Thermal Insulation
7. ASTM F 594: Standard Specification for Stainless Steel Nuts
8. ASTM F 3125: Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated

C. American Welding Society

1. AWS-D.1.1: Structural Welding – Steel

D. Manufacturer’s Standardization Society

1. MSS SP-58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.3 SUBMITTALS

A. Product data:

1. Provide manufacturer’s literature showing compliance with specifications for each type of hanger, framing system, support, fastener and accessory materials.
2. Provide a schedule of piping types and sizes and associated pipe hanger types.
3. Provide a schedule of building attachment types and associated attachment hardware.
4. Provide a schedule of pipe types and sizes and proposed hanger spacing and support rod diameters.
5. Provide manufacturer’s recommended pipe hanger spacing criteria for plastic piping.

B. Welding certificates.

1.4 QUALITY ASSURANCE

A. Qualifications of welders: As specified in Section 23 0500, Common Work Results for HVAC.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe hangers:

1. Anvil International
2. Carpenter and Paterson, Inc.
3. Cooper Industries
4. National Pipe Hanger Corporation
5. PHD Manufacturing, Inc.
6. PHP Systems/Design

2.2 PIPE HANGERS AND SUPPORTS

A. General: Types are identified by MSS type numbers in the article "Installing Pipe Hangers and Supports" below.

B. Materials for hangers and clamps:

1. For copper pipe: Copper plated.
2. For steel, insulated, and cast-iron pipe: Galvanized in crawl spaces, tunnels, or wet areas; galvanized or factory-painted in other areas.
3. For refrigerant piping: Clamp inserts, Cooper "B-line" armafix clamps or Cush-A-Therm by ZSi-Foster, suitable for channel (trapeze) supports.

C. Pipe covering protection saddle: Steel, meeting requirements of MSS SP-58 Type 39, with calcium silicate insulation in the space between saddle and pipe.

D. Hanger rod nuts and washers shall be zinc-plated. Hanger rods shall be solid steel, all threaded, and zinc-plated.

E. Channel: Slotted cold-rolled steel, equal to Grinnell PS 150 S, 12 gage with 0.406- by 3-inch (10 by 76-mm) slots on 4-inch (102-mm) centers.

F. Wall- and floor-mounted supports: Structural support system equal to Grinnell “Power Strut.”

G. Structural shapes: ASTM A 36.

H. Steel pipe: ASTM A 53, standard weight.

I. Threaded rod: MSS SP-58.

2.3 FASTENERS

A. Mechanical expansion anchors: Self-drilling type expansion shields or machine bolt drop-in anchors for drilled holes, equal to ITT Phillips Anchors “Red Head.” Fasteners to floor slabs shall be vibration and shock resistant. Load applied to fasteners shall not exceed 25 percent of manufacturer’s stated load capacity in 3500 psi (24,000 kPa) concrete. Provide zinc-coated anchors for indoor applications and stainless-steel anchors for outdoor applications.

B. Fasteners to drywall or cavity wall construction: Equal to ITT Phillips Anchors “Red Head” toggle bolts, with hollow wall drive anchors or nylon anchors as required.

C. Bolts, nuts, and washers: ASTM A 307, or ASTM F 3125 where high strength is required.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide hangers and supports in accordance with schedules at the end of this section, as modified by specifications for each location and type.

B. Comply with MSS SP-58. Provide hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

C. Provide hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

D. Where required, provide structural steel shapes or metal framing system channels and hardware to transfer load from a hanger location to multiple locations in the structure in order to get support from an appropriate location or to increase the strength of the connection to the structure.

E. Support horizontal piping from above with hangers and threaded rod where possible, unless otherwise indicated.

F. Support pipe risers through floor slabs with riser clamps.

G. Provide hanger sizes to allow for continuous insulation for insulated piping systems.

H. Fabricate wall-mounted and floor-mounted supports using metal framing systems or structural steel where required.

I. Support groups of small piping along a structural wall using a metal framing system secured to the wall.

J. Trim threaded rods with a maximum excess length of 1 inch (25 mm). Provide protective rubber red end caps on the ends of threaded rods exposed and within 8 feet (2.4 meters) of the floor, roof, or grade below.

K. 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.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. 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 BUILDING ATTACHMENTS

A. Attaching to structural walls:

1. Provide a minimum of two 0.375 inch (9.5 mm) minimum screw-type fasteners for attaching brackets and a minimum of three 0.5 inch (13 mm) minimum bolt-type fasteners for attaching structural supports.

B. Attaching to structural steel beams, channels, or angles:

1. Secure threaded rods to MSS SP-58 Type 20 adjustable beam clamps that are clamped to the bottom flange of steel beams for any pipe size.
2. Secure threaded rods to MSS SP-58 Type 23 beam clamps for beams with maximum flange thickness of 0.75 inch (19 mm) and for single pipes NPS 2 (DN 50) and smaller.

C. Attaching to bar joists:

1. Provide MSS SP-58 Type 19 top-beam C-clamps attached to top flange of the joists at panel points.
2. Piping perpendicular to joists:

a. Pipes NPS 2.5 (DN 65) and smaller: Support from at least every other joist to spread the load among joists. Where multiple pipes are grouped together, stagger hangers to distribute the load among available joists.
b. Pipes NPS 3 (DN 80) and larger: Support from every joist to spread the load among joists.
c. If additional support is required between joists, hang metal framing system channel or structural steel shape from joists using MSS SP-58 Type 19 C-clamps attached to the top flange of two joists, and hang piping from metal framing system channel or structural steel shape.

3. Piping parallel to joists:

a. Hang metal framing system channel or structural steel shape from joists using MSS SP-58 Type 19 C-clamps attached to the top flange of two joists. Hang piping from metal framing system channel or structural steel shape.
b. For pipes NPS 2.5 (DN 65) and smaller: A single pipe may be hung from a single joist.

D. Attaching to concrete slabs and composite slabs: Not permitted.

E. Attaching to steel decks: Not permitted.

3.3 PIPING HANGER AND SUPPORT SCHEDULES

A. Uninsulated hydronic applications: Applications include gas piping.

(See schedule, next page)

HANGERS & SUPPORTS FOR UNINSULATED APPLICATIONS		
MSS SP-58 Classification	Description	Piping applications
Hung from Above		
Type 1	Clevis hanger	All sizes
Type 10	Adjustable swivel ring	NPS 0.5 (DN 15) through NPS 4 (DN 100)
Type 59	Trapeze pipe hanger with pipe saddles & U-bolts.	NPS 0.5 (DN 15) through NPS 4 (DN 100)
N/A	Metal framing system with metal framing system pipe clamps for uninsulated piping.	NPS 0.5 (DN 15) through NPS 4 (DN 100)
Supported from Below		
Type 37	Adjustable pipe stanchion saddle with U-bolt, with floor flange and base anchored to floor.	All sizes where supported from the floor or a concrete support pier.
Type 41	Adjustable roller support (cast-iron roll and sockets, steel roll rod, supported from below with threaded rods).	All sizes where supported from racks, fixed structural supports, or brackets where vertical adjustment is required.
Type 44	Roller chair (cast-iron roll, steel roll rod, steel chair, bolts, and hex nuts).	All sizes where supported from racks, fixed structural supports, or brackets where vertical adjustment is not required.
N/A	Metal framing system with metal framing system pipe clamps and pipe clamp insulating inserts.	NPS 0.5 (DN 15) through NPS 8 (DN 200)
Risers		
Type 8	Riser clamp.	All sizes

B. Minimum threaded rod sizes: Provide at least the following minimum rod diameters for single rods supporting a single pipe hanger.

PIPE SIZE	MINIMUM ROD DIAMETER
NPS 2 (DN 50) and below	0.375 inches (10 mm)
NPS 2.5 and NPS 3 (DN 65 and DN 75)	0.5 inches (15 mm)
NPS 4 and NPS 5 (DN 100 and DN 125)	0.625 inches (16 mm)
NPS 6 and NPS 8 (DN150 and DN 200)	0.75 inches (20 mm)

C. Maximum hanger and support spacing: Provide additional hangers or supports for concentrated loads such as flanges, valves, expansion compensators, fittings, and other specialties.

PIPE SIZE	COPPER HYDRONIC PIPING	STEEL HYDRONIC PIPING	REFRIGERANT PIPING
NPS 0.75 (DN 20) and below	5 feet (1.5 m)	7 feet (2.1 m)	3 feet (0.91 m)
NPS 1 (DN 25)	6 feet (1.8 m)		
NPS 1.25 (DN 32)	7 feet (2.1 m)		
NPS 1.5 (DN 40)	8 feet (2.4 m)	9 feet (2.7 m)	
NPS 2 (DN 50)		10 feet (3 m)	
NPS 2.5 (DN 65)	9 feet (2.7 m)	11 feet (3.4 m)	
NPS 3 (DN 75)	10 feet (3 m)	12 feet (3.7 m)	
NPS 4 (DN 100)	12 feet (3.7 m)	14 feet (4.3 m)	
NPS 5 (DN 125)		16 feet (4.9 m)	
NPS 6 (DN 150)	14 feet (4.3 m)	17 feet (5.2 m)	
NPS 8 (DN 200)		19 feet (5.8 m)	

1. Provide hanger spacing to meet manufacturer's recommendations and MSS SP-58 for plastic hydronic piping.

END OF SECTION

SECTION 23 1123

NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Above-ground pipe and fittings.

B. Joining materials.

C. Manual gas shut-off valves.

D. Line Pressure regulators.

1.2 RELATED SECTIONS

A. Pipe assembly: Section 23 0500.

B. Piping and valve identification: Section 23 0500.

C. Pipe hanging and equipment support: Section 23 0529.

1.3 REFERENCES.

A. ANSI

1. ANSI LC1: Fuel Gas Piping Systems Using Corrugated Stainless-Steel Tubing.
2. ANSI Z21.80: Line Pressure Regulators.
3. ANSI Z223.1/NFPA 54: National Fuel Gas Code.

B. ASME

1. ASME B1.20.1: Pipe Threads, General Purpose, Inch.
2. ASME B16.3: Malleable Iron Threaded Fittings: Classes 150 and 300.
3. ASME B16.5: Pipe Flanges and Flanged Fittings, NPS 1/2 through NPS 24 Metric/Inch Standard.
4. ASME B16.20: Metallic Gaskets for Pipe Flanges.
5. ASME B16.39: Malleable Iron Threaded Pipe Unions, 1111111Classes 150, 250, and 300.
6. ASME B18.2.1: Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

C. ASTM

1. ASTM A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A126: Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
3. ASTM A 234: Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
4. ASTM A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
5. ASTM B88: Standard Specification for Seamless Copper Water Tube.
6. ASTM B584: Standard Specification for Copper Alloy Sand Castings for General Applications.

7. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
8. ASTM D 2513: Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
9. ASTM D2657: Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
10. ASTM D 2683: Socket-Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
11. ASTM D 2774: Practice for Underground Installation of Thermoplastic Pressure Piping.
12. ASTM D 3261: Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Fittings.

D. AWS

1. AWS A5.8: Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1: Structural Welding Code Package for Steel and Aluminum.
3. AWS D10.12: Guide for Welding Mild Steel Pipe.

E. UL

1. UL 536: Standard for Flexible Metallic Hose

1.4 SUBMITTALS

A. Product data:

1. Pipe, fitting, and joining materials.
2. Manual gas shut-off valves.
3. Pressure regulators

a. Submit documentation showing that the regulator is suitable for the anticipated inlet pressure range, the required inlet pressure of the associated appliance, and the minimum and maximum gas flow rate of the associated appliance.
b. Submit any associated accessories including vent protectors and vent limiters.
c. Pressure regulators serving boilers and generators shall be submitted with that equipment, furnished by the boiler or generator manufacturer, and shall be selected by the boiler or generator manufacturer to serve the equipment based on the pressure inlet conditions at the site. Regulators shall meet the requirements of this specifications section.

B. Certifications: Test and approval of gas piping installation by the authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. UL label and local testing (if required): As specified in Section 23 0500, Common Work Results for HVAC.

D. Pipe shall be certified by the manufacturer to meet referenced standards and shall bear a label, directly on the pipe, indicating compliance.

1.6 REGULATORY REQUIREMENTS

A. Installation of gas piping shall meet requirements of the authority having jurisdiction, the gas supplier for gas service, and NFPA 54.

B. Upon completion of the work, the piping shall be tested as required by inspection authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

C. Protect stored PE pipes and valves from direct sunlight.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis-of-design products: Subject to compliance with requirements, provide specified or scheduled products, or comparable product by one of the following:

1. Manual gas shut-off valves:

a. Apollo Valves.
b. Milwaukee Valve Co.
c. Nibco.
d. Stockham Valve & Fittings.
e. Walworth Co.
f. Watts Regulator.

2. Pressure regulators:

a. American Meter Company.
b. Belgas.
c. Eclipse.
d. Equimeter.
e. Fisher Controls.
f. Itron
g. Maxitrol
h. Pietro Fiorentini.
i. Sensus.

2.2 ABOVE-GROUND PIPE AND FITTINGS

A. Pipe: ASTM A53, black steel, Schedule 40:

1. NPS 1.5 (DN 40) and smaller: Type F (continuous weld pipe).
2. NPS 2 (DN 50) and larger: Type E (electric resistance welded).

B. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.

C. Wrought-Steel Welding Fittings: ASTM A234 for butt welding and socket welding.

D. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

E. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Threaded or butt welding to match pipe.
3. Lapped Face: Not permitted underground.
4. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
5. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless-steel underground.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 degrees F (540 degrees C) complying with AWS A5.8. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUT-OFF VALVES

A. NPS 2 (DN 50) and smaller: Two-piece, standard or full port, bronze ball valves with bronze trim, MSS SP-110.

1. Body: Bronze, complying with ASTM B584.
2. Ball: Chrome-plated bronze.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE; blowout proof.
5. Packing: Threaded-body packnut design with adjustable-stem packing.
6. Ends: Threaded.
7. CWP Rating: 600 psig (4140 kPa).
8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural and LP gas service with "WOG" indicated on valve body.

B. NPS 2.5 (DN 65) through NPS 6 (DN150): Non-lubricated eccentric plug valves, MSS SP-78, UL Listed.

1. Body: Cast iron.
2. Plug: cast iron.
3. Stem Seal: Compatible with natural and LP gas.
4. Plug Seal: Resilient Nitrile-Butadiene (NBR)
5. Ends: flanged
6. Operator: Square head or lug type with lever handle.
7. Pressure rating: 175 psig (1208 kPa) WOG
8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural and LP gas service with "WOG" indicated on valve body.
10. Equal to SMG Key Port series 400 fig. 425.

C. NPS 2.5 (DN 65) through NPS 10 (DN 250): Cast iron ball valve, MSS SP-72.

1. Body: Epoxy-coated cast iron, ASTM A126, Class B.
2. Ball: cast iron / PFA (Teflon) fused or stainless steel.
3. Stem: Stainless steel, blow-out proof.
4. Stem seal: PTFE.
5. Seats and body seals: PTFE.
6. Plug Seal: Resilient Nitrile-Butadiene (NBR).
7. Ends: Flanged.
8. Operator: Lever handle.
9. Pressure rating: 200 psig (1380 kPa) WOG
10. Service: Suitable for natural and LP gas service with "WOG" indicated on valve body.
11. Equal to American Valve, Inc. Model 4000.

2.5 LINE PRESSURE REGULATORS

A. General: Regulators shall be selected to meet the following criteria at a minimum.

1. Provide required capacity at both the minimum and maximum expected inlet pressure.
2. Provide required outlet pressure.
3. React quickly enough to support a change from no flow to required flow upon startup.

B. Line pressure regulators with internal relief: Adjustable, comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum, with removable threaded cap to allow spring adjustment.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, direct-operated, regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure, or 5 inches w.g. (1.2 kPa) above design discharge pressure (whichever is greater) at shutoff.
9. Atmospheric vent: Threaded vent connection on the side of the diaphragm that communicates with the atmosphere.
10. Internal relief valve: The regulator shall incorporate an adjustable internal relief valve.

    a. The relief valve shall be set to vent excess pressure from the side of the diaphragm that communicates with the regulator discharge pressure to the side of the diaphragm that communicates with the atmosphere.
    b. If the discharge pressure exceeds the force of the set point spring of the relief valve, the diaphragm rises and opens the relief valve. Gas then flows from the discharge pressure side of the diaphragm to the side of the diaphragm that communicates with the atmosphere until the discharge gas pressure drops to the relief valve set point.
    c. The relief pressure must be set above the discharge set point pressure of the regulator, and below any appliance limit switch pressure which may cause nuisance trips for the appliance.

C. Line Pressure Regulators: Adjustable, comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum, with removable threaded cap to allow spring adjustment.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, direct-operated, regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure, or 5 inches w.g. (1.2 kPa) above design discharge pressure (whichever is greater) at shutoff.
9. Atmospheric vent: Threaded vent connection on the side of the diaphragm that communicates with the atmosphere.

PART 3 - EXECUTION

3.1 INSTALLATION GENERAL

A. Install piping as indicated on the drawings, in accordance with the regulations of the local authority and local gas utility company, and in accordance with installation and testing requirements of Section 23 0500.

B. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

C. Install piping free of sags and bends.

D. Install fittings for changes in direction and branch connections.

E. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

F. Take branches from horizontal runs from side or top of such runs. A tee shall be placed at the bottoms of risers in gas piping. Bottom of tee shall be provided with a six-inch-long nipple and cap the same size as riser. When riser is concealed, the cap shall project through wall to be accessible and shall be properly marked with engraved plastic nameplate, "DANGER, GAS, CLEANOUT". Red background with white letters.

G. Install pressure gage downstream from each service regulator.

H. Purge gas lines to equipment when the gas supply is turned on.

3.2 ABOVE-GROUND PIPING INSTALLATION

A. Indoor piping installation:

1. Joints:

   a. Provide welded or threaded joints for piping NPS 1.5 (DN 40) or smaller
   b. Provide welded joints for piping NPS 2 (DN 50) and larger.

2. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
3. Conceal pipe in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

4. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

5. Install exposed piping and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically otherwise indicated.
6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Drips and Sediment Traps: Install natural-gas piping at uniform grade down toward drip and sediment traps. Install drips at points where condensate may collect, including service-meter outlets.

    a. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
    b. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 6 inches (150 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

8. Install appropriate sleeves and seals for piping penetrations of building walls and slabs.

B. Outdoor piping installation:

1. Joints: Welded.

3.3 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

3.4 EQUIPMENT CONNECTIONS

A. General:

1. Install natural-gas piping electrically continuous, and bonded to equipment grounding conductor of the circuit powering the equipment according to NFPA 70. Do not use natural-gas piping as a grounding electrode.
2. Install piping adjacent to equipment to allow service and maintenance.
3. Connect piping to equipment using manual gas shutoff valves and unions. Install valve near each piece of equipment. Install union between valve and equipment. Unions are not required at flanged connections.

B. Emergency Generator:

1. Provide a line pressure regulator with internal relief where the service pressure is in excess of the appliance inlet pressure range.
2. Provide a minimum of 10 feet (3 meters) of gas piping between the regulator and the downstream equipment connection. Provide elbows and additional piping as needed to accommodate the required length. Provide the piping a minimum of two pipe sizes larger than the regulator outlet or equipment connection, whichever is larger, in order to create a reservoir of gas a minimize pressure fluctuations. Provide reducers and increasers as required.
3. Provide rigid piping connection.

3.5 MANUAL GAS SHUT-OFF VALVE INSTALLATION

A. Provide valves in branch lines as indicated on drawings.

B. Provide valves in each connection to equipment, adjacent to the equipment.

C. Provide a shut-off valve upstream at each regulator.

D. Install valves readily accessible for operation and maintenance, with ample clearance for turning wheel handles or operators.

E. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve. Unions are not required at flanged connections.

3.7 PRESSURE REGULATOR INSTALLATION

A. Provide a shut-off valve and a capped tee fitting suitable for connection to a pressure gauge upstream of each regulator.

B. Provide a tee fitting with a pressure gauge with associated shut-off valve approximately 10 pipe diameters downstream of each regulator.

C. Provide a union within one foot on either side of each regulator.

D. Provide each regulator’s vent connection, whether provided with the equipment served, part of an interior gas service regulators (including overpressure protection devices), or provided separately, with a termination as follows:

1. Exterior applications: Provide one of the following:

a. Vent pipe: Provide a vent pipe from the vent connection to a safe location outside of the building.
b. Vent protector: Provide a vent protector, listed for use with the regulator, to protect the vent connection from debris and moisture. Provide the regulator at an elevation and location not subject to flooding or snow cover.

2. Interior applications:

a. Gas service regulator or overpressure protection device: Provide a vent pipe from the vent connection to a safe location outside of the building.
b. Line pressure regulator with internal relief: Provide a vent pipe from the vent connection to a safe location outside of the building.
c. Line pressure regulator without internal relief: Provide one of the following:

1) Provide a vent pipe from the vent connection to a safe location outside of the building.
2) The Contractor may provide a vent limiter (listed for use in combination with the regulator) in lieu of vent piping where approved by the authority having jurisdiction, and where the manufacturer certifies that the regulator's reaction speed will function to adequately serve the associated equipment in conjunction with a vent limiter. Where a vent limiter is provided, the regulator must be installed in horizontal piping, with the regulator in a vertical orientation so the vent limiter is oriented vertically.

E. Regulator vent piping:

1. Material: Material shall be the same as above-grade gas piping.
2. Pipe size: Full size of regulator vent connection minimum. Increase the diameter of the vent pipe one pipe size for each 10 feet (3 meters) of length.
3. Termination: Provide vent piping in accordance with the regulations of the local authority and the local gas company. Terminate with a screened, turned-down elbow. Vents shall not terminate below any window, door, air intake, or opening to the building. Vents shall not terminate near a source of combustion. Vents shall not terminate where subject to flooding or snow cover.
4. Vent piping shall be dedicated to an individual regulator or safety device connection unless otherwise permitted by the local authority having jurisdiction and the local gas company.

F. Regulator performance verification:

1. Verify the proper springs are provided for the inlet and outlet pressures present.
2. Adjust the discharge pressure setting of each regulator.
3. Adjust the relief pressure setting of each relief device.
4. Observe appropriate discharge pressure control through startup, shut-down, and the entire firing range of the associated equipment.

3.8 LABELING AND IDENTIFYING

A. Comply with requirements in Section 23 0500 "Common Work Results for HVAC" for piping and valve identification.

3.9 PAINTING

A. Comply with requirements in Section 23 0500 "Common Work Results for HVAC" and Division 09 for painting interior and exterior natural-gas piping.

B. Prime and paint exposed interior piping OSHA yellow. Do not paint flexible connectors.

C. Prime and paint exterior above-grade piping, and valves, regulators, meters and piping specialties OSHA yellow. Do not paint flexible connectors.

END OF SECTION

SECTION 26 0101

ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General provisions and requirements for electrical work.

1.2 RELATED SECTIONS

A. Requirements of this section generally supplement requirements of Division 01.

1.3 REFERENCES

A. NFPA 10: Portable Fire Extinguishers.

B. NFPA 241: Safeguarding Construction, Alteration, and Demolition Operations.

1.4 SYSTEM DESCRIPTION

A. The full set of Contract Documents applies to work of Divisions 26 and 28.

B. Visit the site and study aspects of the project and working conditions, as required by General and Supplementary Conditions, Bidding and Contracting Requirements, Drawings, and Specifications. Verify field dimensions.

C. The work covered in technical sections includes the furnishing of labor, equipment and materials, and the performance of operations pertinent to the work described.

D. Except as required otherwise in Division 01, promptly obtain and pay for necessary signatures and paperwork, permits, fees and inspections required for work of this division by authorities having jurisdiction, including any utility connection or extension charge. No payment will be made until a copy of the permit is forwarded to the Owner.

E. Electrical work of this project includes, as a brief general description, the following:

1. Work shall be performed over two summer periods.
2. First summer work shall include the following:

    a. Provide conduits and raceways for new generator.
    b. Provide conduits and raceways for new devices and connections to existing equipment. Final connections to new devices and existing equipment shall be performed during the second summer.
    c. Provide new concrete pad for new generator.
    d. Connect lighting fixtures in toilet rooms on normal circuits to existing emergency lighting circuits, where indicated on drawings.

3. Second summer shall include the following:

    a. Provide new generator and associated equipment.
    b. Connect existing boilers and associated pumps to the new standby panelboard.
    c. Connect existing kitchen refrigeration equipment to new standby panelboard.
    d. Connect existing intercommunications/public address system to the new standby panelboard.

e. Connect existing main telecom room receptacles to the new standby panelboard.
f. Connect normal lighting fixtures in the main mechanical room/boiler room and main electrical room to the new emergency panelboard.
g. Connect lighting fixtures in toilet rooms on normal circuits to the new emergency panelboard, where indicated on drawings.

F. See Division 01 for requirements related to Owner's occupancy of the premises, limits on use of site, time restrictions on work, limits on utility outages or shutdowns, and phasing (sequencing) and scheduling.

1.5 PRODUCT OPTIONS

A. Except as modified by provisions of Bidding and Contracting Requirements and Division 01, these options apply to Division 26 and 28 specifications.

B. General: Where Contractor is permitted to use a product other than the specified item and model named as the basis of design, Contractor is responsible for coordination and additional costs as specified in article "Substitutions" below for substitutions.

C. Products specified by reference standards or by description only: Any product meeting those standards or description.

D. Products specified by naming one or more manufacturers, or model name or catalog reference number: Products specified establish a standard of quality, options to be included, and performance.

1. Where other acceptable manufacturers are named, Contractor may provide products of those named manufacturers only, which meet the specifications.
2. Where specification permits "equal" products, without naming other acceptable manufacturers, Contractor may use products of any manufacturer, which meet the specifications.

E. Products specified by naming one manufacturer and particular product, with no provision for other options: No options or substitutions allowed.

1.6 SUBSTITUTIONS

A. Substitutions will be considered only as permitted or required by the Bidding and Contracting Requirements and Division 01. Except as modified by those requirements, the requirements below apply to Division 26 and 28 specifications.

B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed substitution with contract documents.

D. A request constitutes a representation that the Bidder or Contractor:

1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
2. Will provide the same warranty for the substitution as for the specified product.
3. Will coordinate installation and make changes to other work which may be required for the work to be complete with no additional cost to Owner.
4. Waives claims for additional costs or time extension which may subsequently become apparent.

5. Will reimburse Owner for review or redesign services associated with re-approval by authorities.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

F. Substitution submittal procedure is specified in Bidding and Contracting Requirements and Division 01.

1.7 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be new and the best of their respective kinds, suitable for the conditions and duties imposed on them by the project, and of representative manufacturer. The description, characteristics and requirements of the materials to be used shall be in accordance with the specifications.

B. Equipment, construction and installation must meet requirements of local, state and federal governing codes.

C. Singular number: In cases where material, a device, or part of the equipment is referred to in the singular number in the specifications, it is intended that such reference shall apply to as many items of material, devices, or parts of the equipment as are required to complete the installation as shown on the drawings or required for proper operation of the system.

D. Terms have the following meanings:

1. Furnish: Supply item
2. Install: Mount and connect item
3. Provide: Furnish and install

E. Materials and equipment shall be installed and completed in a first class and workmanlike manner and in accordance with the best modern methods, practice and manufacturers' instructions. Any work which shall not present an orderly and neat or workmanlike appearance shall be removed and replaced with satisfactory work when so directed in writing by the Architect.

F. The specifications and drawings are intended to define the minimum requirements, as to quality of materials, construction, finish and overall workmanship.

G. General Conditions describe the correlation and intent of the Contract Documents. In case of discrepancies between the specifications and drawings, the specifications should be followed as to the general methods and principles and the drawings followed as to sizes, capacities and specifics for corresponding parts. If sizes are omitted, the Architect will determine sizes to be utilized.

H. In cases of doubt, uncertainty, or conflict as to the true meaning of the specifications or drawings, it is the responsibility of the Contractor to notify the Architect of said uncertainty, doubt, or conflict and obtain a decision as to the intent prior to initiating any work which may be affected by this decision.

1.8 COORDINATION

A. Should a situation develop during construction to prevent the proper installation of any equipment or item where shown on the drawings, call the situation to the attention of the Architect and await a written decision.

B. Plan and coordinate work to proceed in an orderly and continuous manner without undue delay, and in conformance with the project schedule. Submit samples, shop drawings, schedules, insurance policies and certificates, and the like in time to avoid delays in actual construction. Coordinate electrical work so that work of each trade is completed before other construction begins which would obstruct it.

C. Coordinate trades to ensure that proper clearances between work of the various trades allow access to items which require operation and maintenance.

D. Coordinate location and elevation of conduit, light fixtures, equipment, and appurtenances in such a manner that the finished installation is as indicated on drawings. In the event difficulties are encountered which prevent this, it is the Contractor's responsibility to bring this to the attention of the Architect prior to initiation of work. Correct improperly coordinated installation at no additional cost.

E. The Contractors' assistants shall include a competent electrical foreman, who shall be on the premises at all times to check, layout, coordinate and superintend the installation of work. The foreman shall establish basic requirements relative to the work before starting, and be responsible for the accuracy thereof.

1.9 SUBMITTALS

A. Manufacturers' and subcontractors' lists:

1. As specified in Division 01, submit a complete list of proposed manufacturers for equipment, materials and subcontractors used for the work of this division. Lists shall follow the sequence of the specifications. No considerations will be given for partial or incomplete lists. After review of lists, submit shop drawings and product data.

B. Shop drawings and product data:

1. Submit in accordance with the requirements of Division 01 or as established at the preconstruction conference, the required number of copies of Shop Drawings and Product Data for every item of equipment. Shop drawings or product data will not be considered until Manufacturers' Lists have been approved. Shop drawings and product data shall be submitted, as required by the General Conditions, with sufficient time for checking, return to Contractor, and resubmission as required before Contractor shall install any item.
2. Each item submitted shall be properly labeled, indicating the specific service for which the equipment or material is to be used, section and paragraph number of specification or drawing number to which it applies, Contractor's name and project name and number. Data submitted shall be specific and shall include product data and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents. Clearly identify each item within the data. Data of a general nature will not be accepted. Each sheet must clearly show the project name and number.
3. The review of a shop drawing or product data shall not be considered as a guarantee of the measurements or building conditions or that the shop drawings or product data have been checked to see that item submitted properly fits the building conditions. This review shall not relieve the Contractor of the responsibility for furnishing material or performing work as required by the contract documents, for correctness of dimensions and quantities, or for proper coordination of details and interfaces among trades.
4. Exclusively electrical items furnished as items associated with mechanical items but not specifically described in the mechanical item submission, shall be submitted as a separate submittal but shall be clearly marked as associated with the mechanical item by identified specification paragraph.
5. Product data sheets shall be 8.5-inches by 11-inches cut sheets for operating and maintenance manual.

C. Submit at least three copies of the results of every test required under any section in this division.

D. Specialist shall submit a list of at least three projects similar to this project in type, size, and quality, which have been in place and operating satisfactorily for at least five years.

1. Include project name, address, name and phone number of owner's representative, and project type and size.

E. After the work is completed, submit required certificates of approval from approved inspection agencies and authorities having jurisdiction over work of this division. Certificates of approval must be received by the Architect prior to final acceptance of the work.

1.10 SPECIALIST

A. The term "Specialist" as used in the specification shall mean an individual or firm of established reputation (or, if newly organized, whose personnel have previously established a reputation in the same field,) which is regularly engaged in, and which maintains a regular force of workers skilled in either (as applicable) manufacturing or fabricating items required by the contract, installing items required by the contract, or otherwise performing work required by the contract. Where the specification requires installation by a specialist, the term shall also be deemed to mean the manufacturer of the item, an individual or firm licensed by the manufacturer, or an individual or firm who will perform the work under the manufacturer's direct supervision.

1.11 CONTRACT CLOSEOUT SUBMITTALS

A. Project record documents:

1. Maintain on site one set of the following record documents; record actual revisions to the work of this division:

a. Contract Drawings.
b. Specifications.
c. Addenda.
d. Change Orders and other Modifications to the Contract.
e. Reviewed shop drawings, product data, and samples.

2. Maintain record documents separate from documents used for construction.
3. Record information concurrent with construction progress.
4. Specifications: Legibly mark and record in each section a description of actual products installed, including the following:

a. Manufacturer's name and product model and number.
b. Product options, substitutions, or alternates utilized.
c. Changes made by addenda and modifications.

5. Record documents and shop drawings: Legibly mark each item to record actual construction, including:

a. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the work.
b. Field changes of dimension and detail.
c. Details not on original Contract Drawings.

6. Submit documents as specified in Division 01.

B. Operation and maintenance data:

1. Submit sets prior to final inspection as specified in Division 01. Unless otherwise specified in Division 01, submit no fewer than three sets. In addition to requirements specified in Division 01, submit operating and maintenance manuals for the work of this division as specified below.
2. Prepare covers with printed title “OPERATION AND MAINTENANCE INSTRUCTIONS,” and title of project
3. Internally subdivide the contents with permanent page dividers, logically organized as described below.
4. Contents: Prepare a Table of Contents, with each product or system description identified.
5. Part 1: Directory, listing names, addresses, and telephone numbers of electrical engineers; contractor; electrical subcontractors; and major electrical equipment suppliers.
6. Part 2: Operation and maintenance instructions, arranged by specification section. For each category, identify names, addresses, and telephone numbers of subcontractors and suppliers. Identify the following:

    a. Significant design criteria.
    b. List of equipment.
    c. Parts list for each component, including recommended spare parts list.
    d. Operating instructions.
    e. Maintenance instructions for equipment and systems.
    f. Maintenance instructions for special finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.

7. Part 3: Project documents and certificates, including the following:

    a. Shop drawings and product data.
    b. Photocopies of certificates.
    c. Photocopies of warranties, guarantees, and bonds.
    d. Test reports: Copies of the results of tests required under sections of specifications.
    e. Photocopies of each panelboard circuit directory or directories for each panelboard provided, including panel name, panel location, panel ratings, spare circuit breakers and spaces for additional circuit breakers.

8. Submit one copy in final form 15 days prior to final inspection. This copy will be returned after final inspection, with Engineer comments. Revise content of documents as required prior to final submittal.
9. Submit final revised copy within ten days after final inspection.
10. Submit operation and maintenance data in electronic format using USB flash drive storage media.

1.12 REGULATORY REQUIREMENTS

A. When these specifications call for materials or construction of a better quality or larger sizes than required by the following codes and standards, the provisions of the specifications shall take precedence.

B. Provide, without extra charge, any additional materials and labor which may be required for compliance with these codes and standards even though the work is not mentioned in these specifications or shown on the contract drawings.

C. Perform the work of this division in strict accordance with the following authorities. The latest revision of these codes accepted by the authority having jurisdiction as of the date of the contract documents shall apply.

1. The electrical, building, fire, and safety codes of the state and county or city in which the work is being performed.
2. The National Electric Code, NFPA 70 (NEC).
3. The National Fire Protection Association Code (NFPA).
4. International Building Code (IBC).
5. International Energy Conservation, Fire, and Electrical Codes (ICC).

1.13 REFERENCE STANDARDS

A. Perform the work of this division using the standards of the following organizations, as referred to in technical sections, as a minimum requirement for construction and testing. Unless specified otherwise in Bidding and Contract Documents or Division 01, the latest revision current as of the date of the contract documents shall apply.

1. American National Standards Institute (ANSI)
2. American Society for Testing and Materials (ASTM)
3. International Code Council (ICC)
4. Institute of Electrical and Electronics Engineers (IEEE)
5. National Electrical Code (NEC) (NFPA 70)
6. National Electrical Manufacturer's Association (NEMA)
7. National Fire Protection Association (NFPA)
8. The Occupational Safety and Health Act (OSHA)
9. Underwriters Laboratory Inc. (UL)
10. American Association of State Highway and Transportation Officials (AASHTO)
11. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
12. Maryland Occupational Safety and Health Act (MOSHA)
13. Illuminating Engineering Society of North America (IESNA)

1.14 TEMPORARY STORAGE

A. Maintain upon premises, where directed, a storage area, and be responsible for contents within these areas. Provide security measures necessary for this area.

B. Area shall be maintained and shall be returned to original condition at the completion of the project.

C. Store electrical construction materials such as wire, raceways and boxes, devices, and equipment in buildings, enclosed trailers, or portable enclosed warehouses.

1. Materials and products subject to damage from moisture: Store in dry locations. If necessary, protect with protective wraps or covers.
2. Plastics and other materials and products subject to damage from heat or cold: Store at manufacturer's recommended temperatures.
3. Plastics and other materials and products subject to damage from sunlight: Protect from sunlight.

D. Electrical equipment such as motor controllers, panelboards and circuit breakers stored before installation and installed during construction: Provide clean, dry locations at manufacturer's recommended temperatures, and cover or wrap if required to protect from incidental damage.

1.15 PROTECTION

A. Control dust resulting from construction work to prevent its spread beyond the immediate work area, and to avoid creation of a nuisance.

1. Do not use water to control dust. Use drop cloths or other suitable barriers.

2. In areas where dirt or dust is produced as a result of the work, sweep daily, or more often as required.
3. Provide walk-off mats at entries and replace them at regular intervals.
4. Construct dust partitions, where indicated on the drawings or as required.
5. Protect areas occupied by Owner's personnel or equipment.

B. Each trade and subcontractor is responsible for preventing damage and soiling of work performed by other trades or subcontractors. Each trade and subcontractor is responsible for providing temporary protection of its own work.

1. Protect work from spills, splatters, drippings, adhesives, bitumens, mortars, paints, plasters, and damage from welding or burning.
2. Protect finished work from damage, defacement, staining, or scratching.
3. Protect finishes from cleaning agents, or grinding and finishing equipment.
4. Protect adjacent and finished work from damage, using tape, masking, covers or coatings and protective enclosures.
5. Coordinate installations and temporarily remove items to avoid damage from finishing work.

C. Repair damage or soiling to the complete satisfaction of the Architect; replace any materials or work damaged to such an extent that they cannot be restored to their original condition, at no addition to the Contract sum.

D. Protect work stored in place and supplies stored in the building.

1. Store materials and products, subject to damage from moisture, in dry locations. If necessary, protect in wraps or covers.
2. Store plastics, other materials, and products subject to damage from heat or cold at manufacturer's recommended temperatures.

E. Protect electrical materials and products from weather events and accidents of construction.

F. Use of sidewalk or roadway areas outside of the property lines shall be with permission and approval of the local authorities having jurisdiction.

1.16 FIRE PROTECTION

A. As a minimum, provide hand-carried, portable, UL-rated extinguishers with each work crew working inside the building.

B. Select extinguishers in accordance with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

1.17 PROJECT CONDITIONS

A. Drawings showing utilities in concealed locations are based on the best information available but are not represented as being precisely correct. Work of the contract includes digging, cutting, drilling, using nondestructive methods, and other methods of locating concealed utilities in the field, as well as patching and repairing as specified in "Cutting and Patching" below.

B. If, in the course of the work, workers encounter a material they suspect to present some hazard:

1. Promptly notify the Owner in writing.
2. Do not perform any work which would disturb the suspected material until written instructions have been received.

1.18 WARRANTY

A. Work and equipment provided as work of this division shall be fully warranted under the general project warranty. In addition, provide added special warranties as specified in individual sections.

B. During the correction period, the Contractor shall begin correcting any work found to be not in accordance with the requirements of the Contract Documents within 4-hours of receiving written notice from the Owner. Provide detailed schedule for completion of work within 24-hours of receiving written notice from the Owner and revise schedule based on any Owner comments generated. Except as otherwise required in General Conditions and Division 01, the correction period is one year after the date of substantial completion of the work. Work requiring correction shall promptly be repaired or completely replaced at no addition to the Contract Sum.

1. Service reports for warranty work shall be provided to the Owner.

C. When use of the permanent equipment has been permitted for temporary services during construction of the building, the warranty and correction periods shall nevertheless begin at the time of substantial completion, unless another date of acceptance has been agreed to by the Owner.

D. Special warranties are warranties required by individual specification sections, incidental product warranties, manufacturers' standard warranties, installer or subcontractor service agreements, and other individual warranties in addition to the general project warranty.

E. Provide copies of warranties as required for Operation and Maintenance Manual specified above, and by Division 01.

F. For items of work delayed beyond date of substantial completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

B. Cut walls, floors, partitions, roofs, and other appurtenances for the passage or accommodation of conduits. Close superfluous openings and remove debris caused by work of this division.

C. No cutting of any structure or finish shall be done until the condition requiring such cutting has been examined and approved by the Architect.

D. New or existing surfaces disturbed as a result of such cutting or otherwise damaged shall be restored to match original work and materials used for any patching or mending shall conform to the class of materials originally installed.

E. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

3.2 TEMPORARY FACILITIES

A. Temporary water facilities, electricity, telephone, toilet facilities, and temporary heat, shall be provided as specified in Division 01.

3.3 PROGRESS MEETINGS

A. Progress meetings shall be held as specified in Division 01, and also when and if the Contractor or Engineer finds them necessary or advantageous to progress of work.

B. Contractor, those subcontractors and those material suppliers concerned with current progress or with the scheduling of future progress, Architect and Owner shall each be represented at these meetings by persons familiar with the details of work and authorized to conclude matters relating to work progress.

END OF SECTION

SECTION 26 0500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements applicable to work of more than one section of Division 26.

B. Basic materials and equipment required for electrical work.

C. Date sensitive equipment.

D. Operating instructions.

E. Testing wiring systems.

1.2 RELATED SECTIONS

A. Project and special warranties: Division 01 and Section 26 0101.

B. Operation and Maintenance Manuals: Division 01 and Section 26 0101.

1.3 DEFINITIONS

A. Project correction period: A period after Substantial Completion of the work during which the Contractor shall correct every part of the work found to be not in accordance with the requirements of the contract documents, promptly after receipt of written notice.

B. Qualified testing agency: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual sections; and where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

1.4 DESIGN REQUIREMENTS

A. The drawings and system performances have been designed on the basis of using the particular manufacturers' products specified and scheduled on the drawings.
B. Products of other manufacturers that are listed under the article "Acceptable Manufacturers," or permitted as "equal," are permitted provided:

1. Product shall meet the specifications.
2. Contractor shall make, without addition to the contract sum, all adjustments for deviations so that the final installation is complete and functions as the design basis product is intended.

C. Do not propose products with dimensions or other characteristics different from the design basis product that make their use impractical or cause functional fit, access, or connection problems.

1.5 QUALITY ASSURANCE

A. Provide materials and perform work in accordance with the electrical, building, fire, and safety codes and regulations of the state, county, or city in which the work is performed.

B. Electrical control panels, equipment, materials and devices provided or installed as work of Division 26 shall bear UL label, or, if UL label is not available, the item shall be tested and labeled by a qualified testing agency, acceptable to authorities having jurisdiction, and in accordance with NFPA 70. Provide testing, if required, without addition to the contract sum.

C. Qualifications of DVD documentation technician: For video documentation specified in "Operating Instructions (Demonstration)," employ persons knowledgeable in DVD optical storage media for video and audio production and editing.

D. VOC content: Field-applied adhesives and sealants, limits per South Coast Air Quality Management District (SCAQMD), Rule No. 1168.

E. Products shall contain no urea-formaldehyde content.

PART 2 - PRODUCTS

2.1 GENERAL

A. Techniques, testing, and operating instructions specified in this section apply to products specified in other sections of Division 26.

B. Equipment that uses or processes date and time data in order to perform its function shall be warranted by the manufacturer to properly function and correctly use or process all time-related data for all dates and times which occur during a reasonable life expectancy of the equipment.

2.2 MATERIALS

A. Electrical equipment backing panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated in accordance with AWPA C27, in thickness indicated, not less than 0.5 inch (13 mm) nominal.

1. One side finished.

B. Wood-preservative-treated lumber: Treated by pressure process, AWPA C2, with chemicals acceptable to authorities having jurisdiction, and marked with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. Application: Treat items indicated on the drawings, and the following:

a. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, or waterproofing.
b. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.
c. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
d. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
e. Wood floor plates that are installed over concrete slabs-on-grade.

C. Aircraft cable: 0.25-inch (6-mm) steel wire rope, galvanized, construction 7 by 19 strands, minimum 7000 lbs (31138 N) breaking strength.

2.3 DATE-SENSITIVE EQUIPMENT

A. Date-sensitive equipment: Systems, equipment, or components which use or process date and time data in order to perform their functions.

B. Each item of date-sensitive equipment used in the project shall be warranted by the manufacturer to properly function and correctly use or process all time-related data for all dates and times which occur during a reasonable life expectancy of the equipment.

PART 3 - EXECUTION

3.1 GENERAL

A. Manufacturers' instructions: Except as modified by drawings or specifications, install products and equipment in accordance with manufacturers' instructions and recommendations applicable to the project conditions.

1. Immediately notify Engineer if a difference or discrepancy is found between manufacturers' instructions and the drawings or specifications.

B. The contract drawings are diagrammatic, and do not indicate all fittings or offsets in conduit or all pull boxes, access panels, or other specialties required. Provide required fittings, offsets, access panels, and specialties to coordinate the work.

C. No conduit shall be run below the head of a window or door.

D. Equipment and conduits installed in areas without a suspended ceiling shall be as tight to structure as possible, but at least above a height of 6'-8", unless otherwise noted.

E. Items which require access for operation or maintenance shall be easily accessible. Do not cut or form hand holes for operation or maintenance of appliances through walls or ceilings.

3.2 INSTALLATION OF PRODUCTS AND EQUIPMENT

A. Install conduit exposed to view parallel with the lines of the building and as close to walls, columns, and ceilings as may be practical, maintaining adequate clearance for access at parts requiring servicing.

B. Install conduit a sufficient distance from other work to permit a clearance of not less than 0.5 inch (13 mm) between its finished covering and adjacent work.

C. Pull boxes and other appurtenances which require operation or maintenance shall be easily accessible. Do not cut or form handholes for operation or maintenance of appliances through walls or ceilings.

D. Install plywood backing panels with finished face exposed.

3.3 OPERATING INSTRUCTIONS (DEMONSTRATION)

A. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project for one 8-hour day.

B. Where specified in technical sections, provide longer periods required for specialized equipment.

C. Instruct the Owner or designated personnel in operation, maintenance, lubrication, and adjustment of systems and equipment.

1. Instructions by manufacturer's technical representative for each type of equipment shall include the performance of the recommended preventive maintenance procedures for that equipment.

D. The Operating and Maintenance Manual shall be available at the time of the instructions for use by instructors and Owner personnel.

E. Record each instruction session only in DVD media format (video and audio format), including both the sessions specified above and added sessions required in technical sections for specialized equipment. Provide one complete set of DVDs with each Operating and Maintenance Manual.

F. Schedule the general and specialized instruction periods for a time agreed upon by the Owner and Engineer.

3.4 TESTS

A. During the progress of the work and after completion, test the branch circuits and distribution system, and the low-voltage alarm and signal systems.

B. Results of the tests shall show that the wiring meets the requirements of this specification. Should any test indicate defect in materials or workmanship, immediately repair, or replace with new, the faulty installation, and retest the affected portions of the work.

C. Furnish equipment and instruments necessary for testing.

D. Tests shall demonstrate the following:

1. Lighting, power, and control circuits are continuous and free from short circuits.
2. Circuits are free from unspecified grounds.
3. The resistance to ground of each non-grounded circuit is not less than one megohm.
4. Circuits are properly connected in accordance with the applicable wiring diagrams.
5. Circuits are operable. Demonstration shall include functioning of each control not less than ten times, and continuous operation of each lighting and power circuit for not less than 0.5 hour.

E. Test circuit breakers larger than 100 amps at full voltage.

F. Make voltage built-up tests with a voltage sufficient to determine that no short circuits exist.

G. Immediately repair defects and retest until systems are operating correctly.

H. Submit test reports.

END OF SECTION

SECTION 26 0501

EXCAVATION AND FILL FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Trenching, backfilling, and compacting for electrical work underground inside the building and extending five feet beyond exterior building walls, and outside the building as shown on drawings.

B. Restoring and reseeding grassed areas.

1.2 RELATED SECTIONS

A. Cutting and patching: Division 01 and Section 26 0101.

B. Underground electrical ductbanks: Section 26 0544.

C. Conduit: Section 26 0533.

D. Identification for electrical systems: Section 26 0553.

1.3 REFERENCES

A. ASTM D 1557: Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbs/cu ft (2700 kN-m/cu m)).

1.4 SUBMITTALS

A. Product data: Seed and mulch.

B. Certifications: Test reports showing that compaction meets specified requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill: Earth materials, free from perceptible amounts of wood, debris, or topsoil, free of frost at the time of placement, and not containing marl or other elements which tend to stay in a plastic state.

B. Grass seed: Fresh new-crop seed, 90 percent pure and 85 percent germination.
Mix: 70 percent Kentucky Bluegrass, 25 percent Red Fescue and 5 percent Red Top.
Only strains of Kentucky Bluegrass found adaptable to Maryland shall be acceptable.

C. Mulch: Free of sticks, weeds, or other foreign matter; either licorice root, tan root, or tan bark; fibrous by-product of extraction. Use only one type throughout the project.

2.2 EQUIPMENT

A. Mechanical tampers for compacting backfill: Capable of exerting a blow equal to 250 pounds per square foot (12 kPa) of area of the tamping face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Contact local utility company underground information service (Miss Utility) before beginning excavation outside buildings.

B. The general locations of underground utilities are indicated on the drawings and are not to be assumed to be accurate or complete. Before beginning work, field check the area with the most accurate instruments available, such as Fisher Labs' Pipe and Cable Locators.

3.2 INSTALLATION

A. Perform all excavating, cutting of paved areas, trenching, sheeting, shoring, backfilling, and compacting required for the proper installation of the work.

B. Where obstructions are encountered, obtain written approval and make necessary changes in line, grade or location.

C. Protect existing utilities from damage during excavation and backfilling. Repair damaged new or existing work at no addition to the contract sum. Bracing, shoring and other protection of existing utilities is part of this work.

D. Do not damage or remove existing shrubs or trees including their root systems, without prior notification to the Engineer.

E. Provide temporary roadways over trenches with railings and other safeguards, including amber blinker lamps or other warnings for night use.

F. Note the depths of footings. In cases where conduit is in close proximity to or below footings and where the natural earth under footings is disturbed, after the line is installed, the voids shall be filled up to bottoms of such footings with solid concrete.

3.3 CUTTING

A. Cut concrete and asphalt concrete with masonry saw prior to breaking it into smaller pieces for removal.

B. Cut sidewalks perpendicular to the length at the closest existing joint that is a minimum of 24 inches back from either side of the top of the new trench.

3.4 TRENCHING

A. Excavations inside the building shall be carefully planned. Stockpile excavated earth so as not to interfere with other construction. Dig trenches to the proper depths, providing extra depressions where required for hubs of pipes.

B. Excavations outside the building shall generally follow the routes indicated on the drawings. Stockpile topsoil separately for later replacement. Excavations shall be of sufficient depths to provide, unless indicated otherwise on the drawings, a minimum cover as follows:

1. Electrical conduit: Depth required by NFPA 70 (NEC).

C. Trenches shall be of necessary depth and width for the proper laying of conduit with a minimum of 8 inches (205 mm) on each side of the joint.

1. The sides shall be as nearly vertical as practicable. Unless local regulations are stricter, trenches 4 ft. (1220 mm) and deeper shall have shored sides as required by OSHA trenching regulations.
2. The bottoms of trenches shall be accurately graded to provide uniform bearing and support for each section of conduit on undisturbed soil at every point along its entire length, except for bell holes.
3. No greater length of trench shall be left open, in advance of the completed structure placed in it, than can be completed in that day's operation.
4. Except where rock is encountered, do not excavate below the depths required. Where rock excavation is required, excavate to a depth of at least 6 inches (150 mm) below the trench depth and fill the overdepth with compacted crusher run or bank run stone or sand. Unauthorized overdepths in excavation shall be backfilled with crushed stone, slag, or gravel, thoroughly compacted.
5. Whenever wet or otherwise unstable soil is encountered, it shall be removed to the depth and extent directed, and the trench backfilled to the proper grade with crushed stone, slag, or gravel.

D. Should springs be encountered within the work area, or soft soil conditions at the elevations required for load bearing, immediately notify the Engineer and do not place any portion of the work on such surfaces until instructions are received.

E. Furnish and maintain pumps, flumes, gutters, and appurtenances if required to keep the excavations free from water. Water shall be directed to a point remote from building operations, shown on the approved shop drawing.

3.5 BACKFILL

A. Place no backfill until the adjacent construction or the utility to be covered has been inspected, tested, and approved.

B. Installing underground warning tape: Install in backfill above exterior buried lines not encased in concrete. Select legend and color appropriate for type of line. Install metallic lined tape for non-metallic lines. Install approximately 12 inches (305 mm) below grade.

C. Electrical systems backfill:

1. Backfill and compact in 8-inch (200-mm) layers, to level finished grade with the excavated materials approved for backfilling.
2. Surplus earth shall be mounded up on excavation and left to settle. When directed by the Engineer, surplus earth shall be removed and excavations leveled off to proper grade. Where direct burial cables are placed in trenches, first cover the cables with clean earth.

D. Structure backfill:

1. Do not backfill against structures with cement mortar joints until the mortar is at least twelve hours old.

3.6 COMPACTION

A. Test in accordance with the requirements of ASTM D 1557.

B. Compact under slabs, roads, and sidewalks to a 95 percent density.

C. Compact unpaved areas to a 90 percent density.

D. Backfill and compact trench in unpaved areas to within 4 inches (102 mm) of existing grade. Furnish and install compacted select topsoil for the final layer to finish even with existing grade. Remove surplus earth and rake unpaved areas for final planting.

E. Take particular care in compaction of earth under joints of mechanical piping.

3.7 SEEDING

A. Seed disturbed grass areas at the rate of 5 pounds (2.27 kg) per 1000 sq. ft. (92.9 sq. m), with the seed mix specified.

B. Uniformly distribute seed with an approved machine to ensure a covering of plus or minus 1/4 inch (6 mm). Sow half of the seed in one direction and the rest at right angles.

C. Do not seed during windy weather or when ground is wet or otherwise untillable. Seed between the dates of March 1st to May 1st or August 15 to October 15 unless otherwise approved in writing.

3.8 MULCHING

A. Mulch seeded areas immediately following seeding with fibrous mulch evenly applied at an average rate of 2 tons per acre (4483 kg per hectare) so as to provide a loose depth of not less than 2 inches (50 mm).

B. Wet down mulch, unless a heavy rain wets it, to the Engineer's satisfaction, immediately after application.

3.9 RESURFACING

A. Resurface sidewalks, roads, streets, and other paved areas as work of this section, matching the construction and finish of adjacent paving.

END OF SECTION

SECTION 26 0504

ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Extent and location of demolition are shown on the drawings.

1.2 RELATED SECTIONS

A. Demolition: Division 02.

1.3 REFERENCES

A. EPA 40 CFR 273: Environmental Protection Agency; Code of Federal Regulations; Title 40 - Protection of Environment; Standards for Universal Waste Management.

1.4 DEFINITIONS

A. EPA: Environmental Protection Agency.

1.5 QUALITY ASSURANCE

A. Demolition shall be carried out as expeditiously as possible, in accordance with accepted practice and applicable building code provisions.

1.6 PROJECT CONDITIONS

A. If, in the course of the work, workers unexpectedly encounter a material not identified for special removal but which they suspect to be asbestos, to contain lead or PCBs, or to present some other hazard:

1. Promptly notify the Owner and Engineer in writing.
2. Do not perform any work which would disturb the suspected material until written instructions have been received.

B. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

C. Locate, identify, and protect mechanical and electrical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect existing building and equipment that is to remain, particularly to prevent entry of either dust or water. Ensure weathertightness at all times. Keep materials on hand to patch and maintain protection.

3.2 DEMOLITION

A. Comply with demolition and disposal requirements of Division 02.

B. Perform removal work neatly with the least possible disturbance to the building.

C. Provide temporary barriers, danger signals, and appurtenances for protection of personnel and equipment during removal operations.

D. Demolish, remove, demount, and disconnect inactive and obsolete conduit, fittings and specialties, equipment, and fixtures.

1. Conduit and ducts embedded in floors, walls, and ceilings may be abandoned in place if they do not interfere with new installations. Cut back to at least one inch below finished surface.
2. Remove materials above accessible ceilings.
3. Disconnect and cap items to remain behind finished surfaces.
4. Patch and repair surface materials as required in Division 01 and Section 26 0101 article, “Cutting and Patching.”

E. Remove the anchors, bolts, and fasteners associated with conduit and equipment to be removed.

3.3 DISPOSAL

A. Dispose of equipment and materials removed, and rubbish and waste material, as work progresses. Do not allow demolition debris to accumulate on site. Remove products of demolition from the building daily.

END OF SECTION

SECTION 26 0507

FIRESTOPPING FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Through-penetration firestopping in fire-rated construction.

B. Through-penetration smoke-stopping in smoke partitions.

1.2 RELATED SECTIONS

A. Conduit: Section 26 0533.

1.3 REFERENCES

A. Underwriters Laboratories

1. UL Fire Resistance Directory
2. UL 1479: Through Penetration Firestops.

B. American Society for Testing and Materials Standards:

1. ASTM E 814: Standard Test Method for Fire Tests of Through-Penetration Firestops.

1.4 DEFINITIONS

A. Assembly: Particular arrangement of materials specific to given type of construction described in referenced documents.

B. Barriers: Time-rated fire walls, smoke barrier walls, time-rated ceiling/floor assemblies and structural floors.

C. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses and smoke.

D. Penetration: Opening or foreign materials passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.

E. Sleeve: Metal fabrication or pipe section extending through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.

F. System: Specific products and applications, classified and numbered by the rating agency to close specific barrier penetrations.

1.5 SYSTEM DESCRIPTION

A. Design requirements:

1. Fire-rated construction: Maintain barrier and structural floor fire resistant ratings including resistance to cold smoke at all penetrations.

2. Smoke barrier construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations.

1.6 SUBMITTALS

A. Product data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.
2. Manufacturer's installation instructions.

B. Shop drawings: Submit firestop assemblies and devices for all openings and through penetrations in fire-rated construction. Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, plus the following specific requirements.

1. Details of each proposed assembly identifying intended products and applicable rating agency classification.
2. Manufacturer or manufacturer's representative shall provide qualified engineering judgments and drawings relating to conditions where rated assemblies do not exist.

C. Quality control submittals:

1. Statement of qualifications.

D. Certifications: Letters or forms showing acceptance by local authorities for systems without acceptance by a rating agency.

1.7 QUALITY ASSURANCE

A. Products and assemblies shall be tested and labeled by an independent, nationally recognized testing and labeling authority.

B. Installer's qualification: Firm experienced in installation or application of systems similar in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer, state, or local authority where applicable.
2. At least 2 years' experience with systems.
3. Successfully completed at least 5 projects of comparable scale, using these systems.

C. Local and state regulatory requirements: Obtain acceptance for proposed assemblies not conforming to specific rating agency classifications or rated assemblies.

D. Materials shall have been tested to provide fire rating at least equal to that of the construction in which they are to be installed.

E. VOC content: Field-applied adhesives and sealants, limits per South Coast Air Quality Management District (SCAQMD), Rule No. 1168.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:

1. Deliver products in original unopened packaging with legible manufacturer's identification.
2. Coordinate delivery with scheduled installation date, allow minimum storage at site.

B. Storage and protection: Store materials in a clean, dry, ventilated location. Protect from soiling, abuse, moisture and freezing when required. Follow manufacturer's instructions.

1.9 PROJECT CONDITIONS

A. Existing conditions:

1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

B. Environmental requirements:

1. Furnish adequate ventilation if using solvent.
2. Furnish forced-air ventilation during installation if required by manufacturer.
3. Keep flammable materials away from sparks or flame.
4. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.
5. Comply with manufacturing recommendations for temperature and humidity conditions before, during and after installation of firestopping.

1.10 WARRANTY

A. General project warranty and correction period, as required in general conditions and Division 01, requires repair or replacement of materials or systems which fail in joint adhesion, co-adhesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers and products: Those listed in the UL Fire Resistance Directory for the UL System involved, or rated for the application by Warnock Hersey or by another acceptable rating agency.

2.2 THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

A. Provide systems or devices listed and labeled by a rating agency, and conforming to the construction type, penetrant type, annular space requirements and fire rating involved in each separate instance. The system shall be symmetrical for wall applications. Systems or devices shall be asbestos-free.

1. Additional requirements: Firestopping shall withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the rated system or device, and designed to perform this function.
2. Additional requirements: Firestopping sealants shall be red in color to facilitate field verification of firestopping application.

2.3 SMOKE-STOPPING AT SMOKE PARTITIONS

A. Through-penetration smoke-stopping: Any system complying with the requirements for through-penetration firestopping in fire-rated construction is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.

2.4 ACCESSORIES

A. Fill, void or cavity materials and forming materials: Classified for firestopping use, or included in a rated firestopping assembly, by a rating agency.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify barrier penetrations are properly sized and in suitable condition for application of materials.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.3 INSTALLATION

A. Provide firestop devices or assemblies for every opening and penetration in floors or fire-rated construction.

B. Install penetration seal materials in accordance with printed instructions of the rating agency and in accordance with manufacturer’s instruction.

C. Ensure an effective smoke barrier in each sealed penetration. Install smoke stopping as specified for firestopping.

D. Protect materials from damage on surfaces subject to traffic.

E. Where large openings are created in walls or floors to permit installation of conduits, cables, or other items, close unused portions of opening with firestopping material tested for the application.

3.4 FIELD QUALITY CONTROL

A. Examine penetration seals to ensure proper installation before concealing or enclosing them.

B. Keep areas of work accessible until inspection and acceptance by applicable authorities.

C. Before substantial completion, patch and repair firestopping cut or penetrated by other construction work.

3.5 ADJUSTING AND CLEANING

A. Clean up spills of liquid components.

B. Neatly cut and trim materials as required.

C. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

END OF SECTION

SECTION 26 0519

WIRES AND CABLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wires and cables rated 600 volts and less.

B. Type MC as permitted in Part 3.

1.2 RELATED SECTIONS

A. Underground ducts: Section 26 0544.

B. Conduits: Section 26 0533.

C. Surface metal raceways: Section 26 0535.

D. Fire Detection and Alarm System: Division 28.

1.3 REFERENCES

A. ANSI/NEMA WC 70: Power Cables rated 2000 Volts or Less for Distribution of Electrical Energy.

B. ASTM B3: Standard Specification for Soft or Annealed Copper Wire.

C. ASTM B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors.

D. UL 44: Standard for Thermoset-Insulated Wires and Cables.

E. UL 83: Standard for Thermoplastic-Insulated Wires and Cables.

F. Additional UL Standards as indicated.

1.4 SUBMITTALS

A. Product data:

1. Each type of wire and cable, including accessories.
2. Include copies of UL certifications showing compliance with requirements in “Quality Assurance” below.

B. Product schedule: Provide schedule or detailed statement on use of wires and cables. Indicate wire or cable type, product use, and representative location(s).

1. Identify proposed use of wire or cable types in locations not specifically listed in specifications or on drawings.

1.5 QUALITY ASSURANCE

A. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70 Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Products and installation shall comply with NFPA 70 and other applicable national, state, and local electrical codes.

1.6 DELIVERY, STORAGE, AND HANDLING

A. General requirements: Deliver, store, and handle wire and cable in accordance with the manufacturer's instructions.

1. Wire and cable shall be packaged in a manner that protects them during ordinary handling and shipping. Ship from manufacturer with ends temporarily sealed against moisture.
2. Protect wire and cable during storage (both onsite and offsite).

a. Store in a clean and dry location. Elevate from surfaces where water can accumulate, and cover cable rolls to protect against weather.

3. Handle wire and cable as recommended by the manufacturer. Do not pull from the center or periphery of the cable reel.
4. Damaged wire and cable shall be removed from the project site.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE (600 volts maximum)

A. Conductors: UL listed and NEMA WC 70 compliant; Copper, 98 percent conductivity, suitable for 600-volt duty; rated 90-degree Celsius temperature for wet/dry applications; solid bare annealed copper for No. 10 and smaller complying with ASTM B 3, and stranded for No. 8 and larger complying with ASTM B 8.

B. Conductor insulation: Type THHN / THWN-2: Comply with UL 83; PVC insulation, nylon jacket.

C. Conductor identification: Markings along outer braid denoting conductor size, voltage classification, type of insulation, and manufacturer's trade name, and color code. Identification shall extend to branch circuits and outlets. Use the color coding system tabulated below throughout the building's network of feeders and circuits, unless otherwise required by the authority having jurisdiction.

1. Colors on conductors No. 10 and smaller, or No. 6 and smaller for grounded and grounding conductors: Solid colored insulation.
2. Colors on conductors No. 8 and larger, or No. 4 and larger grounded and grounding conductors: Colored tape wrapped a minimum of 6 inches (150 mm) on either end of conductor.

COLOR CODE (600 volts maximum)				
VOLTAGE	NEUTRAL	PHASE		
		A	B	C
120 volts, 2-wire	White	Black, Red, or Blue depending on phase		
277 volts, 2-wire	Gray	Brown, Orange, or Yellow depending on phase		
208 volts, single-phase, 2-wire		Black/Red, Red/Blue, or Blue/Black		
208/120 volts wye, 3-phase, 4-wire	White	Black	Red	Blue
480/277 volts wye, 3-phase, 4-wire	Gray	Brown	Orange	Yellow
480 volts delta, 3-phase, 3-wire		Brown	Orange	Yellow

D. Wires used solely for grounding purposes shall be green, where insulated.

E. Control wiring shall be coded with colors different from those used to designate phase wires.

2.2 WIRING ACCESSORIES

A. Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service where installed.

B. Twist-on wire connectors (dry locations):

1. Color-keyed.
2. Basis of design: Ideal Industries, Inc., Wingnut®, 3M Company "Scotchlok", or King Innovation.

C. Twist-on wire connectors (damp and wet locations):

1. Connectors shall be listed under UL 486D.
2. Basis of design: Ideal Industries, Inc., UnderGround®, models 60, 64, or 66 as appropriate; King Innovation DryConn®; or 3M Company.

D. Compression connectors:

1. Color-keyed.
2. Basis of design: 3M Company "Scotchlok"™ compressor connectors, "10000" series for copper conductors, "20000" series for aluminum conductors, or Thomas & Betts (Blackburn) or Ilsco.

E. Compression connectors (damp and wet locations):

1. Protect connectors with a waterproof system, UL-listed for direct burial and 600 volts.
2. Basis of design: 3M Company 8420 series, Thomas & Betts Model DBSK82, or Ilsco.

F. Compression taps:

1. Series CT-2 tap with CT-2C cover, or Series 54710 color-keyed compression taps,
2. Basis of design: Burndy Corporation "Versitap" or OZ/Gedney.

G. Power distribution blocks:

1. Basis of design: Hubbell Burndy “U-Blok.”

H. Multi-tap connectors, clear insulated:

1. Basis of design: Burndy Corporation "UNITAP" or Ilsco "Cleartap".

2.3 UNDERGROUND CONDUCTORS

A. Underground cable, Type THHN / THWN-2: Single-conductor, underground cable.

1. Cable: UL 83 listed; NEMA WC 70 construction; 600-volt, single-conductor. Solid copper No. 10 and smaller, stranded copper No. 8 and larger; and with PVC and nylon jacket insulation.

2.4 METAL-CLAD CABLE, TYPE MC

A. Cable: UL 83 and UL 1569 listed; 600-volt, single- or multi-circuit Type MC Cable, multi-conductor with ground conductor; aluminum or steel interlocked armor.

B. Conductors: Solid copper No. 10 and smaller, and stranded copper No. 8 and larger; conforming to ASTM B 3 or B 8.

C. Conductor Insulation: Type THHN/THWN insulated single conductors including ground conductor.

D. Fittings:

1. UL 514B listed, steel or malleable iron fittings. Zinc die-cast fittings shall not be acceptable.

PART 3 - EXECUTION

3.1 VERIFICATION OF CONDITIONS

A. Where aluminum conductors are proposed for feeders to equipment, verify with the manufacturer of the approved equipment, before beginning feeder installation, that aluminum wiring is compatible. Where aluminum is not compatible with equipment, provide copper wiring.

3.2 INSTALLATION, GENERAL

A. Provide wire and cable indicated in accordance with national, state, and local electrical codes.

B. Conceal wire and cable in new construction and in locations with finished walls, ceilings, and floors unless otherwise noted on drawings.

C. Wire and cable serving systems over 100 volts shall be installed in raceways, except where otherwise noted on drawings.

D. Wire and cable serving systems rated below 100 volts shall be installed in raceways, except where otherwise noted in individual specification sections. Refer to paragraph “INSTALLING CABLE RATED BELOW 100 VOLTS” below for additional information.

3.3 INSTALLING INTERIOR WIRING

A. Sizes: Minimum sizes shall be as follows, unless a larger size is indicated on the drawings.

1. 120-volt branch circuits:

a. Homerun from first outlet to panel: No. 12 when run is 50 feet (15,000 mm) or less; No. 10 when run is between 50 feet (15,000 mm) and 100 feet (30,000 mm); No. 8 when run is more than 100 feet (30,000 mm).
b. First outlet to other outlets: No. 12.

2. Exit light and emergency lighting circuits: No. 10. Do not install in raceways, outlet boxes, or other locations with non-emergency wiring systems.
3. Other systems (over 100-volts): Minimum No. 12 unless specified or shown on drawings to be smaller.

B. Wiring methods and locations: Wires and cables shall be installed based on the following requirements, unless otherwise noted.

1. Feeders: Type THHN / THWN-2, single conductors in raceway.
2. Branch circuits, concealed in ceilings, walls, and partitions:

a. Unless otherwise indicated, utilize Type THHN / THWN-2, single conductors in raceway.
b. Metal-clad cable, Type MC cable - Refer to section “INSTALLING MC CABLE” below for acceptable locations.

3. Branch circuits, exposed: Type THHN / THWN-2, single conductors in raceway.
4. All other applications: Provide Type THHN / THWN-2, single conductors in raceway.

C. Splicing shall be done in outlet boxes and junction boxes and not in conduit.

1. Conductors No. 8 and larger: Terminated, spliced and taped, wherever practical, with compression connectors or solderless connectors. Use tools recommended by the manufacturer.
2. Splices in conductors No. 10 and smaller, including lighting fixtures: Made with wire connectors.
3. Taps in conductors No. 6 and larger: Made with compression taps or power distribution blocks.

D. Wiring in high ambient temperature areas shall be of types required by NFPA 70 including over boilers and breechings, and fixture channels.

E. Wires shall be neatly shaped in panels, wireways, boxes, and appurtenances.

3.4 COORDINATION WITH DEVICES AND EQUIPMENT

A. Where conductor size or parallel conductors shown on drawings connect to terminals on devices or equipment which is not sized for the connection:

1. Provide a junction box as near the equipment as possible, but no more than 10 feet (3 m) away. Obtain approval of location before installing.
2. Provide conductor(s) sized to the ampacity of the equipment, from equipment to junction box.
3. In the junction box, splice the conductors from the equipment to the conductors of sizes, or parallel conductors, shown on the drawings.

3.5 INSTALLING EXTERIOR WIRING

A. Wiring methods and locations: Wires and cables shall be installed based on the following requirements, unless otherwise noted.

1. Feeders and branch circuits, exposed: Type THHN / THWN-2, single conductors in raceway.
2. Feeders and branch circuits, underground: Type THHN / THWN-2, single conductors in raceway.

B. Splicing shall be done in outlet boxes and junction boxes and not in conduit. Treat these boxes as wet locations.

1. Conductors No. 8 and larger: Terminated, spliced and taped, wherever practical, with compression connectors. Use tools recommended by the manufacturer.
2. Splices in conductors No. 10 and smaller, including lighting fixtures: Made with wire connectors.
3. Taps in conductors No. 6 and larger: Made with compression taps or power distribution blocks.

3.6 INSTALLING CABLE RATED BELOW 100 VOLTS

A. Install in raceway, unless otherwise indicated in individual specification sections.

B. Where individual specification sections allow cable to be installed either in raceway or on J-hooks, install as follows:

1. Wiring method:

    a. Wiring in walls, above inaccessible ceilings, where exposed in finished spaces, exposed on walls, and wherever it may not be accessible or may be subject to physical damage: Install cables in raceway.
    b. Wiring exposed in ceilings of unfinished spaces: Install cables in raceway.
    c. Wiring concealed above accessible suspended ceilings: Install cables on J-hooks in corridors and J-hooks elsewhere.
    d. Wiring within enclosures, consoles, cabinets, desks, and counters: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and/or distribution spools.

2. Conceal raceway and cables, except in unfinished spaces, and in open ceiling spaces and raceways on existing walls.
3. Cable not in raceways:

    a. Do not install in hangers used for pipes, electric conduits, or ceiling hangers, nor support it in any way by attachments to pipes, conduits, or ceiling hangers.
    b. Install without damaging conductors, shield, or jacket. Cables shall not run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
    c. Install away from potential EMI sources, including electrical power lines and equipment.
    d. Install parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.

4. Cable support with J-hooks:

    a. Install J-hooks at intervals not exceeding 48 inches.
    b. Secure cables on J-hooks with cable ties.

5. Each cable run shall contain an ‘S’ loop or other means to accommodate expansion or contraction.
6. Where ceiling plenums are used for passage of air by heating and air conditioning system, install cable in conduit or use UL listed plenum cable.

C. For cable installed in conduit, comply with requirements for raceways and boxes specified in Section 26 0533, Conduits, and Section 26 0534, Boxes.

    1. Provide separate conduit systems for each low-voltage system.
    2. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

        a. Pull cables simultaneously if more than one is being installed in same raceway.
        b. Use pulling compound or lubricant, if necessary. Use compounds that will not damage conductor or insulation.
        c. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage cables or raceway.

D. Avoid installing near hot utilities, which might adversely affect system performance or result in damage to the cable. If cable must be placed close to such utilities, keep it separate and protect with insulation.

E. Cable bends shall have a radius not less than the value recommended by the cable manufacturer.

F. Tag cables connected to electronic equipment, to show function and the location of other end. Securely fasten labels to the cable.

3.7 INSTALLING MC CABLE

A. Install in compliance with NFPA 70.

1. Bend radius shall not be less than 7 times the external diameter of the cable.
2. Securely fasten in place at intervals of not more than six feet, with suitable clamps or fasteners of approved type.
3. Maintain at least 6-inch clearance between MC cables and other piping systems.
4. Do not fasten MC cable to conduits, pipes, or ducts.
5. Support individual MC cables hung from roof structure or structural ceiling by independently supported hangers using hanger rods, jack chains, or No. 10 wire.
6. Support groups of MC cable run in parallel on trapeze hangers suspended from 0.5-inch hanger rods, held in place with MC cable clamps or fasteners.
7. Installing hangers for MC cable shall be similar to installing conduit hangers.
8. Support MC cable on each side of a bend and not more than 1 foot from an enclosure where an MC cable is terminated.

B. Sizes: Cables larger than No. 8 shall not be permitted.

C. Locations: Type MC cable may be used for branch circuits in the following locations and conditions, unless otherwise indicated:

1. Concealed in accessible ceiling spaces or within casework.
2. Light fixture whips from junction box in accessible ceiling to recess-mounted lighting fixtures.
3. Within drywall partitions / metal stud wall construction: Between wiring devices and from wiring device to nearest junction box in accessible ceiling.
4. From pullbox or wireway located in accessible ceiling space above or below respective panelboard to branch circuit loads served.
5. Do not install in masonry partitions or masonry walls.

D. Connect cable with wiring accessories specified above.

E. MC cable run to switches shall have a neutral conductor. This conductor is not indicated on the drawings.

F. Provide junction box in accessible ceiling space of each room and terminate MC cables in room at box.

END OF SECTION

SECTION 26 0521

WIRING CONNECTIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Power and control wiring for equipment.

1.2 RELATED SECTIONS

A. Equipment: Installed items requiring electricity, specified in other sections or shown on drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Conduits, wires and cables, devices, and accessories as specified in other sections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide power wiring from the motor starters to each motor and its manual controlling device.

1. Make flexible or liquid tight connections as specified in Section 26 0533, Conduits.

B. Except where provided with equipment, furnish and install manual pushbutton stations and pilot lights, with wiring. Where stations and pilot lights are grouped at central locations, mount them under a common faceplate.

C. Rough in and connect to equipment furnished under other sections. Make connections as indicated on drawings with exact locations and details determined by approved shop drawings of the equipment.

1. Under equipment sections, equipment will be set in position and the electrical devices and components furnished loose. Assemble, install, and wire under this section.
2. Accomplish rough-in from walls with flush outlet boxes and from floors by means of conduit couplings finishing flush with finished floor.

D. Certain equipment, as indicated, will be furnished with control panels and auxiliary control components. Mount the panels, furnish and install source wiring and disconnects, and completely connect controls and motors.

E. Provide power and control wiring for emergency generator, controllers, remote control panels and remote alarm bell. Mount remote bell and silence switch where indicated. Provide plastic nameplates under bell and switch.

END OF SECTION

SECTION 26 0526

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Grounding and bonding electrical systems and equipment.

B. Ground system test.

1.2 RELATED SECTIONS

A. Gas flexible pipe connector:

1. Natural-gas piping: Section 23 1123.

1.3 REFERENCES

A. IEEE STD 142

B. NFPA 70

C. ASTM F467 and F468

D. UL 467

1.4 DEFINITIONS

A. Area served by a separately-derived system: The area within the building that contains any part of a circuit of the system.

1.5 SUBMITTALS

A. Product data: Ground rods and connections.

B. Certifications: System test.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Ground conductor, unless specifically noted otherwise, shall be copper, 98 percent conductivity, solid for No. 10 AWG and smaller and stranded for No. 8 AWG and larger.

B. Ground rods:

1. Copper bonded steel, 0.75-inch diameter by 10 feet long, one end pointed and the other end tinned,
2. Basis of design: Erico International Corporation.

C. Mechanical type ground connectors:

1. Connectors:

a. IEEE 837 and UL 467 compliant, listed for use for specific types, sizes, and combinations of conductors and connected items.
b. Basis of design: FCI Burndy G Series.

2. Nuts, bolts, and washers: Silicon bronze alloy type B per ASTM F467 and F468.

D. Exothermic type ground connections:

1. Exothermic welding systems.
2. Basis of design: “Cadweld,” manufactured by Erico International Corporation.

E. Lugs:

1. Lugs shall be two- or four-hole.
2. Basis of design: Burndy Hylug series.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Provide the complete grounding of conduit systems, electrical equipment, conductor and equipment enclosures, motors, transformers, and neutral conductors in accordance with applicable codes. Grounded phase and neutral conductors shall be continuously identified. Continuity of metal raceways shall be insured by double locknuts.

B. Furnish and install main grounds for secondary electrical service to cold water main in accordance with NEC requirement. In addition to the cold-water ground. Provide ground rods as indicated or as required by NEC and applicable codes.

C. Install copper grounding jumpers of 3/0 copper cable around each main water valve in the building. Install copper grounding jumpers around conduit expansion fittings. Jumpers shall be of adequate current carrying capacity corresponding to size of conduit.

D. Ground system connections which are beneath the floor and in a concealed or inaccessible location shall be brazed or welded. Brazing and welding shall be “CADWELD.”

E. Separately-derived three phase wye electrical systems originating in generators shall be grounded at the generator neutral terminal:

1. The grounding electrode for the outdoor generator shall be a ground rod.
2. The grounding electrode for the indoor generator shall be whichever one of the following that is closest to the generator:

a. Building’s grounding electrode.
b. Steel structural member of the building conforming to NEC requirements for grounding electrodes.
c. First five feet of the water service piping to the building.

F. Bonding separately-derived systems:

1. Each metal water piping system, not used as the electrical system’s grounding electrode, in the area served by the electrical system shall be bonded to the electrical system’s neutral by a system bonding jumper.
2. If exposed structural metal is not used as the grounding electrode for the system, bond exposed structural metal in the area served by the electrical system to the system’s neutral by a system bonding jumper.

3. If a metal water piping system in the area served by the electrical system is bonded to exposed structural metal by a NEC-compliant bonding jumper, then only one of the two (piping or structure metal) need to be bonded to the electrical system's neutral.

G. Bonding straps and jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to equipment mounted on vibration isolation hangers and supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connections for outdoor locations; if a disconnect-type connection is required, use a bolted clamp secured with a minimum of two bolts and lock washers.

H. Ufer ground (concrete-encased grounding electrode): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
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.

3.2 EQUIPMENT GROUNDING AND BONDING

A. Provide insulated equipment grounding conductors with feeders and branch circuits.

B. 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.

C. Gas piping:

1. Comply with NFPA 54.
2. Provide bonding jumpers for each length of corrugated stainless-steel tubing (CSST).

a. Jumpers shall be No. 6 AWG or the same size as the equipment grounding conductor serving the equipment served by the CSST, whichever is larger.
b. Install in accordance with CSST manufacturers' instructions and NFPA 54.

3.3 APPLICATIONS

A. Underground grounding conductors: Install bare copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.

3.4 IDENTIFICATION

A. Comply with requirements in Section 26 0553, Identification for Electrical Systems, for instruction signs. The label or its text shall be green.

3.5 GROUNDING SYSTEM TEST

A. Ensure that grounding system is continuous and that resistance to earth is not more than 10 ohms.

B. Test each ground rod for resistance to earth before making connections to rod; tie grounding system together and test for resistance to earth.

   1. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall.

C. Submit written results of each test including location of rods as well as resistance and soil conditions at time measurements were made.

END OF SECTION

SECTION 26 0528

EQUIPMENT FOUNDATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment foundations (housekeeping pads).

B. Outdoor equipment foundations.

1.2 RELATED SECTIONS

A. Generators: Section 26 3213.

1.3 SUBMITTALS

A. Product data: Concrete mix, grout, reinforcement, and accessories.

B. Certifications: Test report showing strength of concrete.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Concrete:

1. Indoor: 3,000 psi (20.7 MPa) compressive strength at 28 days.
2. Outdoor: 4,500 psi (31.0 MPa) compressive strength at 28 days.

2.2 GROUT

A. Non-shrink grout: Premixed, consisting of non-metallic aggregate, cement, water-reducing and plasticizing agents; capable of developing minimum compressive strength of 7,000 psi in 28 days.

1. Five Star Products, Inc. “Five-Star Grout”
2. L&M Construction Chemicals, Inc. “Crystex”
3. Sonneborn “Sonogrout”

2.3 METAL REINFORCEMENT

A. Reinforcing bars: Deformed steel bars in accordance with ASTM A615, Grade 60, clean and free from loose rust, scale, or other coatings that will reduce bond.

B. Welded wire fabric reinforcing: ASTM A 185 No. 6 steel wire spot-welded at intersections and of size 6 by 6-inch mesh.

C. Metal accessories: Include spacers, chairs, bolsters, ties, and other devices necessary for properly placing, spacing, supporting and fastening reinforcement in place.

PART 3 - EXECUTION

3.1 INSTALLING EQUIPMENT FOUNDATIONS (HOUSEKEEPING PADS)

A. Provide 4- inch-high concrete foundations (housekeeping pads) for floor-mounted equipment unless otherwise noted. Furnish foundations, bolts, sleeves, and appurtenances and install as recommended by equipment manufacturer. Anchor the concrete foundations by dowels inserted into the floor slab. Provide welded wire fabric reinforcement.

B. Unless otherwise specified, install concrete work in accordance with the requirements of Division 03.

C. Equipment shall be properly aligned. Level and grout equipment where necessary. Support conduit independently of equipment and so as not to cause a strain or thrust.

D. Coordinate exact locations and configurations of equipment, foundations, and supports with the approved shop drawings of the equipment.

3.2 INSTALLING OUTDOOR EQUIPMENT FOUNDATIONS

A. Provide equipment foundations of size and thickness indicated.

B. Place reinforcement accurately in position shown, securely fasten, and support to prevent displacement before or during pouring. Clean, bend, place, and splice reinforcement in accordance with approved shop drawings. Lap ends and sides of mesh reinforcement in slabs not less than one mesh.

1. Coverage of main reinforcing shall be as follows: Slabs, 0.75 inch (19 mm); concrete poured against earth, 3 inches (75 mm); other locations, 2 inches (50 mm).

C. Properly align, level, and grout equipment.

END OF SECTION

SECTION 26 0533

CONDUITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit, raceways, and accessories, aboveground and below ground where not in duct banks.

1.2 RELATED SECTIONS

A. Trenching: Section 26 0501.

B. Firestopping: Section 26 0507.

C. Boxes: Section 26 0534.

D. Surface raceways: Section 26 0535.

E. Exterior duct banks: Section 26 0544.

1.3 DEFINITIONS

A. Conduit: Conduit, raceway, or tubing.

B. EMT: Electrical metallic tubing.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquid-tight flexible metal conduit.

F. PVC: Polyvinyl chloride.

G. RGS: Rigid galvanized steel.

1.4 SUBMITTALS

A. Product data:

1. Each type of conduit and raceway included in the work, and related fittings.
2. Accessory materials.
3. Hangers and fasteners.

PART 2 - PRODUCTS

2.1 CONDUIT AND FITTINGS

A. Galvanized steel conduit: Hot-dip galvanized with threads galvanized after cutting:

1. Rigid full weight, heavy-wall steel conduit (RGS) conforming to UL 6 and ANSI C80.1.
2. Intermediate steel conduit (IMC) conforming to UL 1242 and ANSI C80.6.

B. Steel conduit fittings: Cast malleable iron fittings with smooth finish and full threaded hubs. Include steel or malleable iron locknuts, bushings, and other fittings.

1. Insulating bushings: Basis of design: Thomas & Betts Series 22.
2. Hub fittings with recessed sealing ring and nylon insulated throat: Basis of design: Thomas & Betts Series 370.
3. Fittings for exposed locations: Conduit outlet bodies, cast iron or cast aluminum, zinc or cadmium plated.

C. Electrical metallic tubing (EMT):

1. Indoors: Hot-dip galvanized or sherardized thin-wall steel conduit conforming to UL 797 and ANSI C80.3.

D. Connectors and couplings for EMT: Concrete- or rain-tight, compression or set screw type, made of zinc- or chromium-plated steel. Connectors shall have nylon insulating throats.

1. Compression connector: Basis of design: Thomas & Betts No. 5223.
2. Compression coupling: Basis of design: Thomas & Betts No. 5220.
3. Set screw connector: Basis of design: Steel City No. TC722A.
4. Set screw coupling: Basis of design: Steel City No. TK122A.

E. Flexible metal conduit (Type FMC): Made of sheet metal strip, interlocked construction, conforming to UL 1.

F. Liquidtight flexible metal conduit (Type LFMC) shall conform to UL 360.

G. Connectors and couplings for flexible metal conduit:

1. Connectors: Angle wedge with nylon insulated throat. Basis of design: Thomas & Betts “Tite-Bite” connector Series 3110 and 3130.

H. Liquidtight type connectors:

1. UL 14814A. Fittings: With nylon insulated throat.
2. Basis of design: Thomas & Betts Series 5331.

I. Plastic conduit: Polyvinyl chloride (PVC) Schedule 40, rated for use with 90-degree conductors, for exposed, underground, and encased applications, complying with NEMA Specification TC-2 and UL 651.

J. Plastic conduit fittings, solvents and adhesives:

1. Fittings: Complying with NEMA TC 3 and UL 514.
2. Solvents and adhesives: As recommended by conduit manufacturer.

K. Wireways: Steel wireway with hinged cover, complying with UL 870 Standard for Wireways, Auxiliary Gutters, and Associated Fittings.

1. Cover: Front accessible opening along complete length of wireway.
2. Finish: Gray polyester powder finish inside and out.
3. Basis of design: Square D "Square-Duct" or Pentair/Hoffman "Angled Trough".

L. Fittings for wireways: Made with removable covers to permit installation of a complete system with access to wires throughout the system, UL listed with wireways. Connections: Threaded screws at every connector.

M. Weatherproof expansion fittings:

1. With bonding jumpers.
2. Basis of design: O-Z/Gedney Types AX and TX.

2.2 SLEEVES FOR RACEWAYS

A. Steel pipe sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

1. Sleeves for exterior walls: Anchor flange welded to perimeter.

B. Sleeves for rectangular openings: Galvanized sheet steel of length to suit application. Minimum thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm): 0.052 inch (1.3 mm).
2. For sleeve cross-section rectangle perimeter equal to or more than 50 inches (1270 mm) and 1 or more sides equal to or more than 16 inches (400 mm): 0.138 inch (3.5 mm).

C. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 26 0507.

2.3 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annual space between sleeve and conduit.

1. Sealing elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure plates: Reinforced nylon polymer. Include two for each sealing element.
3. Connecting bolts and nuts: Stainless-steel of length required to secure plates to sealing elements. Include one for each sealing element.

2.4 ACCESSORY MATERIALS

A. Pull rope: Polypropylene, minimum 0.1875 inch (5 mm) thick, tensile strength 800 pounds (3559 N), work load 130 pounds (578 N).

B. Caps and plugs:

1. Basis of design: Thomas & Betts Series 1470.

C. Lubricant:

1. UL approved.
2. Basis of design: Ideal Industries, Inc. “Yellow 77”.

D. Bituminous protective coating: Coal tar based, self-priming on steel, applied in a wet film thickness at least 22.0 mils (559 microns) per coat.

E. Rust inhibitive paint:

1. Alkyd based, white, black, or bronzetone; applied in a wet film thickness of at least 2.9 mils.
2. Basis of design: Benjamin Moore Super Spec HP D.T.M. Alkyd Low Lustre P23.

2.5 CONDUIT HANGERS

A. Adjustable hangers:

1. Basis of design: Kindorf C-711 lay-in hanger or C-710 Clevis hanger.

B. Trapeze hangers:

1. Constructed of channels with notched steel straps.
2. Steel strap basis of design: Kindorf C-105.

C. Channels:

1. Steel, 1.5 inches (38 mm) wide with 7/8-inch (22-mm) continuous slot, gauges and weights.
2. Basis of design: Kindorf B-900 series, hot-dipped galvanized finish.

D. Beam clamps:

1. Adjustable type for connecting hanger rod to steel beam.
2. Basis of design: Kindorf E-160 or U-569

E. Hangers for conduit 1.0 inch (27 mm) and smaller, through or below bar joists: "Hang-on" hangers attached to joists with Minerallac scissor clips or two-piece stud clips.

F. Finish: For hangers, assemblies, plate washers, rods, locknuts, channels, bolts, and appurtenances:

1. Zinc plated.
2. Hot-dip galvanized, where required for weather-exposed or damp locations.

2.6 FASTENERS

A. General: Select fasteners such that load applied does not exceed one-fourth of manufacturer's load capacity in 3500 psi (24000 kPa) concrete.

B. Fasteners to concrete: Self-drilling type expansion anchors, or machine bolt drop-in anchors for drilled holes. Fasteners to concrete ceilings shall be vibration- and shock-resistant.

C. Fasteners to drywall or cavity wall: Toggle bolts, hollow-wall drive anchors, or nylon anchors as required.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Provide complete, separate and independent raceway system for each of the various wiring systems including, but not limited to, the following:

1. Lighting
2. Power
3. Exit Lighting*
4. Emergency Lighting System*
5. Fire Alarm System
6. Low Voltage Control System
7. Control Wiring

*These wiring systems may be installed in common raceways.

B. Wire raceway systems completely, except where otherwise indicated, as shown on drawings and as required for satisfactory operation of each system.

C. Where wireways are required or used to facilitate the installation, size them to accommodate conductors, in accordance with NFPA 70.

D. Types and locations of conduits are scheduled at the end of the section.

E. Do not install conductors or pull rope during installation of conduit.

F. Where conduit is connected to a cabinet, junction box, pull box, or auxiliary gutter, protect the conductors with an insulating bushing. Provide locknuts both inside and outside the enclosure. Where conduit is stubbed up to above ceilings for future wiring, close ends with bushings.

G. Bituminous protective coating:

1. Coat exposed threads on steel conduits in concrete slabs at couplings and fittings, after joints are made up.
2. Coat metallic conduits below grade not in concrete, and where emerging from below grade or slabs, four inches above and below grade or slab.

H. Rust-inhibitive paint:

1. Exposed threads of exterior conduit.
2. Unfinished metal components.

I. Make turns in conduit runs with manufactured elbows or using machines or tools designed to bend conduit. Turns shall be not less than the various radii permitted by NFPA 70.

J. Sizes:

1. Do not use conduit smaller than 0.75 inch (21 mm),
2. Feeder conduits shall be as large as indicated, or as required by NFPA 70 (whichever is larger). Do not install more than one feeder in a single conduit.
3. Conduit sizes shown on drawings are based on Type THHN/THWN-2 wire.

K. Make vertical runs plumb and horizontal runs level and parallel with building walls and partitions.

L. Ground conduits as required by NFPA 70.

M. Where conduits pass through building expansion joints, and wherever relative movement could occur between adjacent slabs, equip with weatherproof expansion fittings and bonding jumpers.

N. Where conduits through roof cannot be installed inside equipment or pipe curbs, flash them in accordance with the SMACNA Architectural Manual.

1. Coordinate flashing details and materials with manufacturer and installer of roofing system.

O. Run conduits concealed in new construction except where connecting to surface-mounted cabinets and equipment, and in electrical and mechanical equipment spaces. Install conduit above suspended ceilings and within walls and partitions.

P. Immediately after each run of conduit is completed, test it for clearance, smooth the joints, and close at each end with caps or plugs to prevent entrance of moisture or debris.

Q. Conduit installed outdoors or at indoor locations exposed to continuous or intermittent moisture shall provide a liquidtight seal. Use steel or malleable iron hub fittings. Coat exposed threads with bituminous protective coating.

R. Where conduit is stubbed up through concrete slab, exterior walls, or bearing walls, provide galvanized steel conduit elbows.

3.2 INSTALLING PULL BOXES, JUNCTION BOXES, OUTLET BOXES

A. Install as specified in Section 26 0534, Boxes.

B. Install pull or junction boxes in long runs of conduits or where necessary to reduce the number of bends in a run.

1. Install boxes flush with wall or ceiling surfaces, with flat covers. Where removable ceiling units are used, locate boxes above ceilings.

C. Verify door swings with door frame installed before locating switch outlets.

3.3 INSTALLING FLEXIBLE CONDUIT

A. Installation shall comply with NFPA 70.

1. Minimum length: Two feet (610 mm).
2. Maximum length: Six feet (1830 mm).

B. Make immediate connections to transformers, recessed lighting fixtures, speakers, and other equipment in suspended ceilings with flexible metal conduit. Include sufficient slack to permit removal of fixture or equipment.

C. Make immediate connections to motors with liquidtight flexible metal conduit. Include sufficient slack to reduce the effects of vibration.

D. In wet locations, install liquidtight type, in such a manner that liquid tends to run off the surface and not drain toward the fittings.

E. Where fittings are brought into an enclosure with a knockout, install a gasket assembly consisting of an O ring and retainer on the outside.

3.4 INSTALLING PULL ROPE AND CONDUCTORS

A. After conduit is installed, fish pull rope. After completion of the work of this project, pull rope shall remain in conduits identified as to be left empty.

B. Do not use a pull rope that has a tensile strength of more than one of the conductors of a two-wire circuit, more than two of the conductors of a three-wire circuit, or more than three of the conductors of a four-wire circuit.

C. Do not pull conductors into the conduits until the system is entirely completed and wet building materials are dry.

D. Use only a lubricant approved for use with conductor materials and pull rope materials.

3.5 INSTALLING SLEEVES

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Section 26 0507.

B. Concrete slabs and walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Fire-rated assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

D. Cut sleeves to length for mounting flush with both surfaces of walls.

E. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

F. Size pipe sleeves to provide 0.25-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

H. Interior penetrations of non-fire-rated walls and floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint.

I. Fire-rated-assembly penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Section 26 0507.

J. Roof-penetration sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

K. Exterior-wall penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 INSTALLING CONDUIT HANGERS

A. Single runs of overhead conduits 1.25-inch (35-mm) size and larger shall be supported by adjustable hangers, using 0.375-inch (10-mm) rods for conduits up to 2-inch (53-mm) size and 0.5-inch (13-mm) rods for conduits larger than 2.0 inches (53 mm).

B. Support groups of conduits run in parallel on trapeze hangers suspended from 0.5-inch (13-mm) hanger rods.

C. Space hangers not over 10 feet (3 m) apart for metal conduits. Support conduits within 3 feet of each outlet, junction or pull box.

D. Below bar joist construction, support hangers from a length of structural channel, welded to the top chords of at least two joists.

E. Where large numbers of conduits are grouped together, stagger individual hangers so as not to concentrate the load on a few joists.

F. Where hanger rods are attached to structural beams, use adjustable beam clamps.

G. Below precast plank construction, hanger rods shall pass through the precast planks and be secured on top side with nut, locknut and plate washer. Plate washers shall be at least 4 inches (102 mm) square and 0.125 inch (3.2 mm) thick. Top of hanger assembly shall be concealed in the concrete fill which will be placed over the planks.

H. Attach hanger rods to concrete with expansion bolts and anchors.

3.8 CONDUIT IN EXISTING BUILDING

A. Remove superfluous electrical equipment and cap outlets not being used, as specified in Section 26 0504, Electrical Demolition.

B. In existing areas that are being renovated it is the intent to show on the drawings what the finished areas will contain when completed. Except as specified otherwise, existing conduit, and outlet boxes may be reused where they meet specifications and code requirements. Replace existing products or materials which are not suitable for reuse as determined by the Engineer.

C. Suitably cap superfluous concealed outlets, and remove unused wire. Remove superfluous raceways exposed in finished areas, and abandon superfluous raceways concealed in walls.

D. Install concealed conduit in existing building wherever possible above ceilings, in new walls, and in existing furred spaces. Install exposed conduit in secondary rooms, such as storage rooms. Install exposed surface raceways on existing wall as specified in Section 26 0535, Surface Raceways.

E. Where existing conduit penetrates fire-rated partitions, and where there is no firestopping, provide firestopping. Maintain fire rating of walls, partitions, ceilings, and floors at existing conduit penetrations. Comply with Section 26 0507.

3.9 INSTALLING UNDERGROUND CONDUIT, GENERAL

A. Depth:

1. Outside building: Top of conduit no less than 24 inches below finish grade.

B. Slope: At least 3 inches in 100 feet away from buildings and toward manholes or other drainage points.

C. Cleaning: At the completion of each run, in each conduit, first run a testing mandrel not less than 12 inches (305 mm) long with diameter 0.25 inch (6.35 mm) less than the inside diameter of the conduit; then draw through a stiff-bristled brush until particles are removed. Immediately install conduit plugs.

D. Except at conduit risers, make changes in direction of runs, either vertical or horizontal, by long sweep bends. Bend may be made up of one or more curved or straight sections or combinations. Use manufactured bends with a minimum radius of 36 inches.

E. Where underground nonmetallic conduit runs penetrate floor slabs, exterior walls, or bearing walls, use galvanized steel conduit elbows. Coat metallic elbows with bituminous protective coating.

3.10 INSTALLING UNDERGROUND CONDUIT WITHOUT CONCRETE ENCASEMENT

A. Run conduit in straight lines except as necessary.

B. Trenches: At least three inches (80 mm) clearance on each side of the conduit.

C. Warning tape: Install in backfill approximately 12 inches (300 mm) below grade.

D. Under existing roads and paved areas not to be disturbed, jack rigid steel conduit into place.

3.11 SCHEDULE OF LOCATIONS

A. RGS with screw joint couplings:

1. Conduits in concrete slabs except where noted to be plastic.
2. First five feet of conduit extending outside building.
3. Under roads and paved areas where existing pavement is not to be disturbed, extending at least five feet beyond edges of pavement.
4. Elbows penetrating floor slabs, exterior walls, or bearing walls.
5. Exposed on exterior building walls.

B. IMC with screw joint couplings:

1. Wiring to exterior equipment, except RGS on exterior building walls.

C. EMT:

1. Sizes 4 inches (102 mm) and smaller except as noted above.

D. PVC with solvent cement joints:

1. For exterior circuits, directly buried, except first five feet from building.
2. Where noted under concrete slab, concrete encased, except elbows penetrating floor slabs, exterior walls, or bearing walls shall be galvanized steel conduit.
3. Where noted under concrete slab, direct buried.
4. For concrete encased duct banks.

END OF SECTION

SECTION 26 0534

BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Boxes with covers.

1.2 RELATED SECTIONS

A. Conduits: Section 26 0533.

B. Wiring devices: Section 26 2726.

1.3 SUBMITTALS

A. Product data: Each type of box included in the project.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

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

B. Boxes:

1. Appleton/EGS Electrical Group
2. RACO/Hubbell Electrical Products
3. Steel City/Thomas & Betts

2.2 MATERIALS

A. Outlet, switch, and junction boxes:

1. Sheet metal: NEMA OS 1, sherardized or galvanized stamped.
2. Cast-metal, where required for weather-exposed, or exposed locations: NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

2.3 JUNCTION AND PULL BOXES

A. Junction and pull boxes in feeder conduit runs: Galvanized, of size required for conduit arrangement and not less than the size required by NFPA 70, and furnished with screwed covers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Boxes in metal stud walls or partitions shall be securely supported by metal channels spanning between two studs and attached to same.

B. Provide box at each outlet, switch, and appurtenance. Each box shall be of a type suitable for the duty intended and shall be installed in accordance with the manufacturer's instructions.

1. Where conduit is weather-exposed or exposed, provide cast-steel or cast-aluminum boxes.

C. Coordinate locations of boxes with installation of conduit as specified in Section 26 0533.

D. Do not install boxes back-to-back (through the wall) in partitions.

E. Firmly secure the boxes in place, plumb, level, and with front of device cover even with finished wall surface.

F. Outlet boxes used for supporting lighting fixtures: Furnish with malleable iron fixture studs of "No-Bolt" type, secured by locknut. Provide structural channel supports for boxes occurring in ceilings. Outlets in ceilings directly on bottom of joists shall be supported independent of ceiling construction. Outlets in suspended ceilings shall not be supported from ceiling construction. Special supports for boxes shall be as directed and approved by the Engineer.

G. Where service fittings will not permit ganging of boxes for floor outlets, outlets shall be as close as practical.

H. Verify door swings with door frame installed before locating switch outlets.

I. Outlet boxes in fire-rated assembly:

1. Clearance between boxes and wallboard shall not exceed 0.125 inch (3.2 mm).
2. Surface area of individual outlet box does not exceed 16 square inches (103 sq cm).
3. Entire surface area of boxes shall not exceed 100 square inches (645 sq cm) per 100 square feet (9.3 sq m) of wall surface.

3.2 IDENTIFICATION

A. Identification on outside covers of pull and junction boxes in ceiling space or exposed on walls: Paint with colored enamel or mark with permanent waterproof black marker, or both, as specified.

1. Fire alarm system: Red.
2. Other special systems: Mark with system type, such as Data, or Communications.
3. Power and lighting: Panelboard designation and circuit number(s).

B. Identification inside boxes for recess-mounted or concealed in walls and partitions: Plasticized card stock tags marked with permanent waterproof black markers.

1. Fire alarm system: Fire alarm.
2. Other special systems: Mark with system type, such as Data, or Communications.
3. Power and lighting: Panelboard designation and circuit number(s).

END OF SECTION

SECTION 26 0535

SURFACE RACEWAYS

PART 1 - GENERAL

1.1 WORK INCLUDES

A. Surface raceway, metal.

1.2 RELATED SECTIONS

A. Conduits: Section 26 0533.

1.3 SUBMITTALS

A. Product data:

1. Surface raceway.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis-of-design product: Subject to compliance with requirements, provide the specified Wiremold product, or comparable product by one of the following:

1. Hubbell Inc./Hubbell Wiring Device-Kellems
2. Niedax MonoSystems, Inc.
3. Legrand North and Central America, LLC/Wiremold

2.2 SURFACE METAL RACEWAYS

A. UL listed and meeting requirements of NFPA 70 (NEC).

B. One-piece type:

1. 3/4 inch by 21/32 inch as a minimum size, galvanized steel 0.04-inch (1-mm) thick, complete with device boxes, fittings, connectors, and appurtenances.
2. Basis of design: Wiremold 700.

C. Finish: Field paintable baked enamel, ivory.

PART 3 - EXECUTION

3.1 INSTALLING SURFACE METAL RACEWAYS

A. Install surface metal raceways in accordance with sizes as required by NFPA 70 (NEC).

B. Install each assembly as recommended by the manufacturer.

1. Where field cutting is required, make each cut with the manufacturer’s tool specifically designed for cutting the part and model.
2. Metal raceway shall be electrically continuous and bonded in accordance with NEC.
3. Each assembly shall be installed so each section or component is coupled together and no conductors or cables are exposed at any location.

C. Attach raceway and boxes to walls and ceilings with fasteners as specified for conduits. Attach each outlet box with at least two screws. Secure one-piece raceways with two-hole straps at intervals not exceeding four feet (1220 mm) and with no less than two straps per straight raceway section.

D. Raceway routes, mounting heights, and locations of types of outlets are shown on drawings.

E. Make raceway runs plumb and true and parallel with building and casework lines.

F. Except as otherwise shown on drawings, locate raceways in corners, adjacent to door trims, and in other ways to be inconspicuous, even when this requires additional lengths.

3.2 CLEANING AND ADJUSTING

A. Touch up surfaces damaged during installation with paint supplied by the manufacturer.

END OF SECTION

SECTION 26 0544

UNDERGROUND DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Ducts in directly-buried duct banks.

1.2 REFERENCES

A. Society of Cable Telecommunications Engineers (SCTE):

1. SCTE 77: Specification for Underground Enclosure Integrity. Light duty and pedestrian traffic only. Includes Tiers for specific applications, and static vertical wheel load ratings:

a. Tier 5: Sidewalk applications with a safety factor for occasional nondeliberate vehicular traffic.
b. Tier 8: Sidewalk applications with a safety factor for nondeliberate vehicular traffic.
c. Tier 15: Driveway, parking lot, and off-roadway applications subject to occasional nondeliberate heavy vehicular traffic.

1.3 SUBMITTALS

A. Product data: For the following:

1. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
2. Underground warning tape.

1.4 QUALITY ASSURANCE

A. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.6 PROJECT CONDITIONS

A. Existing utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect Owner at least two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner’s written permission.

1.7 COORDINATION

A. Coordinate layout and installation of ducts with final arrangement of other utilities and site grading, as determined in the field.

B. Coordinate elevations of ducts with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

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

1. Nonmetallic ducts and accessories:

a. ARNCO Corp.
b. Beck Manufacturing Inc.
c. Cantex, Inc.
d. CertainTeed Corp.; Pipe & Plastics Group.
e. ElecSys, Inc.
f. Electri-Flex Co.
g. IPEX, Inc.
h. Lamson & Sessions; Carlon Electrical Products.
i. Manhattan/CDT
j. Spiraduct/AFC Cable Systems, Inc.

2.2 CONDUIT

A. Conduit and fittings are specified in Section 26 0533.

2.3 DUCTS

A. Rigid nonmetallic conduit: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Underground ducts for electrical branch circuits 600 V and below: Type EPC-40-PVC, directly-buried duct bank, except use Type EPC-80-PVC when crossing roads.

B. Underground ducts for telephone utility service: Type EPC-40-PVC, directly-buried duct bank, except use Type EPC-80-PVC when crossing roads.

C. Underground ducts for communication circuits: Type EPC-40-PVC, directly-buried duct bank.

3.2 EARTHWORK

A. Excavation and backfill: Comply with Section 26 0501, Excavation and Fill for Electrical Work but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

3.3 CONDUIT AND DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 and away from buildings and equipment.

B. Curves and bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet (7.5 m), both horizontally and vertically, at other locations.

C. Use solvent-cement joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

D. Building entrances: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below:

1. Concrete-encased ducts: Install reinforcement in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
2. Waterproofed wall and floor penetrations: Install a watertight entrance-sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

E. Directly-buried ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator installation: Space separators close enough to prevent sagging and deforming of ducts.
2. Install expansion fittings as shown on shop drawings.
3. Trench bottom: Continuous, firm, and uniform support for duct bank. Prepare trench bottoms as specified in Section 26 0501, Excavation and Fill for Electrical Work.
4. Backfill: Install backfill as specified in 26 0501, Excavation and Fill for Electrical Work. After installing first tier of ducts, backfill and compact. Repeat backfilling after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, complete backfilling normally.
5. Minimum clearances between ducts: 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
6. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade, unless otherwise indicated.

F. Warning tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank.

G. Stub-ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 5 feet (1.5 m) from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete.

H. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

I. Pull rope: Equal to Graybar Electric Co., Inc., “Pro-Pull”: Polypropylene, minimum 0.1875 inch (5 mm) thick, tensile strength 800 lbs (3559 N), work load 130 lbs (578 N).

3.4 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts.

B. Duct integrity: Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of the duct. If obstructions are indicated, remove obstructions and retest.

C. Correct installations if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

3.5 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION

SECTION 26 0553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes electrical identification materials and devices required to comply with ANSI, NFPA, and OSHA standards.

B. This section addresses identification of electrical equipment, raceways, boxes, conductors, and other related electrical system components.

1.2 SECTION INCLUDES

A. Identification of power conductors and control cables.

B. Identification of equipment and instructions.

C. Miscellaneous identification products.

1.3 RELATED SECTIONS

A. Sections in Division 26.

1.4 REFERENCES

A. ANSI Z535.4: Standard for Product Safety Signs and Labels.

B. ANSI/IEEE C2: National Electrical Safety Code.

C. NFPA 70: National Electrical Code.

D. NFPA 70E: Standard for Electrical Safety in the Workplace.

E. OSHA 29 CFR 1910.144: Safety Color Code for Marking Physical Hazards.

F. OSHA 29 CFR 1910.145: Specifications for Accident Prevention Signs and Tags.

G. UL 969: Standard for Marking and Labeling Systems.

H. Definitions:

1. Circuit designation includes both equipment source and equipment position.

1.5 SUBMITTALS

A. Product data: For each type of electrical identification product.

1.6 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with OSHA standards.

D. Comply with ANSI Z535.4 for safety signs and labels.

1.7 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other sections requiring identification applications, drawings, shop drawings, manufacturer's wiring diagrams, and the operation and maintenance manual; and with those required by codes, standards, and safety regulations. Use consistent designations throughout Project.

B. Coordinate installation of identification materials and devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identification materials and devices with location of access panels and doors.

D. Install identifying materials and devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following manufacturers, or approved equal:

1. Brady USA, Inc.
2. Carlton Industries
3. Graphic Products, Inc.
4. Ideal Industries, Inc.
5. Panduit Corporation
6. Presco
7. Seton Identification Products
8. Thomas & Betts Company
9. Utility Safeguard

2.2 GENERAL PRODUCT REQUIREMENTS

A. Except where otherwise indicated, provide manufacturer's standard identification products of category and type suitable for each application. Where more than one identification method is specified for an application, the Installer shall select and utilize each material in a consistent manner.

2.3 CONDUCTOR AND CABLING IDENTIFICATION

A. Adhesive labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

B. Color-coded, adhesive tape: Self-adhesive, vinyl tape, in appropriate colors for system voltage and phase.

C. Marker tapes: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

2.4 EQUIPMENT IDENTIFICATION

A. Engraved plastic nameplates: Laminated plastic, engraved, white letters on black background, except where other color schemes are noted or specified.

1. Size: Minimum 0.75-inch (19 mm) by 2.5-inches (64 mm).
2. Letter size: Minimum height of 0.375-inch (10 mm).
3. Mechanically fastened, except adhesive mounted where necessary due to substrate.

a. Mechanical fastener: Punched or drilled, with vandalproof stainless steel or brass screws or rivets.

B. Baked-enamel signs: Preprinted, aluminum signs, punched or drilled for fasteners with corner grommets; with colors, legend, and size required for application.

C. Exterior, metal-backed, signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate (CAB) signs with galvanized steel backing; punched or drilled for fasteners with corner grommets; with colors, legend, and size required for application.

D. Adhesive film label: Machine-printed, black letters on white background, through thermal transfer or equivalent process, with clear weatherproof and UV-resistant covering. Minimum letter size height of 0.375-inch (10 mm).

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Underground warning tape: Permanent, bright-colored, continuous-printed, vinyl tape for use with underground cables, conduits, and ductbanks. Comply with ANSI Z535.

1. Not less than 6-inches wide by 4 mils thick (152 mm wide by 0.102 mm thick).
2. Tape Material:

a. Made of metal detectable polyester or vinyl.
b. Compounded for permanent direct-burial service. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to destructive substances commonly found in soils.

3. Printed legend with black lettering, indicating type of underground line.

a. Provide inscriptions for power cabling with red-colored tape: Example – “CAUTION – BURIED ELECTRIC LINE BELOW” .

B. Wiring device tape labels:

1. Adhesive film label: Machine-printed, black letters on clear background, through thermal transfer or equivalent process. Minimum letter size height of 0.25-inch (6 mm).

a. Labeling for electrical devices and components such as receptacles, switches, control device stations, manual motor starters, network and phone jacks, junction and pull boxes, etc.

C. Warning labels and signs:

1. Self-adhesive warning labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configures for display on front cover, door, or other access to equipment unless otherwise noted.

2. Baked-enamel warning signs: Preprinted, aluminum signs, punched or drilled for fasteners with corner grommets; with colors, legend, and size required for application.
3. Fasteners: Self-tapping, stainless-steel screws or, stainless-steel machine screws with nuts, flat and lock washers.

D. Cable ties: Fungus-inert, self-extinguishing, one-piece, self-locking, color-coded, nylon cable ties suitable for the application (general purpose, UV-stabilized outdoor, or plenum rated).

E. Paint: Formulated for the type of surface, location, and intended use.

F. Stenciling: Nonfading, waterproof, ink or paint. Black or color-coded.

G. Adhesive: Heavy-duty, thermo-resistant, industrial grade adhesive, for adhesion to any surface without identification curling, peeling, or falling off.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification products at locations for most convenient viewing without interference with operation and maintenance of equipment.

1. For finished public spaces, coordinate identification product mounting locations with Owner.

C. Existing equipment: Apply identification products to unmarked existing equipment where work is being performed.

D. Apply identification products to surfaces after equipment finish work has been completed.

E. Clean surfaces before applying identification products, using materials and methods recommended by manufacturer of identification device.

F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

G. System identification labeling for raceways and cables: Each label shall be installed on sidewall of conduit and easily placed for proper identification. Locate labels at changes in direction, at penetrations of walls and floors, at 50-foot (15-meter) maximum intervals in straight runs, and at 25-foot (7.6-meter) maximum intervals in congested areas.

H. Cable ties: For attaching tags, use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In spaces handling environmental air: Plenum rated.

I. Underground-line warning tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16-inches (400 mm) overall.

3.2 APPLICATION

A. Miscellaneous:

1. Access doors and panels: Apply engraved nameplate labels at access doors identifying concealed electrical item. Do not locate labels in finished, public spaces.
2. Available fault current labels: Refer to Section 26 0573, Overcurrent Protective Device Studies, for fault current labeling requirements.
3. Arc flash warning labels: Refer to Section 26 0573, Overcurrent Protective Device Studies, for arc flash labeling requirements.

B. Junction and pull boxes:

1. Label each junction and pull box, identifying circuit designation or type of system.

    a. Exposed boxes: Place label on coverplate, externally visible.
    b. Concealed boxes: Place label or tag on inside cover of box.
    c. Junction boxes concealed above suspended ceilings or exposed in non-occupied spaces may be marked with permanent ink marker in lieu of printed labels.

2. Boxes with conductors greater than 600V: Apply labels identifying nominal system voltage on cover and minimum of one fixed side. One label shall be visible from the floor where boxes are installed exposed.
3. Fire alarm system boxes shall have red finish. Boxes shall be prefinished prior to installation.

C. Wiring and cabling identification:

1. Power circuit conductor identification, 600 volts or less: Apply color-coded identification for cables, feeders, and power circuit conductors exposed in accessible vaults, junction and pull boxes, utility structures, and equipment enclosures. Apply color-coding scheme as indicated below throughout the building's network of feeders and circuits, unless otherwise required by the authority having jurisdiction.

    a. Colors on conductors No. 10 and smaller, or No. 6 and smaller for grounded and grounding conductors: Solid colored insulation.
    b. Colors on conductors No. 8 and larger, or No. 4 and larger for grounded and grounding conductors: Apply colored tape wrapped a minimum of 6 inches (150 mm) on either end of conductor and in boxes where splices or taps are made.
    c. Conductors used solely for grounding purposes shall be green, if insulated.
    d. Where multi-conductor cables are used, use same color coding system for identification of wiring.

COLOR CODE (600 volts maximum)				
VOLTAGE	NEUTRAL	PHASE		
		A	B	C
120 volts, 2-wire	White	Black, Red, or Blue depending on phase		
277 volts, 2-wire	Gray	Brown, Orange, or Yellow depending on phase		
208 volts, single-phase, 2-wire		Black/Red, Red/Blue, or Blue/Black		
208/120 volts wye, 3-phase, 4-wire	White	Black	Red	Blue
480/277 volts wye, 3-phase, 4-wire	Gray	Brown	Orange	Yellow
480 volts delta, 3-phase, 3-wire		Brown	Orange	Yellow

2. Conductors for future use: Attach tags with circuit designation for conductors to be extended for future use.
3. Control and low-voltage system wiring shall be coded with colors and markings different from those used to designate phase wires.

D. Wiring device labels: For wiring devices such as receptacles, devices installed in surface raceway assemblies, and other wiring devices operating at or greater than 120V.

1. Apply adhesive film labels on outside of wiring device coverplates identifying circuit designation serving device.

E. Equipment identification: Install unique designation label consistent with contract documents and shop drawings.

1. Labeling instructions:

a. Engraved plastic laminate nameplates, unless otherwise indicated.
b. Unless otherwise required, provide a single line of text with 0.5-inch (13 mm) high lettering on 1.5-inch (38 mm) high label. Where two or more lines are required, use single label with increased height.
c. For multi-section or multi-compartment equipment, apply labels identifying each compartment or section.
d. For fusible equipment, identify fuse type and size on the front cover.
e. For enclosed circuit breaker equipment, identify device trip rating where rating is not visible.
f. Where equipment has more than one source of power (i.e., transfer switch, separate control power source), the location and circuit designation of each power source shall be clearly identified at the equipment location.

2. Apply nameplates and labels to equipment according to the below identification schemes:

a. Identify available fault current and calculation date. Apply products to the following equipment:

(1) Panelboards
(2) Switchboards

b. Identify equipment designation; voltage rating; phase and number of wires; and designation and location of load served. Apply products to the following equipment:

(1) Panelboards

c. Identify equipment designation; primary and secondary voltage ratings; phase and number of wires; circuit designation and location of primary source; and designation and location of load served. Apply products to the following equipment:

(1) Enclosed switches (disconnects/safety switches)
(2) Enclosed circuit breakers

d. Identify equipment designation; voltage rating; phase and number of wires; and capacity rating. Apply products to the following equipment:

(1) Generator: Capacity rating in kilowatts (kW).
(2) Transfer switches: Capacity rating in amperes; identify the location and circuit designation of each power source at the equipment location.

3. Nameplates shall incorporate white lettering on colored backgrounds based on the following color-coding scheme:

a. Normal power system: Black background.
b. Emergency power system (life-safety branch): Red background.
c. Emergency power system (equipment branch): Blue background.

F. Warning and caution labels and signs:

1. Apply warning and caution labels on equipment in accordance with NFPA 70 and 70E, ANSI, and OSHA requirements including arc flash hazard warning labels and special clearance requirements.
2. Apply warning and caution labels and signs at locations where safe operation and maintenance of electrical system equipment is of concern.
3. Apply warning signs on electrical room doors in accordance with NFPA 70 and 70E, ANSI, and OSHA requirements. Where doors are located in finished, public areas, located sign on the inside of the door. Coordinate mounting requirements with door type.

G. Service-entrance equipment: Update field marking of service entrance equipment maximum available fault current values in accordance with NFPA 70 requirements.

H. Underground warning tape: Apply underground warning tape above underground ductbanks, conduit, or direct-buried cable.

3.3 FIELD QUALITY CONTROL

A. Coordinate names, abbreviations, colors, and other designations with construction documents, submittals, and applicable code and standards requirements. Utilize consistent designations and identification techniques throughout project.

B. Install identification products at locations that are clearly visible at normal viewing angles and without interference with operation and maintenance of the equipment.

C. Install identification products in a neat and clean, workmanship-like manner where products are securely attached and oriented parallel to equipment edges.

END OF SECTION

SECTION 26 0573

OVERCURRENT PROTECTIVE DEVICE STUDIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical system fault-current and protective device study:

1. Fault-current analysis.

B. Description: Provide study for overcurrent protective devices connected to existing switchboard and new generator serving new panelboards, and for new panelboards.

1.2 RELATED SECTIONS

A. Sections in Division 26, including Section 26 2416 Panelboards.

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
2. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
3. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
4. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
4. ANSI C37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. National Fire Protection Association (NFPA):

1. NFPA 70 – National Electrical Code, latest edition.
2. NFPA 70E – Standard for Electrical Safety in the Workplace.

D. Occupational Safety and Health Administration (OSHA):

1. OSHA 29 Code of Federal Regulations (CFR) Part 1910, Subpart S.

1.4 SUBMITTALS

A. Product data: For computer software to be used to perform studies.

B. Product certificates: For coordination-study and fault-current analysis computer software programs, certifying compliance with IEEE 399.

C. Qualifications: Submit evidence indicating individual and organization compliance with requirements indicated in “Quality Assurance” below.

D. Preliminary electrical system study: Submit for review before distribution equipment shop drawings have been submitted, and before equipment order has been released to the manufacturer.

1. If formal completion of the study may delay the project schedule, Engineer may approve use of the preliminary draft for ordering equipment.
2. If approved for use in ordering equipment, preliminary draft shall include sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.

E. Final electrical system study:

1. Submit final report for review and record.
2. Incorporate changes resulting from deficiencies and corrections of preliminary draft report.

F. Reports:

1. Electrical system study report: Submit reports required above including the following items:

a. General report information: Scope, definitions, descriptions, assumptions, and other information necessary to properly interpret results of the report.
b. Tabulated summary comparing protective device ratings and calculated available fault-current levels.
c. Fault-current analysis calculations.
d. System one-line diagram.
e. Input and output data used for each component and for study calculations.

2. Submit final reports as electronic files in portable document format (.pdf) to Owner. Submit program base files in file format of computer software utilized to perform study.

1.5 QUALITY ASSURANCE

A. Electrical system study shall be performed by one or more independent qualified organizations, and under the supervision and approval of a Registered Professional Engineer skilled in performing and interpreting the power system studies.

B. Qualifications of organization performing electrical system study: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices:

1. Registered Professional Engineer shall be a full-time employee of the equipment manufacturer or of an approved engineering firm.
2. Registered Professional Engineer shall have a minimum of five (5) years of experience in performing power system studies and registered in the state where the project is located.

C. Qualifications of computer-based software: Widely available, complying with standards, guides, and codes as referenced above.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Computer software: Subject to compliance with requirements, utilize product by one of the following:

1. EDSA Micro Corporation
2. Operation Technology, Inc.
3. SKM Systems Analysis, Inc. (Basis of Design)

2.2 COMPUTER SOFTWARE REQUIREMENTS

A. Comply with IEEE 399.

B. Computer software program shall be capable of performing fault-current analysis of project electrical distribution system.

C. 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.

D. Computer software program shall be capable of performing arc fault hazard analysis using equations as established by IEEE 1584 and requirements presented in NFPA 70E, Annex D.

E. Software shall include a comprehensive equipment library of manufacturer-based and IEEE / ANSI based equipment to accurately model the electrical distribution system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine project submittals for compliance with electrical distribution system requirements outlined on the drawings and in electrical specification sections.

3.2 SYSTEM DATA COLLECTION

A. The Contractor shall furnish data required to perform the power system studies. The Engineer performing the fault analysis study shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to ensure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. If applicable, include fault contribution of existing motors and equipment in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

C. The Engineer performing the studies shall gather and tabulate input data necessary to support each study including the following:

1. Product data for each component of the electrical distribution system.
2. Utility available fault contribution and impedance values.
3. Drawings, one-line, and riser diagrams showing system configuration, equipment designations, feeder lengths, and other applicable system characteristics.

3.3 SYSTEM FAULT CURRENT ANALYSIS

A. Calculate the maximum available short-circuit momentary current and interrupting duties in amperes rms symmetrical for electrical power distribution system components. The calculation shall be performed for current immediately after initiation and for a three-phase bolted fault at each of the following locations:

1. Electric utility's supply termination.
2. Existing switchboard.
3. New branch circuit panelboards.
4. Generator output terminals.

B. Study the project's electrical distribution system from normal and alternate power sources throughout electrical distribution system.

C. For grounded systems, provide line-to-ground fault current values for areas as defined above for the three-phase, bolted fault, short-circuit study.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, IEEE 241 and IEEE 242.

E. Study report:

1. Input data: Gather and provide the following input data, in tabular or graphic form, used to perform fault calculations and other studies in this section.

    a. Utility three-phase and line-to-ground available contribution with associated X/R ratios.
    b. Short-circuit reactance of rotating machines with associated X/R ratios.
    c. Cable type, construction, size, quantity per phase, length, impedance and conduit type.
    d. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio.
    e. Circuit breaker types and sizes.

2. Methods and assumptions: Indicate calculation methods and assumptions that may have been used to perform analysis.
3. Results: Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram. Provide the following in a table format:

    a. Source fault impedance and generator contributions
    b. X/R ratios
    c. Asymmetry factors
    d. Motor contributions
    e. Short circuit KVA
    f. Symmetrical and asymmetrical fault currents

4. Equipment evaluation and conclusions:

    a. Verify interrupting ratings and withstand ratings are equal to or higher than calculated fault current levels.
    b. Verify adequacy of phase conductors at maximum three-phase, bolted fault currents.

5. Recommendations: List recommendations for equipment with inadequate ratings. Notify Engineer, in writing of existing equipment improperly rated for the calculated available fault current of the system.

3.4 AVAILABLE FAULT CURRENT LABELS

A. Provide a machine printed adhesive label on the enclosure for each switchboard and new panelboard. The label shall include the following information, at a minimum:

1. Available fault current
2. Calculation date

B. Labels will be based on calculated maximum available short-circuit momentary current and will be provided after the results of the analysis have been presented to the Owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. Labels shall be in compliance with NFPA 70E and OSHA standards.

3.5 FIELD QUALITY CONTROL

A. Field adjustment: Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Engineer in writing of any required equipment modifications.

END OF SECTION

SECTION 26 2200

TRANSFORMERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Transformers for electric power 600 volts and below.

B. General-purpose transformer.

1.2 RELATED SECTIONS

A. Equipment foundations: Section 26 0528.

1.3 REFERENCES

A. NEMA ST 20: Dry-Type Transformers for General Applications.

B. DOE 2016: Department of Energy federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment."

1.4 SUBMITTALS

A. Product data: Each transformer, includes the following:

1. Outline dimensions and weights.
2. kVA rating.
3. Primary and secondary voltage.
4. Taps.
5. Impedance.
6. Insulation class and temperature rise.
7. Sound level.

B. Certifications:

1. Specified sound levels.
2. Compliance with DOE 2016 for energy efficiency.

C. Test reports: Factory and field test reports specified in Parts 2 and 3 below.

D. Unit shown on drawings is based on the characteristics of the design basis unit specified in Part 2. If another acceptable manufacturer’s unit should be proposed, ascertain that it will meet the required standards and performance. Include, with shop drawings of the unit, scale drawings similar to the contract drawings, showing any changes in wiring, arrangement or access made necessary to accommodate the unit proposed.

E. Operation and maintenance data: For transformer to include in operation and maintenance manuals: In addition to items specified in Division 01 and Section 26 0101, include the following:

1. Final settings for transformer taps and measured voltage.

1.5 QUALITY ASSURANCE

A. UL label and local testing (if required): As specified in Section 26 0500, Common Work Results for Electrical.

B. UL Energy Verification Mark to confirm compliance with DOE 2016.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Schneider Electric; Square D products units are the basis for design of the project. The following listed manufacturers also provide units of acceptable quality. If units by any of these manufacturers should be proposed, verify that they meet requirements specified in the article “Product Options” in Section 26 0101, and submit shop drawings as specified in the article “Submittals” above.

1. ABB; General Electric products
2. Eaton Corporation
3. Schneider Electric; Square D products
4. Siemens Industry, Inc.

2.2 TRANSFORMERS, GENERAL

A. Factory-assembled and -tested, air-cooled units of types specified, of size, phase, and voltage ratings indicated on the drawings, designed for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous copper windings without splices except for taps.

D. Enclosure: Heavy-gauge steel enclosure and base, arranged for conduit entrance on the primary and secondary sides and provided with adequate louvered openings to allow suitable ventilation and cooling. NEMA 250 Type 1.

E. Enclosure finish: Degreased, cleaned, phosphatized, primed and finished with baked enamel paint. Comply with NEMA 250; color manufacturer's standard gray.

F. Taps: Four, 2.5 percent rated kVA taps, two below and two above rated primary voltages, except transformers rated 15 kVA and smaller may have two 5-percent-rated kVA taps, one above and one below rated primary voltage.

G. Sound levels based on NEMA ST 20 test procedure:

1. Transformer 50 kVA and smaller: Not more than 45 dB.
2. Transformers 51 to 150 kVA: Not more than 50 dB.
3. Transformers 151 to 300 kVA: Not more than 55 dB.
4. Transformers 500 kVA: Not more than 60 dB.

2.3 GENERAL-PURPOSE TRANSFORMERS

A. Self-cooled, dry type of size, phase, and voltage rating indicated on the drawings, designed in accordance with NEMA ST-20. Dry-type, general-purpose transformers shall be Energy Efficient type in compliance with DOE 2016.

B. Insulation: The maximum hot spot temperature can be 30 degrees C higher than the specified average below.

1. Transformers below 15 kVA: Class 150 degrees C having a maximum temperature rise under full load conditions not exceeding 115 degrees C when the transformer is operating in 40 degrees C ambient temperature.

2. Transformers 15 kVA and higher: Class 220 degrees C having a maximum temperature rise under full load conditions not exceeding 150 degrees C when the transformer is operating in 40 degrees C ambient temperature.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Mount on wall, ceiling, or floor as shown on the drawings. Transformers shall be level and plumb. Transformers shall not be mounted in corrosive areas.

1. Wall mount: Use manufacturer's wall-mounted bracket in accordance with manufacturers' instructions.
2. Ceiling mount: Use one of the following two methods:

a. Use manufacturer's ceiling-mounted bracket in accordance with manufacturers' instructions.
b. Field-fabricated trapeze mount: Trapeze mounting made from galvanized-steel strut or channel. Suspend trapeze from galvanized-steel rods, anchor to ceiling or structure above. If trapeze is adjacent to wall, additionally fasten to wall. Provide vibration isolation between transformer and trapeze or between trapeze and its supports.

B. Floor mount: On equipment foundation (housekeeping pad).

C. Mount exterior equipment on equipment foundation as shown on drawings.

D. Ground neutrals of dry type transformers as specified in Section 26 0526, Grounding and Bonding and as required by NEC (NFPA 70).

3.2 INSTALLING TRANSFORMER

A. Protect against overload on the primary side by circuit breakers in the panelboards or fused disconnects as indicated.

B. Install transformers on neoprene vibration isolator pads.

C. Make immediate connections to and from transformers through flexible metal conduit.

3.3 IDENTIFICATION

A. Materials: Refer to Section 26 0553, Identification for Electrical Systems.

B. Nameplates: Refer to Section 26 0553, Identification for Electrical Systems, for additional requirements. Provide identification nameplate for each transformer located on front of assembly.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's field service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Remove and replace units that do not pass tests or inspections and retest as specified above.

C. Test labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING AND CLEANING

A. Refinish painted surfaces damaged during construction to match the rest of the equipment.

B. Measure voltage on the secondary side of transformer during a typical occupancy period and adjust taps to achieve nominal voltage output. Nominal voltage shall be plus three percent or minus two percent of nameplate secondary voltage.

C. Record final tap settings and measured voltage and include in Operation and Maintenance manuals.

3.6 PROTECTION

A. Apply temporary heat within indoor transformer enclosures, in accordance with manufacturer's recommendations, until the space temperature and humidity are under normal control.

END OF SECTION

SECTION 26 2416

PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Circuit breaker panelboards, distribution and lighting and appliance branch-circuit types.

B. Fusible branch circuit panelboards.

1.2 RELATED SECTIONS

A. Identification for electrical systems: Section 26 0553.

B. Overcurrent protective device studies: Section 26 0573.

C. Fuses: Section 26 2813.

D. Surge protective devices: Section 26 4313.

1.3 REFERENCES

A. ANSI/NECA 407: Recommended Practice for Installing and Maintaining Panelboards.

B. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).

C. NEMA PB 1: Panelboards.

D. NEMA PB 1.1: Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.

E. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

F. UL 50: Enclosures for Electrical Equipment.

G. UL 67: Panelboards.

H. UL 1449: Surge Protective Devices.

1.4 DEFINITIONS

A. Circuit-breaker panelboards in this section:

1. Lighting and appliance panelboards: Maximum branch circuit breaker amperage:

a. 277/480-volt panelboards: 125 amperes
b. 120/208-volt panelboards: 100 amperes.

1.5 SUBMITTALS

A. Product data: For each type of panelboard, overcurrent protective device, surge protective device, accessory, and component indicated.

B. Bill of materials: Provide detailed list of components.

C. Shop drawings: For each type of panelboard, include the following details:

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings in panel schedule format.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.

D. Operation and maintenance data: For panelboards and components to include in operation and maintenance manuals. In addition to items specified in Division 01 and Section 26 0101, include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.
3. Copy of each printed panelboard schedule representing.

1.6 QUALITY ASSURANCE

A. Do not submit equipment submittals prior to completing Short-Circuit and Coordination Study as indicated in Section 26 0573.

B. Source limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

C. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency accepted by the authority having jurisdiction, and marked for intended location and application; listed as a complete assembly.

1. UL label and local testing (where required): As specified in Section 26 0500, Common Work Results for Electrical.

D. Comply with referenced standards and listings previously identified including NEMA PB 1, NFPA 70, and UL 67.

1.7 COORDINATION

A. 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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.9 PROJECT CONDITIONS

A. 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. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service. Provide applicable details of proposed outage including sequence of work and methods of providing temporary electrical service.
2. Do not proceed with interruption of electrical service without written permission.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Furnish spare breakers for panelboards as indicated in schedule on drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Circuit breaker panelboards: Subject to compliance with requirements, provide circuit breaker panelboards manufactured by Schneider Electric; Square D products or comparable product by one of the following:

1. ABB; General Electric products
2. Eaton Corporation
3. Schneider Electric; Square D products
4. Siemens Industry, Inc.

B. Fusible branch circuit panelboards: Subject to compliance with requirements, provide fusible branch circuit panelboards manufactured by Eaton Corporation; Bussmann products or comparable product by one of the following:

1. ABB; General Electric products
2. Eaton Corporation; Bussmann
3. Littelfuse, Inc.
4. Mersen
5. Schneider Electric; Square D products
6. Siemens Industry, Inc.

2.2 PANELBOARDS, GENERAL

A. UL listing: UL 67, listed and labeled.

B. Integrated equipment short-circuit rating: Each panelboard, as a complete unit, shall have a short-circuit rating equal to or greater than the integrated equipment rating shown or scheduled on the drawings.

1. Rating shall be established by testing in accordance with UL 67, with the overcurrent devices mounted in the panelboard. Make short-circuit tests on the overcurrent devices and on the panelboard structure simultaneously, by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. The source shall be capable of supplying specified panelboard short-circuit current or greater.

2. Testing of overcurrent devices only while individually mounted is not acceptable. Testing the bus structure by applying a fixed fault to the bus structure alone is not acceptable.
3. Mark each panelboard with its maximum short-circuit current rating at the supply voltage.
4. Series rating of panelboards with devices outside of the panelboard enclosure are not permitted.

C. Enclosures: Flush- or surface-mounted as indicated, NEMA PB 1, Type 1, UL 50, galvanized steel.

D. Directory card: Inside panelboard door, mounted in metal frame with transparent protective cover with information as indicated in Part 3, Identification.

E. Provisions for future devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Furnish each unit with a master nameplate, listing standard manufacturer information including voltage, ampacity, frequency, and short-circuit ratings; manufacturer's model and project designations.

2.3 CIRCUIT-BREAKER PANELBOARDS

A. Factory-assembled complete with breakers.

B. Cabinets and fronts: Minimum 20 inches wide, wiring gutter space in accordance with UL 67, with minimum four-inch width on every side.

1. Cabinet front: Hinged trim with entire front hinged to cabinet box with piano hinge and screw fasteners for surface mounted cabinets. Door-in-door construction, one or more latches as required for size, with outer door covering the gutter.
2. Door: Required for sizes up to and including 600 amperes.

a. Lock: Flush, cylinder tumbler type, with catch and spring-loaded stainless steel door pull. All panelboards shall be keyed alike. Provide two keys per lock. Provide extra keys as required in "Extra Materials" in Part 1 above.
b. Hinges: Steel, completely concealed.

C. Circuit breakers: UL 489; voltage, continuous-current rating, and interrupting rating as indicated on the drawings or determined by the results of the Short-Circuit Analysis performed under Section 26 0573, whichever is greater.

1. Breakers shall be 1-, 2- or 3-pole, with an integral crossbar to ensure simultaneous opening of all poles in multipole circuit breakers.
2. Operating mechanism: Over center, trip-free, toggle-type with quick-make, quick-break action. Handles shall have on, off, and tripped positions.
3. Circuit breakers shall be able to be installed in the panelboard without requiring additional mounting hardware or disturbing adjacent units, bars, or branch circuit connections.
4. Where indicated on the drawings, provide shunt-trip main breakers, standard main breakers, or lugs.
5. Main and branch circuit breakers shall have device ampacity rating engraved on the front or side of each breaker handle. The breaker rating shall be clearly visible without removing panelboard cover.
6. Circuit breakers shall be rated for use with 75 deg C wire (conductor temperature rating).
7. Thermal-magnetic circuit breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 amperes and larger.

8. Adjustable instantaneous-trip circuit breakers: Magnetic trip element with front mounted, field-adjustable trip setting.
9. Electronic trip circuit breakers: RMS sensing; field-replaceable rating plug or field replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

10. Ground-fault circuit interrupter (GFCI) type circuit breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
11. Tandem breakers are not permitted.

D. Bussing assembly and temperature rise: Panelboard bus structure and main lugs or main circuit breaker shall have current ratings as shown on the panelboard schedule, established by heat rise tests conducted in accordance with UL 67.

    1. Conductor dimensions shall not be accepted in lieu of actual heat tests.
    2. Current-carrying parts of the bus structure shall be hard-drawn copper, 98 percent conductivity.
    3. Provide a separate copper ground bus with screw terminals for branch wiring and feed-through lugs.

E. Branch circuit panelboards: Panelboard shall be capable of accepting up to 125-ampere branch circuit breakers at 277/480 volts, and 100-ampere branch circuit breakers at 120/208 volts.

    1. Branch circuit breakers serving exit lights, fire alarm, telephone equipment, shall be provided with handle-blocking devices which shall prevent accidental operation but not prevent tripping.

2.4 FUSIBLE BRANCH CIRCUIT PANELBOARDS

A. Factory-assembled complete with branch fuse disconnect:

    1. Emergency (life-safety) panelboard(s) shall be fusible branch circuit panelboards.
    2. Main lug only, main fused switch, or main non-fused switch as indicated on the drawings, with main fused switch selectively coordinated with fusible branch switches.
    3. Six spare single-pole 20-ampere fuses, unless otherwise noted.
    4. UL Listed minimum interrupting rating of 200,000 rms symmetrical amperes at 600 volts AC.

B. Cabinets and fronts: Minimum 20 inches wide, wiring gutter space in accordance with UL 67.

    1. Cabinet front: Door-in-door construction, one or more latches as required for size, with outer door covering the gutter.
    2. Door: Lock, two keys per lock, steel hinges, and circuit directory card on inside of door.

C. Branch fuse disconnects: UL 248, UL 98, and NEMA FU 1; voltage, continuous-current rating, and interrupting rating as indicated on the drawings.

    1. Incorporating overcurrent protection fuse and disconnecting means into a single integrated finger-safe component (1-pole, 2-pole or 3-pole) mechanically interlocked to prevent removal of the fuse while fuse terminals are energized.
    2. Interchangeable from 15 amperes to 100 amperes without requiring additional space.
    3. Time-delay UL Listed Class CF power fuses (equivalent to Class J).
    4. Visible circuit ON/OFF indication positions and open fuse indication.

5. Permanently installed lockout means in the OFF position.

D. Bussing assembly and temperature rise: Panelboard bus structure and mains shall have current ratings as shown on the drawings:

1. Sufficient cross section to meet UL 67 temperature rise requirements.
2. Current-carrying parts of the bus structure shall be hard-drawn copper, 98 percent conductivity.
3. Provide a separate copper equipment ground bar and neutral bus bar.

2.5 SURGE PROTECTIVE DEVICE (SPD)

A. As part of the panelboard, provide service entrance SPD specified in Section 26 4313, Surge Protective Devices where indicated on drawings. Note the requirement of that section for a single manufacturer to provide all SPD of all types in the project.

2.6 SOURCE QUALITY CONTROL

A. With branch circuit breakers installed, short-circuit test panelboards as complete units, in accordance with requirements of UL 67.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Securely attach panelboards to the wall where indicated on the drawings. Install in accordance with NEMA PB 1.1 and manufacturer's written installation instructions.

1. Mounting height:

a. 72 inches (1829 mm) to top of panelboard.
b. Panelboards taller than 72 inches (1829 mm): Bottom edge no more than 4-inches (102 mm) above floor.
c. Top breaker maximum height: No more than 6-feet, 7-inches (2.0 m) above the floor or working platform.

B. Comply with applicable portions of NECA 407.

C. Frame and mount printed circuit directory indicating type and location of equipment on each circuit.

D. Wiring in gutters: Arrange conductors into groups, and bundle and wrap with wire ties.

E. Install filler plates in unused spaces.

3.2 CONNECTIONS

A. Connect panelboards and components to wiring and to ground as indicated.

B. Shared neutral conductors shall not be permitted, except where indicated.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's values are not indicated, use those specified in UL 486A and UL 486B.

3.3 IDENTIFICATION

A. Materials: Refer to Division 26 Section "Identification for Electrical Systems." Identify units, auxiliary devices, controls, and wiring. Identify equipment ratings.

B. Nameplates: Refer to Division 26 Section "Identification for Electrical Systems" for additional requirements. Provide identification nameplate for each panelboard and associated components located on front of assembly.

C. Identify field-installed wiring and components. Refer to Division 26 Section "Identification for Electrical Systems" for additional requirements.

D. Identify available fault current and calculation date. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

E. Provide printed directory for each panelboard. Handwritten directories are not acceptable. Copying of panel schedules and descriptions on drawings is not acceptable. Circuit directory shall reflect final circuit installation. Include the following information:

1. Panelboard designation and room location.
2. Circuit breakers, size and number of poles.
3. Circuit or feeder description including destination room name(s) and number(s).
4. Clear description of type of load circuit serves.
5. Panelboard ratings: Main bus ampacity, main circuit breaker or main lug ampacity, AIC rating.
6. Incoming primary feeder size and source panelboard circuit designation.

F. Room names and numbers on the panelboard circuit directories shall match names and numbers used by the Owner. Note that room names and numbers on the drawings may not match the Owner's final room name and numbering scheme.

3.4 FIELD QUALITY CONTROL

A. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuit.

B. Make continuity tests of each circuit.

C. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification for molded-case circuit breakers. Certify compliance with test parameters.

D. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 CLEANING

A. Clean interior and exterior of panelboards.

B. Refinish painted surfaces damaged during construction to match the rest of the panelboard.

END OF SECTION

SECTION 26 2550

GENERATOR DOCKING STATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Generator docking station.

1.2 RELATED SECTIONS

A. Generators: Section 26 3213.

1.3 REFERENCES

A. UL 1008: Transfer Switch Equipment.

1.4 SUBMITTALS

A. Product data: For generator docking station indicated. Include electrical ratings, operating characteristics, manufacturers' technical data on features and functions, enclosures, and furnished accessories.

B. Shop drawings: For generator docking station indicated, submit the following:

1. Ratings, dimensioned plans, elevations, and sections; weights; loads; required clearances; mounting arrangements; components; conductor entry, gutter space; and location of each field connection.
2. Wiring diagrams differentiating between manufacturer-installed and field-installed wiring, and including power and control wiring.

C. Field quality-control test reports.

D. Operation and maintenance data: For generator docking station and associated components, include in operation and maintenance manuals. In addition to items specified in Division 01, include the following:

1. Features and operating instructions.
2. Troubleshooting procedures.

E. Warranty: Certificate of special warranty.

1.5 QUALITY ASSURANCE

A. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL (Underwriters Laboratories, Inc.) Standards, UL 1008.

C. Comply with NFPA 70, National Electrical Code (NEC).

1.6 WARRANTY

A. Special warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the generator docking station that fail in materials or workmanship within specified warranty period:

1. Warranty period: Two years from date of substantial completion.

PART 2 - PRODUCTS

2.1 GENERATOR DOCKING STATION

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. ESL Power Systems, Model "TripleSwitch"
2. TRYSTAR, Model DPDS-5 (basis-of-design)

2.2 GENERAL REQUIREMENTS

A. Enclosure: Pad or wall mounted cabinet, front accessible, NEMA 250 Type 3R.

1. Front door: Hinged, gasketed, with pad-lockable latch.

B. Phase, neutral, and ground buses:

1. Material: Silver-plated, hard-drawn copper.
2. Equipment ground bus: Bonded to box.
3. Ground bus: 50 percent of phase size.
4. Neutral bus: Neutral bus rated 100 percent of phase bus.
5. Round edges on bus.

C. Temporary generator connections:

1. Camlocks: Color coded according to system voltage, with protective flip lids.

a. A phase: Brown
b. B phase: Orange
c. C phase: Yellow
d. N neutral: White
e. G ground: Green

2. Termination lugs for cable connections.

D. Voltage and phase: Indicated on drawings.

E. Amperage: Indicated on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive generator docking station for compliance with installation tolerances and other conditions affecting performance of the work.

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

3.2 INSTALLATION

A. Install anchor bolts to elevations required for proper attachment to generator docking station.

B. Temporary lifting provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 FIELD QUALITY CONTROL

A. Tests and inspections to include the following:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

B. Generator docking station will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports, including a certified report that identifies generator docking station. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Manufacturer's field start-up: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections prior to turn-over to Owner.

END OF SECTION

SECTION 26 2726

WIRING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Receptacles.

1.2 RELATED SECTIONS

A. Boxes: Section 26 0534.

B. Identification: Section 26 0553.

1.3 REFERENCES

A. ANSI/NEMA WD 6: Wiring Devices - Dimensional Specifications.

B. NEMA WD 1: General Color Requirements for Wiring Devices.

C. UL 498: Attachment Plugs and Receptacles.

1.4 SUBMITTALS

A. Product data: Each type of device used in the project.

B. Field quality-control test reports.

PART 2 - PRODUCTS

2.1 RECEPTACLES

A. Acceptable manufacturers:

1. Arrow Hart/Eaton Wiring Devices
2. Hubbell/Bryant Electric
3. Legrand/Pass & Seymour (P&S)
4. Leviton Manufacturing Co.

B. Receptacles: NEMA 5-20R, 20-ampere rating, 125 volts AC, 2-pole, 2-wire plus ground, conforming to NEMA WD 1 and WD 6 configuration numbers, and UL 498.

1. Specification grade:

a. General-use, duplex:

(1) Basis of design: P&S TR5362, hard-use, tamper-resistant.

b. Ground-fault circuit-interrupter (GFCI) type for exterior and wet locations, duplex:

(1) Basis of design: P&S 2097TRWR, tamper-resistant, weather-resistant.

C. Device colors:

1. Normal power receptacles: White.
2. Generator power receptacles: Red.

D. Device covers:

1. Wall plates: Smooth nylon, color shall match device color.

a. Basis of design: P& smooth nylon, TP series, color shall match device color.

2. Wet-location, weatherproof cover, single-gang, extra-duty:

a. Basis of design: P&S WIUCAST1, while-in-use, cast aluminum, gray.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices in complete compliance with the manufacturer’s recommendations.

B. Arrangement of devices: Unless otherwise indicated, mount flush with long dimension vertical. Group adjacent devices under single multi-gang wall plates.

C. Receptacles:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

D. Wall plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard wall plates do not fit flush or do not cover rough wall opening.

3.2 IDENTIFICATION

A. Comply with Section 26 0553 "Identification for Electrical Systems."

B. Identify receptacles with panelboard identification and circuit number. Use self-adhesive labeling.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and inspections:

1. After installing devices and after electrical circuitry has been energized, test for compliance with requirements.
2. Receptacles:

a. Insert and remove test plug to verify that device is securely mounted.
b. Verify polarity of hot and neutral pins.
c. Measure line voltage.
d. Measure grounding circuit continuity; impedance shall be not greater than 2 ohms.

C. Correct malfunctioning devices on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new devices and retest.

D. Report results of tests and inspections in writing.

END OF SECTION

SECTION 26 2800

ENCLOSED CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Enclosed switches (disconnects/safety switches).

1.2 RELATED SECTIONS

A. Motors:

B. Fuses: Section 26 2813.

C. Overcurrent protective device study: Section 26 0573.

1.3 REFERENCES

A. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. UL 98: Enclosed and Dead-Front Switches.

1.4 SUBMITTALS

A. Product data: Each type of enclosed switch.

1.5 QUALITY ASSURANCE

A. Comply with the following standards:

1. NEMA KS 1 for enclosed switches.
2. UL 98.
3. UL 198E.

B. UL label and local testing (if required): As specified in Section 26 0500, Common Work Results for Electrical.

PART 2 - PRODUCTS

2.1 ENCLOSED SWITCHES (DISCONNECTS/SAFETY SWITCHES)

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

1. ABB; General Electric products.
2. Eaton Corporation.
3. Schneider Electric; Square D products.
4. Siemens Industry, Inc.

B. Properly size switches for number of poles and provide fused or non-fused as required for project conditions and to meet NFPA 70 requirements.

1. Neutral kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
2. Auxiliary contact kit: Two NO/NC (Form “C”) auxiliary contact(s), arranged to activate before switch blades open.

C. Fuse contacts and quick-make/quick-break jaws shall ensure positive contacts with reinforcing spring clips or other approved means.

D. Switches shall be front-operated.

E. Current-carrying parts: Plated copper.

F. Hinges: Noncurrent-carrying.

G. Switches shall be lockable in either open or closed position.

H. Type:

1. Non-fused switches: General-duty type on 120/208-volt systems, and heavy-duty type on 277/480-volt systems.
2. Fused switches: Heavy-duty type.

I. Enclosures: Indoors NEMA 250 Type 1; outdoors Type 3R with raintight hubs.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install enclosed switches where indicated and as required for motor outlets, transformers, and other equipment.

B. Securely attach and properly connect enclosed switches.

C. Provide an enclosed switch for each motor, as required by NFPA 70, except where it is provided in a panelboard within sight and easy reach of the motor, and provide wiring and connections from source. Enclosed switches shall be fused where protection is required or indicated on drawings and unfused elsewhere.

D. Enclosed switches:

1. Provide neutral kit where required for four-wire application.
2. Provide auxiliary contact kit where indicated on drawings.

END OF SECTION

SECTION 26 2813

FUSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fuses.

1.2 RELATED SECTIONS

A. Enclosed switches: Section 26 2800.

1.3 REFERENCES

A. UL 198E: Class R fuses.

B. UL 198C: High-Interrupting-Capacity Fuses, Current Limiting Types.

1.4 SUBMITTALS

A. Product data: Each type of fuse.

B. Published data on fuses shall include time/current curves, peak-let-through curves and I^2t melting and clearing curves.

1.5 QUALITY ASSURANCE

A. Comply with UL 198C, Class L fuses, also Classes G and J.

B. UL label and local testing (if required): As specified in Section 26 0500, Common Work Results for Electrical.

1.6 EXTRA MATERIALS

A. Provide three spare fuses for each type and size of fuse in the work.

PART 2 - PRODUCTS

2.1 FUSES

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

1. Eaton Corporation; Bussmann
2. Littelfuse, Inc.
3. Mersen

B. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

C. Fuses 0-600 amperes for 600-volt or 250-volt, UL labeled Class RK1 with time delay, with a minimum short-circuit interrupting capacity of 200,000 rms symmetrical amperes, and shall carry 500 percent of rating for a minimum of 10 seconds.

1. Fuses for enclosed switches (disconnects/safety switches) for packaged HVAC equipment: Size and type recommended by the equipment manufacturer and as required for equipment to meet UL rating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fuses where indicated and as required for motor outlets or other equipment.

END OF SECTION

SECTION 26 2923

VARIABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Variable frequency drives, rated less than 600V, for speed control of three-phase, induction motors.

1.2 RELATED SECTIONS

A. Motor requirements for HVAC equipment: Section 23 0513.

B. Pumps: Section 23 2123.

1.3 REFERENCES

A. ANSI/IEEE 399: Standard Practice for Industrial and Commercial Power Systems Analysis

B. NEMA: Application Guide for AC Adjustable Speed Drive Systems

C. NEMA ICS 61800-2: Adjustable Speed Electrical Power Drive Systems

D. NEMA ICS 7.0: Industrial Controls & Systems for Adjustable Speed Drives

E. NEMA ICS 7.1: Standard Standards for Construction and Guide Selection, Installation, and Operation of Adjustable Speed Drive Systems

F. NEMA MG 1: Motors and Generators

G. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

H. NFPA 70: National Electrical Code

I. UL 508: Standard for Industrial Control Equipment

J. UL 508C: Standard for Safety for Power Conversion Equipment

1.4 SUBMITTALS

A. Product data: For each type and rating of equipment, include electrical ratings, operating characteristics, manufacturers' technical data on features and functions, enclosures, and furnished accessories. Include product data for each of the following:

1. Variable frequency drive (VFD).

a. List rated capacities and relationship to motor values including voltage, horsepower, rated current, and short-circuit ratings.

B. Bill of materials: Provide detailed list of components.

C. Shop drawings: For each type of unit, indicate the following:

1. Dimensioned plans, elevations, and sections; weights; loads; required clearances; mounting arrangements; components; and location of each field connection.
2. List of installed device and related equipment ratings and features including:

    a. Unit type and standard details
    b. Enclosure type
    c. Nameplate and identification labels
    d. Factory settings of installed devices

3. Wiring diagrams: Power, signal, and control wiring.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and maintenance data: For each type of variable frequency drive and associated components, include in operation and maintenance manuals. In addition to items specified in Division 01 include the following:

1. Detailed operating and programming instructions.
2. Troubleshooting procedures.
3. Detailed spare parts list.
4. Warranty, executed and signed at the time of putting the unit in service.

1.5 QUALITY ASSURANCE

A. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application; listed as a complete assembly.

1. UL label and local testing (where required): As specified in Section 26 0500, Common Work Results for Electrical.

B. Variable frequency drives shall be fully assembled, inspected, and tested at the factory prior to shipment.

C. Provide variable frequency drives from the same manufacturer.

D. Installer qualifications:

1. Staff is authorized and factory-trained by manufacturer. Includes training in electrical safety as required by NFPA 70E and qualified as defined in NEMA PB 2.
2. Maintains a service center location with staff factory-trained by manufacturer in the Baltimore/Washington, DC, metropolitan area.
3. Service available 24 hours a day, seven days a week, 365 days a year.
4. Maintains an adequate stock of manufacturer’s genuine or approved parts to service this equipment.
5. Service and maintenance contracts available.

E. Testing agency qualifications: Member company of NETA or a nationally recognized testing laboratory (NRTL).

1. Testing agency’s field supervisor: Currently certified by NETA to supervise on-site testing.

F. Comply with referenced standards and listings previously identified including NEMA MG 1, UL 508C, and NFPA 70.

G. Verify motor, drive, and load compatibility. Motors shall be inverter duty rated, per NEMA MG1.

1.6 COORDINATION

A. Ratings and functions of each variable frequency drive unit shall be coordinated with associated motor and connected load including the following:

1. Load requirements such as torque, speed, and horsepower.
2. Motor and power supply characteristics.
3. Control and operational sequences.
4. Ambient, environmental, and physical conditions of installation location.

B. Coordinate layout and installation of drive and associated components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access.

C. Coordinate method and location for mounting equipment including size and location of housekeeping pads and structural channel supports.

D. Coordinate location of underslab and overhead conduit.

E. Coordinate with ATC for proper control and communications functions.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.8 PROJECT CONDITIONS

A. Environmental conditions: Variable frequency drive assembly and associated components shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient temperature: 0 to 40 deg C.
2. Relative humidity: 5 to 95 percent, non-condensing.
3. Altitude: Sea level to 3300 feet (1000 m).

B. Special environmental conditions: Where indicated on the drawings, provide equipment with enclosure ratings suitable for the installed space. Enclosure ratings shall comply with NEMA 250 and UL standards.

1.9 WARRANTY

A. Special warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of drive unit and associated auxiliary components that fail in materials or workmanship within specified warranty period:

1. Warranty period: Five years from date of substantial completion.
2. Warranty shall include all parts and labor.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Control power fuses: Six of each type and rating used.
2. Indicating lights: Six of each type installed.
3. Touchup paint: Three containers of paint matching enclosure finish, each 0.5 pint (250mL).

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-design product: Subject to compliance with requirements, provide products manufactured by ABB, Inc., or comparable product by one of the following:

1. ABB, Inc.
2. Eaton Corporation
3. Trane/Danfoss
4. Yaskawa Electric America, Inc.

2.2 VARIABLE FREQUENCY DRIVES

A. Description: Enclosed variable frequency, alternating-current (AC) motor controller assembly suitable for operation of inverter-duty, Design A and Design B, induction motors as defined by NEMA MG1. The drive shall be designed for variable torque applications.

1. Unit shall be a packaged assembly including power conversion components, disconnecting means, overcurrent and overload protection, bypass, and control components.

B. Equipment ratings and design:

1. Ratings: VFD shall be sized to match the motor load type served. The motor current, voltage, and/or horsepower ratings are scheduled on the drawings. The following drive ratings shall also apply:

a. Input power characteristics: Unit shall be capable of continuous operation under the following conditions.

(1) Voltage variation: Plus 10 percent or minus 15 percent, nominal 208 VAC or 480 VAC.
(2) Frequency variation: Plus or minus 5 percent, 60 Hz.
(3) Power factor (input-primary side): 0.95 minimum.

b. Output power characteristics: 0 to Rated Input Voltage, 3-phase, 0 to 120 Hz.

(1) Current: Drive shall be capable of continuous operation at rated full load motor current.
(2) Power factor (output-secondary side): 0.90 minimum.

c. Minimum efficiency: 95 percent at half speed; 97 percent at rated full speed.
d. Overload capability: 110 percent of the normal duty current rating for 60 seconds, and 130 percent for 2 seconds.
e. Short-circuit current (withstand) rating: Minimum 65 kA, without additional input fuses, or available fault current value determined by short circuit analysis, whichever is greater.

f. Audible noise: Motor and VFD combination noise level shall not be increased more than 2 dBA at 3 feet (1m), compared to motor operation from across-the-line motor control.
g. Output carrier frequency: Unit shall have adjustable frequency switching settings up to 4 kHz without derating the drive output characteristics. Drive selection size may be increased to comply.

2. Design: Unit shall consist of the following components and characteristics:

a. Power conversion components: Microprocessor based control.

(1) Rectifier: Solid state, full-wave, diode-bridge rectifier used to convert AC input power to DC power, with metal-oxide-varistor (MOV) surge protection.

(a) Provide 6-pulse drives.

(2) DC bus: DC-bus reactor and capacitor components to minimize reflected harmonics and manage DC power to inverter. Bus shall interface with VFD programmable logic controller, for continuous monitoring and protection of system components, and include short circuit protection and filtering.
(3) Inverter: Insulated-gate-bipolar-transistor (IGBT) type employing pulse-width-modulated (PWM) technology power supplies for sine-code, AC output waveform.

b. Standard power conditioning components: Provide the following power conditioning and filter devices.

(1) Integral, DC link reactor.
(2) Integral, 3-phase, EMI/RFI filter capable of filtering out radio frequency interference (RFI) in the range of 10 kHz to 30 MHz, and compliant with FCC regulations.
(3) Output reactor filters on load side of drive for motor protection where motor length is greater than 100 feet (30.5 m).

C. Construction:

1. Enclosure: UL (NEMA 250) Type 12 (indoors), Type 3R (outdoors), and Type 1 (within HVAC units) according to UL 508; or as scheduled on the drawings.

a. For units located outdoors and subject to direct sun exposure, provide sun shields over front, side and top of enclosures.

2. Completely assembled and tested by the manufacturer. Listed and labeled as a complete assembly under UL 508C.
3. Furnish each unit with a master nameplate, listing standard manufacturer information including voltage, ampacity, frequency, and short-circuit ratings; manufacturer's model and project designations.

D. Drive features:

1. System interface:

a. Digital display and keypad operator station sealed and located on front of assembly.

(1) Operator interface shall provide complete programming, program copying, operating, monitoring, and diagnostic capabilities.
(2) Operator interface shall include menus and selections to display system characteristics such as metering, program parameters, settings, and messages. Standard displays shall include:

(a) Output frequency (hertz).
(b) Set-point frequency (hertz).
(c) Motor current (amperes).
(d) DC-link voltage (volts-dc).
(e) Motor torque (percent).
(f) Motor speed (rpm).
(g) Motor output voltage (volts).
(h) Historical Information: Displays indicating current time and date, total run time, total power versus time log, and fault log.

(3) Keypad shall include Hand-Off-Auto selections in addition to programming and control keys.
(4) Security access: Capable of preventing access by unauthorized personnel and protecting data and system parameters.

b. System input characteristics capable of accepting remote signals from the Building Automation System (BAS) shall include the following:

(1) Minimum of six programmable, multifunction digital inputs.
(2) Minimum of two programmable analog inputs accepting current or voltage signals for speed reference.
(3) Minimum of one external fault input, programmable for normally open or normally closed contact, used for connection of freeze, fire, smoke contacts, or high-pressure limits.

c. System output characteristics including the following:

(1) Minimum of three programmable, multifunction, digital, Form-C type, relay outputs.
(2) Minimum of two programmable analog outputs.
(3) Programmable loss-of-load, Form-C type, relay output dedicated to drive protection under motor failure condition.

2. Building automation system (BAS) interface: Factory-installed or optional card hardware and software package to enable the BAS to monitor, control, and display VFD status, alarms, and energy usage.

a. Network communications: Ethernet based with RS-422/RS-485 communication port.
b. Integral or removable communications card embedded with standard BAS protocols including Johnson Controls, Modbus, Siemens Building Technologies, and BACnet. Additional protocols such as LonWorks, DeviceNet, Ethernet TCP/IP, and Profibus shall be available with the addition of an optional card.

3. Provide separate terminal strip and four auxiliary contacts for connection to remote device providing remote start/stop signals. All interlocks and start/stop contacts shall remain functional whether the drive is in Hand, Auto, or Bypass.
4. Local Communication Port: RS-232 or USB 2.0 for connection of portable computer or peripheral device.
5. Cooling fans: VFD shall incorporate cooling fan system to dissipate heat from assembly to maintain drive temperature control.
6. Control power for drive controls as well as digital inputs and outputs shall be derived from internal power supply or control system power source.

E. Drive functions: The VFD shall include the following functions, either pre-programmed or field-programmed according to project requirements.

1. Minimum of three programmable preset speeds.
2. The ability to automatically reset and restart after an overcurrent, overvoltage, undervoltage, or over-temperature condition; overload fault; loss of phase, or loss of input signal.
3. Capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to programmed set point without drive tripping or component damage.
4. Capable of adjusting acceleration and deceleration ramp control time from 1 to 360 seconds.
5. Equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be 12 cycles (200 milliseconds), based on full load and no inertia. Control logic shall incorporate programmable ride-through with minimum one-second (60 cycles).
6. Stop modes shall be field-selectable allowing the VFD to ramp or coast to a stop.

F. Drive and motor protection: Include the following electrical protection and safety features, factory mounted and wired within the VFD enclosure.

1. Input disconnecting means and overcurrent protective device: Integral, NEMA AB1, thermal magnetic, molded-case circuit breaker, with door interlocked, padlockable handle mechanism connected to input line side of drive.

    a. Circuit breaker shall be selected to provide trip-free operation. Breaker trip size and thermal curve shall be selected to allow VFD to operate the motor under continuous running and starting conditions as recommended by the motor manufacturer.
    b. Service personnel shall be able to circumvent the main power disconnect and open the bypass enclosure without disconnecting power. A specific tool and mechanism shall be provided to accomplish this occurrence while meeting code and safety requirements.

2. Transient voltage surge suppression (TVSS): Integral, system to provide three-phase protection against damage from supply voltage surges.
3. Motor and VFD overload and overtemperature protection: NEMA ICS 2, bimetallic thermal, Class 20 or solid-state, overload relay protection monitoring both motor and VFD characteristics. Relay shall be interconnected with motor thermal couple.
4. Protective relays or functions for the following conditions:

    a. Overvoltage
    b. Undervoltage
    c. Phase loss – Equal to ICM 450 phase monitor
    d. Phase reversal
    e. Ground fault

5. Programmable, critical frequency lock-out: Multi-range selection, preventing VFD from operating load continuously at an unstable speed.
6. Control fuses utilized within the drive enclosure shall be 100,000 A current limiting type. Input AC power fusing is not acceptable.

G. Comply with requirements of NEMA ICS 7, NEMA ICS 61800-2, and UL 580C.

2.3 DRIVE CONTROL AND OPERATION

A. VFD shall operate according to the following scenarios:

1. “Hand”: VFD shall start and speed controlled manually through user interface.
2. “Off”: VFD shall stop or disregard start signal.
3. “Auto”: VFD shall start via external contact closure or control signal reference.

B. VFD shall run at programmable preset speed if input reference signal is lost.

2.4 SOURCE QUALITY CONTROL

A. Test and inspect variable frequency drive units and associated controls according to requirements in NEMA ICS 61800-2 and UL 508C.

1. Perform tests at rated full load to ensure proper operation.
2. Provide three certified copies of factory test reports.

B. Each drive shall undergo a burn-in test at 100 percent inductive or motor load prior to final testing.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine project submittals for compliance with electrical distribution system requirements outlined on the drawings and in electrical specification sections.

3.2 INSTALLATION

A. Install drive units in locations shown on drawings. Equipment shall not be located further from the equipment it serves than the maximum distance recommended by the drive manufacturer.

B. Install wiring between drive and motor in ferrous metallic conduit, with separate conduits for power input, power output, and control wiring.

1. Maintain minimum separation between conduits of 3 inches.

C. Service engineers trained and authorized by the variable-frequency drive manufacturer at the service center shall provide start-up service, including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements.

3.3 IDENTIFICATION

A. Materials: Refer to Section 26 0553 for requirements on identification of electrical systems. Identify units, devices, fuse blocks, relays, controls, and wiring. Identify equipment ratings.

B. Nameplates: Refer to Section 26 0553 for requirements on identification of electrical systems. Provide nameplate for each drive unit and associated components located on front of assembly.

C. Control components mounted within the assembly shall be identified corresponding to designations on manufacturer’s drawings using tags and other identification materials.

D. Operating instructions: Provide fabricated frame on side of each unit to house operating instruction manuals.

3.4 FIELD QUALITY CONTROL

A. Test variable frequency drives by operating them in all modes with associated components and motors. Perform tests recommended by manufacturer under supervision of manufacturer’s factory-authorized representative. Tests shall include simulation of various building conditions through the BAS, ATC, or DDC control system.

B. Coordinate tests with system balancing of fan and pump equipment.

C. Perform mechanical and visual inspection of equipment installation including verification of wiring and components, connections, enclosures, and auxiliary devices and components.

D. Perform testing in compliance with NETA ATS. Perform manufacturer standard tests including the following:

1. Test insulation resistance and circuit continuity for power and control wiring.
2. Verify voltage values follow nameplate ratings at drive input and output terminals.

E. Correct deficiencies and retest equipment until equipment is operational. Report results and identify corrections in writing. Where necessary, replace damaged and malfunctioning equipment.

F. Record field adjustable settings.

3.5 ADJUSTING

A. Program variable frequency drives for required operations as outlined by the mechanical control sequences.

B. Set field-adjustable elements such as switches, relays, timers, and trip devices as required for proper system operation and coordination with related power and control systems.

3.6 CLEANING

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Clean components internally using methods and materials recommended by the manufacturer.

3.7 SYSTEM STARTUP

A. Perform startup service.

3.8 OPERATING INSTRUCTIONS

A. As specified in Sections 26 0500, provide operating instructions.

END OF SECTION

SECTION 26 3213

GENERATORS, WEATHER-PROTECTED

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Packaged engine generator set for standby, emergency power application including the following:

1. Natural gas engine with electronic generator set controls, governor, and voltage regulator.
2. Located in outdoor, weather-protected, sound-attenuated enclosure.
3. Complete with remote annunciator, sub-base fuel tank, and generator accessories.

1.2 RELATED SECTIONS

A. Gas piping:

1. Natural-gas piping: Section 23 1123.

B. Grounding and bonding: Section 26 0526.

C. Equipment foundations: Section 26 0528.

D. Transfer switches: Section 26 3600.

1.3 REFERENCES

A. ANSI/NECA/EGSA 404: Standard for Installing Generator Sets.

B. CFR Title 40, Protection of Environment.

C. IEEE 115: Test Procedures for Synchronous Machines.

D. IEEE 446: Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.

E. NECA/EGSA 404: Standard for Installing Generator Sets.

F. NEMA MG 1: Motors and Generators.

G. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

H. NFPA 30: Flammable and Combustible Liquids Code.

I. NFPA 37: Installation and Use of Stationary Combustion Engines and Gas Turbines.

J. NFPA 70: National Electrical Code.

K. NFPA 110: Emergency and Standby Power Systems.

L. UL 1236: Battery Chargers for Charging Engine Starter Batteries.

M. UL 2200: Stationary Engine Generator Assemblies.

1.4 DEFINITIONS

A. CFR: Code of Federal Regulations.

B. EPA: Environmental Protection Agency.

C. NIST: National Institute of Standards and Technology

D. NSPS: New Source Performance Standards.

1.5 SUBMITTALS

A. Product data: For each type of packaged generator set indicated. Include rated capacities, operating characteristics, manufacturers' technical data on features and functions, finishes, and furnished accessories. Include product data for each of the following:

1. Engine generator set.

a. Thermal damage curve for generator.
b. Time-current characteristic curves for generator protective device.

2. Generator accessories including batteries and battery charger, silencer, and jacket heater.
3. Remote alarm annunciator panel.
4. Enclosure components and accessories.
5. Sub-base fuel tank.

B. Bill of materials: Provide detailed list of components.

C. Shop drawings: For each type of generator set and related equipment, detail assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design calculations: Calculate requirements for designing vibration isolation bases.
3. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring diagrams: Power, signal, and control wiring.
5. Piping schematics for fuel system, lubricating oil, jacket coolant, and cooling water.

D. Source quality-control test reports.

1. Certified summary of performance tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
2. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
3. Report of sound generation.
4. Report of exhaust emissions showing compliance with applicable regulations.

a. Factory certification of compliance with EPA emissions regulations.

E. Field quality-control test reports.

F. Operation and maintenance data: For packaged engine generator sets, accessories, and remote annunciator panel to include in operation and maintenance manuals. In addition to items specified in Division 01, include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
2. Detailed operating instructions for event conditions.
3. Fuel adjustment procedures and maximum tolerances of wear on bearings and other rubbing surfaces that will require corrective measures.
4. Sub-base fuel tank.

G. Warranty: Certificate of special warranty.

H. Air quality permits: Submit air quality construction and operational permits for Owner record.

1.6 QUALITY ASSURANCE

A. Generator accessories, appurtenances, and installation of the same, shall comply with referenced codes and standards listed in Part 1 and applicable federal, state, and local codes and regulations.

B. Emissions: Equipment shall be certified to U.S. EPA Stationary Emission Regulation, 40 CFR, Part 60.

C. Permits: Serve as the Owner's representative during the application process. Collect generator information, prepare and submit required applications for air quality construction and operational permits required by the State of Maryland Department of the Environment in compliance of state environmental regulations. Include payment for applicable permit costs. Approved permits and registration shall be issued to the Owner.

D. Equipment shall bear UL label, and shall be locally tested by an electrical testing specialist, acceptable to local authority having jurisdiction where required.

E. Source limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

F. Installer qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this project.

1. Installer has training in electrical safety as required by NFPA 70E and is qualified as defined in NEMA PB 2.

G. Testing agency qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and that is acceptable to authorities having jurisdiction.

1. Testing agency's field supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

H. Service and maintenance agency qualifications: Manufacturer's authorized service and maintenance representative characteristics shall include the following:

1. Located in the Baltimore/Washington, DC metropolitan area.
2. Staff is factory employed and trained.
3. Service available 24 hours a day, seven days a week, 365 days a year.
4. Maintains an adequate stock of manufacturer's genuine or approved parts to service this equipment.

5. Service and maintenance contracts available.

1.7 COORDINATION

A. Obtain interconnection diagrams, interface hardware, accessory components, and installation manual for generator, and other components of the system. Coordinate installation to provide a complete, integrated, operating generator system.

1. Coordinate installation and interface connections with other emergency power supply system equipment.

B. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate terminations of generator fuel piping outside of generator enclosure.

1.8 PROJECT CONDITIONS

A. Environmental conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient temperature: 5 to 40 deg C.
2. Relative humidity: 0 to 95 percent.
3. Altitude: Sea level to minimum 1000 feet (300 m).

1.9 WARRANTY

A. Special warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period:

1. Warranty period: Five years from date of substantial completion.
2. Warranty shall include all parts and labor with no deductible.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every ten of each type and rating, but no less than one of each.
2. Indicator lamps: One for every five of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

B. Provide fuel required for testing, re-testing, and demonstrations.

1.11 MAINTENANCE SERVICE

A. Initial maintenance service: Beginning at Substantial Completion, provide 12 months, full maintenance by skilled employees of manufacturer’s designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-design product: Subject to compliance with requirements, provide products manufactured by Kohler Co.; Power Systems, or comparable product by one of the following:

1. Caterpillar; Power Generation
2. Cummins Inc.; Power Systems
3. Generac
4. Kohler Co.; Power Systems
5. MTU Onsite Energy; Rolls-Royce Power Systems AG

2.2 GENERATOR SET

A. Generator set characteristics: The generator set system shall comprise a package of equipment including:

1. A natural gas engine and alternator assembly to provide emergency electric power.
2. Generator-mounted start-stop control system.
3. Mounted accessories as specified.
4. Factory-assembled and -tested, engine-generator set.

B. Generator set ratings:

1. Duty rating shall be based on emergency/standby service.
2. Operate at 1800 rpm and 277/480 volts AC, 3-phase, 4-wire, 60 hertz.
3. The generator set shall be rated at values indicated on the drawings at 0.8 pf based on the project conditions listed in Part 1.

C. Performance characteristics:

1. The engine-generator set shall be able to handle the starting step load effects of the connected equipment. Each automatic transfer switch shall be considered a step unless otherwise indicated.
2. Generator set characteristics shall not exceed the following:

a. Starting voltage dip: 30 percent.
b. Peak voltage dip: 15 percent.
c. Frequency dip: 15 percent.
d. Voltage regulation (no load to full load): Plus or minus 1 percent of rated output voltage.
e. Voltage regulation (random): Plus or minus 0.5 percent of rated output voltage.
f. Frequency regulation (steady-state): Isochronous.
g. Frequency regulation (random): Plus or minus 0.25 percent of rated frequency from no load to full load.

3. AC output waveform: Distortion at no load measured line-to-line or line-to-neutral.

a. Total harmonic distortion (THD): Less than 5 percent
b. Singe harmonic: Less than 3 percent.
c. Telephone influence factor (TIF): Less than 50, as determined by NEMA MG 1.
d. Telephone harmonic factor (THF): Less than 3, as determined by IEC 60034.

4. Steady-state frequency stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5. Sustained short-circuit current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
6. Start time: Comply with NFPA 110, Type 10, system requirements.
7. Excitation system: Performance shall be unaffected by voltage distortion caused by nonlinear load.

D. Engine:

1. Natural gas engine: Four-cycle, natural gas with fan and water pump. It shall have the number cylinders and minimum displacement to achieve required brake horsepower rating at 1800 rpm.

    a. Carburetor.
    b. Secondary gas regulators.
    c. Fuel-shutoff solenoid valves.
    d. Flexible fuel connectors.
    e. Natural gas source pressure shall be 7 to 11 inches H_2O for proper operation.

E. Generator: Three-phase, single bearing, synchronous type built to NEMA MG 1 standards.

1. Alternator: Brushless, 4-pole, 2/3 pitch windings, 125 degrees C standard temperature rise. Class H insulation shall be used on the stator and rotor, and both shall be further protected with 100 percent epoxy impregnation and an overcoat of resilient insulating material on end coils to protect against fungus or abrasion. The alternator shall incorporate a resettable thermal protector for exciter/regulator protection. The alternator shall be twelve lead, wye connected.
2. Regulator: Permanent magnet excitation for power source to voltage regulators, solid-state controlled, exciter/regulator, matching the characteristics of the alternator and engine. Voltage regulation with adjustable electronic isochronous governor. Readily accessible voltage droop, voltage level, and voltage gain controls shall be provided. The solid state regulator module shall be shock mounted and epoxy encapsulated for protection against vibration and atmospheric deterioration.
3. The subtransient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

F. Mounting:

1. Unit shall be capable of installation on rail system within enclosure base and include vibration isolation as required.

G. Cooling system: Closed loop, liquid-cooled system with engine mounted radiator and blower type fan, sized to maintain safe operation at 104 degrees F (40 degrees C) maximum ambient temperature. The radiator shall be equipped for a duct adapter flange connected to exterior cabinet with flexible connection.

1. Centrifugal jacket water pump: Built on the engine and driven from the engine crankshaft or camshaft, ample capacity to circulate the required flow of engine jacket water through the radiator to remove the total heat rejected from the engine to the jacket water and lubricating oil at 110 percent rated load in 104 degrees F (40 degrees C) ambient while maintaining the optimum jacket water temperature leaving and entering the engine recommended by the engine manufacturer.

2. Thermostatic control valve: Shall maintain constant water temperature to the engine. Provide modulating type thermostatic valves using self-contained thermostats without external bulbs. Provide valves with one or more interchangeable thermostatic elements. Provide nonadjustable type thermostat with operating temperature factory set at the temperature recommended by the engine manufacturer. Design valve so that in event of thermostatic element failure it will fail safe, permitting water flow through the engine.

H. Fuel system: Natural gas.

1. Fuel system shall consist of the following fuel supply:

a. Uninterrupted natural gas fuel supply specified in Section 23 1123.

I. Exhaust system:

1. Provide a silencer, including flexible exhaust fitting, properly sized and installed according to the manufacturer's recommendation. Mounting shall be provided by the installing contractor. The silencer shall be mounted so that its weight is not supported by the engine.

a. Muffler/silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

(1) Minimum sound attenuation of 25 dB at 500 Hz.
(2) Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.

2. Exhaust pipe size shall be sufficient to ensure that exhaust backpressure does not exceed the maximum limitations specified by the generator set manufacturer.

J. Automatic starting system:

1. Starting motor: DC electric starting system with positive engagement drive. The motor voltage shall be as recommended by the engine manufacturer.
2. Automatic controls: Fully automatic generator set start-stop controls in the generator control panel. Controls shall provide shutdown for low oil pressure, high water temperature, overspeed, and overcrank; and one auxiliary contact for activating accessory items. Controls shall include a multi-cycle, cranking limit with lockout contacts for starting by switch on remote panel.

K. System accessories:

1. Jacket water heater: Unit mounted thermal circulation type water heater incorporating a thermostatic switch, capable of maintaining engine jacket water to 90 degrees F in ambient temperature of minus 10 degrees F. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
2. Starting and station batteries: Lead-acid storage battery set of the heavy duty starting type. 24Vdc battery voltage shall be compatible with the starting system. The battery set shall be of sufficient capacity to provide for 1 1/2 minutes total cranking time without recharging. Include a battery rack and necessary cables and clamps.

3. Battery charger: UL 1236 listed. Engine starting, current limiting battery charger to automatically recharge batteries. The charger shall have adjustable float and equalize voltage. DC amperage output shall be no less than 10 amperes. Output voltage shall be compatible with starting system. AC input voltage shall be 120V. Charger shall include fused overload protection; circuit breaker overcurrent protection; solid-state, silicon diode full wave rectifiers; voltage surge suppressors; DC voltmeter and AC ammeter; temperature voltage regulator; relays indicating AC power failure, low-, and high-battery voltage.

L. Generator control panel:

1. Type: Generator mounted NEMA 250 Type 1, vibration isolated, dead front, made of sheet metal gauge steel, with lockable hinged door.
2. Panel shall contain, but not be limited to, the following equipment:

    a. Voltmeter, 2 percent accuracy.
    b. Ammeter, 2 percent accuracy.
    c. Ammeter voltmeter, phase selector switch.
    d. Frequency meter, dial type (45-65 Hz).
    e. Automatic starting controls.
    f. Voltage level adjustment rheostat.
    g. Dry contacts for remote alarms wired to terminal strips.
    h. Fault indicators for low oil pressure, high water temperature, overspeed, and overcrank.
    i. Three position selector switch with the following functions: auto, manual, off/reset.
    j. Emergency stop switch.
    k. Panel light.
    l. Running time meter.
    m. Oil pressure and water temperature gauges.

3. Remote outputs for monitoring.

M. Generator output circuit breaker(s):

1. Type: Molded-case circuit breaker serving standby loads, Molded-case electronic trip type serving life safety loads, size as indicated on drawings. Circuit breaker shall conform to standards established by UL 489, and NFPA 70. Circuit breaker trip elements shall have inverse time delay for overload conditions and instantaneous magnetic tripping for short-circuit protection.
2. The circuit breaker trip curve shall be coordinated with alternator thermal damage curve as required by generator manufacturer data.

    a. Generator/exciter field circuit breakers do not meet the specified electrical standards and are unacceptable for line protection.

3. Shunt trip device: The shunt trip shall open the generator circuit breaker in the event of an engine shutdown signal, and shall operate from the cranking battery voltage.
4. Circuit breakers shall be lockable in the open position.

2.3 GENERATOR ENCLOSURE

A. Manufacturer's standard enclosure: Prefabricated weather-resistant, sound attenuated enclosure sized to house the generator, sub-base fuel tank, battery charger, batteries, and required accessories. Enclosure shall be factory-assembled by the generator manufacturer.

B. Sheet metal steel enclosure primed with corrosion protection and painted with electrostatically-applied powder coat finish of manufacturer's standard color. Enclosure shall include roof, side walls, and end walls. Hardware shall be stainless steel.

1. Lifting provisions: Capacity to support total assembly weight during rigging.
2. Access doors: Provide sufficient access for maintenance and operation from outside the enclosure.

    a. Handles key lockable, all doors keyed alike.

3. Air intake and sound attenuation louver openings shall be screened to limit entry of rodents.
4. Roof shall be designed to prevent collection of rainwater.
5. Provide factory-mounted exhaust silencer inside the enclosure. Exhaust shall exit the enclosure through a rain collar and terminate at a rain cap. Exhaust connections to the generator set shall be made with seamless flexible connections.

C. Sound attenuation: Enclosure shall be constructed to mitigate noise level to 85 dBA maximum at 23 feet (7 m) from enclosure at rated generator output.

D. Accessories:

1. Enclosure manufacturer shall provide the hardware required to mount the exhaust silencers while maintaining the enclosure's weather resistance.

2.4 EXTERNAL VIBRATION ISOLATION DEVICES

A. Elastomeric isolator pads: Oil- and water-resistant elastomer, arranged in single or multiple layers, molded with a non-slip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Double layer, standard neoprene.

2.5 REMOTE ALARM ANNUNCIATOR PANEL

A. Surface-mounted panel, complying with the requirements of NFPA 110, Level 1 equipment, providing visible and audible alarm signals powered by the storage battery of the generator. Unit enclosure: Fabricated of sheet steel, with removable front panel. The front panel shall contain LED type indicating lamps (visible signals) as listed below. The enclosure shall contain the required printed circuits, internal wiring, terminal block and battery voltage sensors. Provide knockouts for external wiring through bottom of box.

B. Provide on face of panel the following switches:

1. Lamp test pushbutton.
2. Audible alarm: Silence switch.

LAMP LEGEND	GENERATING SET CONDITION INDICATED	DERANGEMENT SIGNALS	
		Audible	Visible
EXERCISING	Generator exercising	No	Yes
GENERATING	Generating Power to Load	Yes	Yes
OVERCRANK	Failed to Start	Yes	Yes
LOW ENG TEMP	Low Lube Oil Pressure	Yes	Yes
HI ENG TEMP PRE	Excessive Engine Temperature Pre-Alarm	Yes	Yes
HI ENG TEMP	Excessive Engine Temperature	Yes	Yes
LOW OIL PRESS PRE	Low Lube Oil Pressure Pre-Alarm	Yes	Yes
LOW OIL PRESS	Low Lube Oil Pressure	Yes	Yes
OVERSPEED	Engine Overspeed	Yes	Yes
LOW FUEL	Low Fuel Supply	Yes	Yes
LOW COOLANT	Low Engine Coolant Level	Yes	Yes
AUTO SWITCH	Control Switch Not in Automatic Position	Yes	Yes
LOW CRANK VOLT	Low Engine Cranking Voltage	Yes	Yes
LOW BATT VOLT	Low Battery Voltage	Yes	Yes
HI BATT VOLT	High Battery Voltage	Yes	Yes
ALARM CONTACT	Contacts for Common Alarm	Yes	Yes

2.6 MONITORING SYSTEM

A. Monitoring system: Provide contacts from generator for monitoring by the power monitoring system for the following functions:

1. Generator off.
2. Generator running.
3. Generator exercising.
4. Generator alarms: Overcrank, low oil pressure, high or low engine temperature, overspeed, batteries.

B. Provide control interface for monitoring the generator status through the building fire alarm system.

2.7 SYSTEM OPERATION

A. Loss of normal power:

1. System is given signal to start by one of the automatic transfer switches or a remote device. Loss of power can occur at any automatic transfer switch, which can cause the generator to start. On receipt of this signal, generator shall automatically start, accelerate to rated frequency and build up to rated voltage.
2. Priority shall be set to actuate the automatic transfer switch designated in the following order:

   a. ATS-1: Emergency / Life safety
   b. ATS-2: Standby Equipment

3. After the first transfer switch closes to the bus, subsequent transfer switches shall close to the bus after pre-determined time delays.

B. Failure of generator to start:

1. If a unit fails to start, after the overcrank time delay (in the generator set control) has expired, the unit will be shut down, and an alarm will sound.

C. Return of normal power:

1. When normal power has been restored to the normal power system bus and sensed at each transfer switch, the loads shall be transferred back to normal source.
2. The generator shall operate until all transfer switches have returned to normal power switch position and operate at no load for a cool-down period. When the cool-down period has been completed, the generator shall shut down.
3. If a system start signal is received during the cool-down period, generator shall remain online and operate as described in “Loss of Normal Power” above.

2.8 SOURCE QUALITY CONTROL

A. Prototype testing: Perform factory performance tests using prototype generator of same engine model and alternative configuration, and assembled with like components and accessories. Provide three certified copies of the successful test reports.

1. Tests: Comply with NFPA 110, Level 1, energy converters in Paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2.
2. Alternator tests: Comply with IEEE 115.
3. Equivalent components and accessories: Submit evidence that items furnished with the unit, but that are not identical to those on the prototype, are reliable and compatible with the application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough-in requirements for connecting piping and wiring for generator and verify conditions. Verify actual sizes and locations of connections are correct before packaged engine-generator installation.

3.2 PREPARATION

A. Battery equalization: Equalize charging of battery cells according to manufacturer’s written instructions.

3.3 INSTALLATION - GENERATORS

A. Install generators, complete with controls, accessories, sub-base tanks, and enclosure, as indicated on the drawings and in accordance with manufacturer’s recommendations.

B. Comply with generator manufacturer’s written installation and alignment instructions and with NFPA 37 and 110.

C. Install the remote alarm annunciator panel where indicated on drawings.

D. Set generators plumb and level on concrete base with vibration isolators. Secure to anchor bolts installed in the concrete base.

E. Install generators so as to provide access for maintenance and service, including removal of drivers and accessories.

F. Install piping, wiring, accessories, and appurtenances in accordance with the applicable specifications and manufacturers’ recommendations. Ground equipment.

G. Comply with applicable portions of NECA 404.

H. Generator and enclosure accessories shall be connected to the building electrical distribution system via branch circuits and feeders as indicated on drawings.

I. Verify proper fuel pressure for natural gas engines.

3.4 IDENTIFICATION

A. Materials: Refer to Section 26 0553 for requirements on identification of electrical systems. Identify units, devices, fuse blocks, relays, controls, and wiring. Identify equipment ratings.

B. Nameplates: Refer to Section 26 0553 for requirements on identification of electrical systems. Provide nameplate for each unit and associated components located on front of assembly.

C. Control components mounted within the assembly shall be identified with tags and other identification materials, and correspond to designations on manufacturer's drawings.

D. Operating instructions: Provide fabricated frame on side of unit to house operating instruction manuals.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's field service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections; and to assist the Contractor in testing.

B. Tests and inspections:

1. Perform tests recommended by manufacturer. Perform electrical tests and visual and mechanical inspection for "AC Generators and or Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. NFPA 110 acceptance tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
3. Battery tests: Record individual cell voltages.

    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.

4. Battery-charger tests: Verify specified rates of charge for both equalizing and float charging conditions.
5. System integrity tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks. Retain subparagraph below for long, restricted exhaust systems.
6. Voltage and frequency transient stability tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
7. Harmonic-content tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

8. Noise level tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations, and compare measured levels with required values.

C. Coordinate generator testing with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units; retest and reinspect as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. The unit shall operate without undue noise or vibration, or excessive heating. Correct defects and retest until unit is operating satisfactorily.

K. Demonstrate satisfactory operation of each feature required of the generator set and accessories.

L. Test emergency power system: After completion and acceptance of the generator tests, perform an operational test of the emergency power system. Perform a power failure test on the emergency electrical system. This shall be performed by interrupting the normal power source and verifying proper generator start and transfer switch operation.

M. Report results of tests and inspections in writing. Record adjustable device settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 ACCEPTANCE TESTING

A. In addition to the factory and field tests required in Part 2, perform a scheduled on-site test and demonstration of the completely installed generator before making final electrical connections.

B. Test shall be witnessed by the Owner’s representative, and manufacturer’s representative. Manufacturer’s representative shall conduct demonstrations.

C. Provide and utilize load bank for testing. Load banks shall be capable of providing full load at 1.0 power factor.

D. Test procedures: Test the generator in accordance with NFPA 110 and as follows:

1. Test the generator for at least two hours under full load, starting and stopping at least five times.

    a. The unit shall operate without undue noise or vibration, or excessive heating. Correct defects and retest until unit is operating satisfactorily.

b. Demonstrate satisfactory operation of each feature required of the generator set and accessories.

3.7 CLEANING

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Clean components internally using methods and materials recommended by the manufacturer.

3.8 OPERATING INSTRUCTIONS

A. As specified in Section 26 0500, provide operating instructions.

B. Provide at least one session of four consecutive hours of additional instruction time for each system specified in this section.

END OF SECTION

SECTION 26 3600

TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Automatic transfer switches rated 600 volts and less.

1.2 RELATED SECTIONS

A. Identification of electrical systems: Section 26 0553.

B. Overcurrent protective device coordination study: Section 26 0573.

C. Generator: Section 26 3213.

1.3 REFERENCES

A. NFPA 110: Emergency and Standby Power Systems.

B. UL 1008: Transfer Switch Equipment.

1.4 SUBMITTALS

A. Product data: Include assembly ratings and dimensioned plans, sections, and elevations showing minimum clearances, cable termination sizes, conductor entry, gutter space, installed features and devices, and material lists for each switch.

B. Bill of materials: Provide detailed list of components.

C. Shop drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each transfer switch specified. Wiring diagrams showing detail wiring for transfer switch, differentiating between manufacturer-installed and field-installed wiring, and including power and control wiring.

1. Single-line diagram: Show connections between transfer switch, power sources, and load.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Certifications:

1. Product certificate signed by manufacturer certifying that products furnished comply with requirements and that switches have been tested for applicable load ratings and short-circuit closing and withstand ratings.
2. Manufacturer's test reports showing that controllers meet the specified requirements.
3. Evidence that manufacturer, installer, and equipment meet the requirements specified in "Quality Assurance" below.

G. Operation and maintenance data: For transfer switches and associated components, provide product data, shop drawings, and test reports in operation and maintenance manual. In addition to items specified in Division 01 Section “Operation and Maintenance Data,“ include the following:

1. Features and operating sequences, both automatic and manual

1.5 QUALITY ASSURANCE

A. Transfer switches shall comply with UL 1008. Where specified requirements exceed requirements of UL 1008, switch shall meet the stricter requirements.

B. automatic transfer switch shall be manufactured by the same manufacturer. Design shall have been in production for not less than 10 years, with at least 100 installations operating successfully.

1. Manufacturer shall maintain records of each switch, by serial number, for no less than 20 years.

C. Qualifications of manufacturer: Maintain a factory-authorized service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

D. Qualifications of supplier/installer:

1. Staff factory-trained and -authorized in the installation, testing, and operation of the specified equipment.
2. Provides emergency service on call 24 hours a day, seven days a week.
3. Maintains an adequate stock of manufacturer's genuine or approved parts to service this equipment.
4. Has service contracts available which can meet requirements specified for the equipment of this project.

1.6 COORDINATION

A. Coordinate layout and installation of switches and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store switches indoors in clean dry space with uniform temperature to prevent condensation. Protect switches from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.8 PROJECT CONDITIONS

A. Product selection for restricted space:

1. Drawings indicate maximum dimensions for switches, including clearances between switches, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
2. Contractor shall make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum clearances specified in NFPA 70.

B. 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. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service. Provide applicable details of proposed outage including sequence of work and methods of providing temporary electrical service.
2. Do not proceed with interruption of electrical service without written permission.

1.9 WARRANTY

A. Special warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of transfer switch and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty period: Two years from date of substantial completion.
2. Warranty shall include all parts and labor.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis-of-design product: Subject to compliance with requirements, provide products manufactured by Kohler Co.; Power Systems, or comparable product by one of the following:

1. ASCO Power Technologies / Schneider Electric
2. Caterpillar; Power Generation
3. Cummins Inc.; Power Systems
4. Eaton
5. Generac Power Systems, Inc.
6. Kohler Co.; Power Systems
7. MTU Onsite Energy; Rolls-Royce Power Systems AG
8. Russelectric, Inc. / Siemens
9. Zenith / ABB

2.2 GENERAL TRANSFER SWITCH REQUIREMENTS

A. Equipment shall be based on the following: 480/277 volts, 3-phase, 4-pole; Level 1 equipment according to NFPA 110; rated in accordance with UL 1008 for continuous loading and total system transfer; suitable for motor, resistance heating, electric-discharge lighting, and tungsten filament lamp loads.

B. Tested fault-current closing and withstand ratings (3 cycles): Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Provide transfer switches with ratings based on available fault current determined by Short-Circuit Analysis performed under Section 26 0573 or as indicated on one-line diagram, whichever is larger.

C. Neutral switching. Provide neutral pole switched simultaneously with phase poles on four-pole transfer switches.

D. Enclosure: NEMA 250, Type 1; NEMA ICS 6; and UL 508.

E. Terminal block: Termination of all auxiliary contacts, switches, pilot lights, and appurtenances mounted in transfer switch enclosure.

F. Clearly label and identify each indicating light and switch as to its purpose or function.

2.3 AUTOMATIC TRANSFER SWITCH

A. Ratings: Unit ratings involving ampacity, number of poles, and withstand close rating are indicated on drawings.

B. Switching arrangement:

1. Delayed, Open Transition Transfer Operation: Double-throw design, with break-before-make capability where indicated on drawings. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in both the normal and emergency positions without the use of hooks, latches, magnets, or springs.

a. ATS-1: Emergency / life-safety.
b. ATS-2: Standby equipment.

2. Switch characteristics:

a. Designed for continuous-duty, repetitive transfer of full-rated current between active power sources.

b. The contact driving system shall be mechanically held and electrically operated by a single motor operator.
c. Contacts: Silver alloy, capable of making or breaking any load within the rating of the switch.

(1) Contacts that close to start the engine generator: Include a time delay of transfer switch and engine starting signals, factory set at 5.0 seconds (adjustable from 0-5 minutes).

d. Interlocked, molded case circuit breakers or contactors are not acceptable.

C. Controls: Microprocessor-based controller integrally mounted in the transfer switch with all components and wiring accessible from the front.

1. Tested and rated as follows:

a. For storage at temperatures from minus 25 to plus 85 degrees C.
b. For operation:

(1) At minus 20 to plus 70 degrees C.
(2) At 0 to 99 percent humidity, non-condensing.
(3) Withstands infinite power interruptions.
(4) Withstands surges when tested in accordance with ANSI/IEEE C37.90.1.

2. Include a real-time clock with nickel-cadmium battery backup.
3. Monitoring: On both normal and emergency sources, include three-phase over or under voltage, over or under frequency, and phase sequence detection, and phase differential monitoring.
4. Communications: Industry standard open-architecture communication protocol for high-speed serial communications via multidrop connection to other controllers and to a master terminal with up to 4000 feet of cable, or farther with the addition of a communication repeater.

a. Serial communication port: RS422/485 compatible

5. Self-diagnostics: Shall perform periodic checks of the memory I/O and communications circuits, with a power failure circuit.
6. Password protection shall limit access to designated personnel.
7. Operation: Keypad with multi-character liquid crystal display.
8. Memory / flash-backup: Accessible both locally and from remote controller, including:

    a. Number of hours transfer switch has been in the emergency position (total since reset).
    b. Number of transfers in either direction (total since reset).
    c. Date, time, and description of the last 4 source failures.
    d. Date of the last exercise period.
    e. Date the record was reset.

D. Provide close differential voltage sensing of all phases of both the normal and alternate sources of power. Factory settings preset for:

    1. Dropout at 87 percent of nominal voltage (adjustable 75-98 percent)
    2. Pickup at 95 percent of nominal voltage (adjustable 85-100 percent).

E. The transfer of the load shall occur only if the alternate source has attained factory setting of 95 percent of nominal voltage (adjustable 85-100 percent) and 95 percent of nominal frequency (adjustable 90-100 percent) and the transfer to alternate time delay has expired. The time delay shall be factory set for 5 seconds and adjusted in the field to comply with system priority requirements outlined in Part 2 below. (Field adjustable range of 0 to 2 minutes.)

    1. Upon return of the normal source to within the limits of the voltage sensor, the switch shall retransfer to the normal source after a retransfer to normal time delay. The time delay shall be factory preset for 15 minutes. (Field-adjustable range of 0.5 to 30 minutes.) A synch-check function shall confirm synchronization prior to retransfer.

F. Time delay for engine generator cooldown: Unloaded, running, factory-set at 5 minutes (adjustable 0-5 minutes).

G. Indicating lights: LED type. Green, indicating that the normal source is connected to the load, and red, indicating that the alternate source is connected to the load.

H. Test switch: Simulates a normal source outage.

I. Reset switch: To manually retransfer the automatic transfer switch to the normal source, except that retransfer shall occur automatically if alternate source fails.

J. In-phase monitor control for transfer and retransfer of motor loads.

K. Automatic exerciser with load for 0.5 hour monthly. The automatic exerciser function shall be enabled in one transfer switch selected by the Owner.

L. Relay protection:

    1. Full-phase voltage on normal side.
    2. Three-phase voltage frequency on generator side.

M. Auxiliary contacts: Provide number of sets of auxiliary contacts necessary to initiate generator starting through paralleling switchgear and interface with Owner monitoring system.

N. The transfer switch shall have the following programming functions available:

1. Block transfer to emergency source.
2. Load shedding.
3. Peak-shaving.

O. The transfer switch shall control the load functions.

2.4 MONITORING SYSTEM

A. Provide contacts from each automatic transfer switch for monitoring by the power monitoring system for each of the following functions.

1. Switch in normal position.
2. Switch in emergency position.
3. Switch in maintenance bypass position.
4. Normal power available.
5. Emergency power available.

2.5 TRANSFER SWITCH OPERATION AND EMERGENCY SYSTEM PRIORITY

A. Priority status: Transfer switch priority shall apply as follows:

1. ATS-1
2. ATS-2

B. Transfer to generator source: Switches shall transfer to emergency power source in order of priority status listed above. In the event that the emergency source cannot generate enough capacity to carry the total emergency system load, switches shall transfer in decreasing order of priority until system capacity is reached. Switches can later be transferred to the emergency source if additional capacity is available. Field adjust the time delay settings to achieve system transfer of loads as follows:

1. ATS-1: Use factory setting or 5 seconds, whichever is less. Total system transfer time shall not exceed 10 seconds per NFPA 110.
2. ATS-2: Time delay: 30 seconds.

C. Generator failure: In the event generator system power is not sufficient to carry the loads of each emergency branch, transfer switches shall open and shed load in reverse priority order.

D. Transfer back to normal source: Switches shall transfer back to normal source in reverse priority order as follows:

1. Delayed, open transition operation: When the normal source has been restored and is within the pre-selected ranges for voltage and frequency, and after an adjustable time delay to ensure the integrity of the normal power source, the load shall be transferred back to normal source in a break-before-make transfer scheme. The generator set will continue to run for a user adjustable time to allow the generator set to run unloaded for cool down, after which the engine will be shut down. Upon completion, the system will then be ready for automatic operation.

2.6 REMOTE ANNUNCIATOR SYSTEM

A. Remote annunciator panel:

1. Functional Description: Annunciate conditions at each transfer switch including the following indications:

    a. Source availability, both Normal and Emergency sources, as defined by actual pickup and dropout settings of transfer-switch controls.
    b. Switch position.
    c. Switch in test mode.
    d. Failure of communication link.

2. Features: LED-lamp indicators with audible signal and silencing switch.

    a. Indicating Lights: Grouped for each transfer switch monitored.
    b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
    c. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
    d. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.7 SOURCE QUALITY CONTROL

A. Factory-test components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test in accordance with NEMA ICS 1.

B. As a condition of approval, the manufacturer of the automatic transfer switches shall verify that their switches are listed by Underwriters Laboratories, Inc., Standard UL-1008 with 3-cycle short circuit closing and withstand of 65,000 RMS symmetrical amperes at nominal voltage of building electrical service, utilizing a 200,000-ampere current limiting fuse on the normal load side of the automatic transfer switches.

C. During the 3-cycle closing and withstand tests, there shall be no contact welding or damage. The 3-cycle tests shall be performed without the use of current limiting fuses. The test shall verify that contacts separation has not occurred, and there is contact continuity across all phases. Test procedures shall be in accordance with UL-1008, and testing shall be certified by Underwriters' Laboratories, Inc.

D. When conducting temperature rise tests to UL-1008, the manufacturer shall include post-endurance temperature rise tests to verify the ability of the combination transfer bypass/isolation switch to carry full rated current after completing the overload and endurance tests.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install transfer switches on concrete equipment foundations (housekeeping pad).

1. Anchor equipment to concrete housekeeping pad according to manufacturer’s written instructions and requirements in other sections of Division 26.
2. Install each unit level and plumb.

B. Maintain minimum clearances and workspace at equipment according to manufacturer’s written instructions and NFPA 70.

C. Install in accordance with national, state, and local codes, and manufacturer's instructions.

D. Include items not specifically mentioned but necessary for proper operation.

E. Connect wiring as indicated on the drawings and in accordance with manufacturer's recommendations.

F. Identify components.

3.2 CONNECTIONS

A. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

B. Wiring to Remote Components: Provide type and number of cables and conductors in raceway as recommended by manufacturer between emergency distribution system components for control and communication requirements.

3.3 IDENTIFICATION

A. Materials: Refer to Division 26 Section "Identification of Electrical Systems." Identify units, devices, fuse blocks, relays, controls, and wiring. Identify equipment ratings.

B. Nameplates: Refer to Division 26 Section “Identification of Electrical Systems” for additional requirements. Provide nameplate for each switch and major control or display component located on front of assembly.

1. Furnish master nameplate, stamped metal, listing standard manufacturer information including voltage, ampere, frequency, and short-circuit ratings; manufacturer’s model and project designations.

C. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be identified corresponding to designations on manufacturer’s drawings using tags and other identification materials.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer’s field service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections; and to assist the Contractor in testing.

B. Tests and inspections:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform tests recommended by manufacturer. Perform electrical tests and visual and mechanical inspection described under "Emergency Systems, Automatic Transfer Switches" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

3. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

C. Coordinate automatic transfer switch tests with tests of generator and run them concurrently.

D. Remove and replace malfunctioning units and retest as specified above.

E. Correct deficiencies identified by tests and observations and retest until specified requirements are met.

F. Demonstrate satisfactory operation of each feature required of the transfer switches.

G. Test emergency power system: After completion and acceptance of the generator tests, perform an operational test of the emergency power system. Perform a power failure test on the emergency electrical system. This shall be performed by interrupting the normal power source and verifying proper generator start and transfer switch operation.

H. Report results of tests and inspections in writing. Record adjustable relay settings.

3.5 CLEANING

A. Inspect and clean surfaces and repair damaged finishes to match original finish.

B. Clean interior of equipment according to manufacturer's instructions.

3.6 OPERATING INSTRUCTIONS

A. As specified in Section 26 0500, provide operating instructions.

B. Provide a period of 4 hours for equipment instruction to operating personnel.

C. Coordinate this instructional training with that for generator equipment.

END OF SECTION

SECTION 26 4313

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Surge protective devices (SPD's) for the protection of AC electrical circuits from the effects of lightning-induced currents, substation switching transients, and internally generated transients resulting from inductive or capacitive load switching.

1.2 RELATED SECTIONS

A. Panelboards: Section 26 2416.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. MCOV: Maximum continuous operating voltage.

C. MOV: Metal-oxide varistor.

D. SPD: Surge protective device.

E. VPR: Voltage protection rating.

1.4 SUBMITTALS

A. Product data: Manufacturer’s catalog information, including unit dimensions and rated capacities for each type of unit included in the project.

B. Certifications:

1. Cover page of manufacturer’s UL test report for each type of unit, showing that the unit is UL 1449 Fourth Edition listed.
2. UL 1449 Fourth Edition listing documentation verifying the following:

a. Voltage protection rating (VPR).
b. Maximum continuous operating voltage (MCOV).

3. Electromagnetic interference certification in accordance with UL 1283.

1.5 QUALITY ASSURANCE

A. Each SPD shall be UL 1449 Fourth Edition listed and labeled.

B. A single manufacturer shall provide SPD’s for every location.

1.6 WARRANTY

A. In addition to the general project warranty and correction period, provide manufacturer’s special warranties providing unlimited replacements of suppressor modules if they are destroyed by transients. Length of warranties:

1. Secondary distribution SPD: Ten years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Distribution equipment SPD's: Basis-of-design product: Subject to compliance with requirements, provide SPD units manufactured by ASCO Power Technologies, 400 Series, or comparable product by one of the following:

1. ABB; General Electric products.
2. ASCO Power Technologies.
3. Eaton Corporation.
4. Erico International Corp.; Pentair.
5. Schneider Electric; Square D products.
6. Siemens Industry, Inc.
7. Surge Suppression Inc.

2.2 SURGE PROTECTIVE DEVICES FOR SECONDARY BRANCH CIRCUIT PANELBOARDS

A. SPD unit factory installed and mounted integral to the panelboard as specified in Section 26 2416, Panelboards. Externally mounted SPD's separate from panelboards shall not be acceptable.

B. Suppression components shall be MOV based, serviceable, and replaceable.

C. SPD shall provide surge current paths for the following modes of protection: L-N, L-G, L-L, and N-G.

D. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.

E. Provide terminals for the necessary power and ground connections. Each terminal shall accommodate wire sizes of No. 10 to No. 1 AWG.

F. SPD's shall meet or exceed the following criteria:

1. Surge current capacity, single pulse rated, (L-N + N-G):

a. For branch-circuit panelboards: 100 kA per phase.

2. The UL 1449 Fourth Edition; voltage protection ratings (VPR) shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
208Y/120V	700V	800V	1200V	700V

3. UL 1449 listed maximum continuous operating voltage (MCOV):

System Voltage	Allowable System Voltage Fluctuation	MCOV
208Y/120V	25 percent	150V

G. SPD shall be equipped with the following:

1. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.

H. Enclosure: NEMA 250 Type 1.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install per manufacturer’s installation instructions and recommendations.

B. Install SPD's plumb, level and rigid without distortion.

3.2 FIELD QUALITY CONTROL

A. Test and inspections:

1. Perform each visual and mechanical inspection and electrical test in accordance with NETA Acceptance Testing Specifications in section, Surge Arresters, Low-Voltage Surge Protection Devices. Certify compliance with test parameters.
2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
3. Complete startup procedures according to manufacturer’s written instructions.

B. SPD device shall be considered defective if it does not pass tests and inspections.

END OF SECTION

SECTION 28 3100

FIRE DETECTION AND ALARM SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Connect generator to existing Fire Alarm Control Panel for monitoring points supervisory.

B. Costs of certification and testing, including tests required by NFPA 72, shall be included in the contract sum.

1.2 DEFINITIONS

A. FACP: Fire alarm control panel.

B. HVAC: Heating, ventilation, and air-conditioning.

C. LED: Light-emitting diode.

D. SPDT: Single pole, double throw.

E. Definitions in NFPA 72 apply to fire alarm terms used in this section.

1.3 SUBMITTALS

A. General:

1. When approved, no variation will be permitted except with the approval of the Engineer.
2. Submit to the authority having jurisdiction and to the Engineer for review and approval.

B. Shop drawings:

1. Floor plans indicating final equipment and device locations and raceway routes.
2. System operation description: Detailed description for this project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
3. Wiring diagrams and riser diagrams.

C. Product data: Schedule and each type of system component, including dimensioned plans and elevations showing minimum clearances and installed features and devices. Include UL listings.

D. Battery calculations.

E. Certifications:

1. UL Certificate of Compliance of system supplier as specified in "Quality Assurance" below.
2. Fire and smoke detection system inspection and test report, completed by the factory representative, endorsed by the Owner and the factory representative, including test data, detector locations and serial numbers, a summary of maintenance performed, recommendations for relocation or addition of detectors and final action regarding these recommendations, and system certification.

1.4 QUALITY ASSURANCE

A. System and equipment shall be UL listed. Each major component shall bear the manufacturer's name and catalog number.

B. UL labels and local testing (if required): As specified in Section 26 0500, Common Work Results for Electric.

C. Single-source responsibility: Obtain system components from a single source who assumes responsibility for their compatibility.

D. Qualifications of system supplier and installer:

1. Staff shall consist of at least one NICET Level III Technician or a professional engineer registered in Maryland.
2. Has installed at least ten systems of the type specified which have performed satisfactorily for not less than two years.
3. Maintains a facility with a sufficient stock of spare parts.
4. Shall respond within 24 hours of notification to correct system failure or malfunction. During the project correction period defined in General Conditions, perform such corrections at no addition to the Contract Sum.

E. Factory-authorized service representative: Trained and certified by the manufacturer of the system, and experienced in the installation and operation of the type of system included in the work.

F. Comply with NFPA 72, applicable local codes, and regulations and requirements of the authorities having jurisdiction. Montgomery County is the local code authority.

1.5 SEQUENCING AND SCHEDULING

A. Existing fire alarm equipment: Maintain fully operational until new equipment has been tested and accepted.

1. Field verify existing system is fully operational before beginning work on the existing components. If existing system is not fully operational immediately notify the Owner and Engineer in writing, and do not perform any work on the existing system until directed by the Engineer.
2. As new equipment is installed, label it NOT IN SERVICE until new equipment is accepted. As equipment is put in service, remove label and label existing equipment NOT IN SERVICE until it is physically removed.

B. Disconnected equipment: Remove equipment and restore damaged surfaces.

1. Operational disconnected equipment: Package, label, and deliver to Owner.

1.6 INSPECTIONS AND SERVICE CONTRACT

A. During the general project correction period, every six months starting six months after Substantial Completion, the supplier shall inspect and test the system.

1. Submit written reports to the Owner and Engineer, describing test results, including defects found and how they have been corrected, and listing components replaced.

B. At the end of the correction period, offer the Owner a service contract for the complete system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis-of-design system: Existing system is Firelite Alarms MS-9600UDLS. New devices shall be compatible with existing system.

2.2 ADDRESSABLE INTERFACE DEVICE

A. Monitor module: Microelectronic monitor module listed for use in providing a system address for external alarm-initiating devices with normally open contacts.

1. Dual circuit, intelligent, signaling circuit interface module.

B. Control module: Microelectronic control relay module listed for use in providing control to external appliances or equipment shutdown.

1. One Form C (SPDT) dry relay contact rated at 2 amps and 24 volts DC.

C. Isolator module: Microelectronic fault isolator module listed for isolating and removing a fault from a data circuit while allowing the remaining data loop to continue operating.

1. Protect loop system against wire-to-wire short circuits by isolating section of loop and permitting other loop sections to continue to operate.

D. Non-addressable control relay: Isolation relay for the control of HVAC unit contactors, UL 864 Listed.

1. Construction: Sealed, non-removable, with terminations to pressure-type screw terminals.
2. Rating: Use with circuits up to 240 volts AC at 7amperes inductive.

2.3 WIRE AND WIRING SYSTEM

A. Non-power-limited circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-voltage circuits: No. 16 AWG, minimum.
2. Line-voltage circuits: No. 12 AWG, minimum.

B. Power-limited circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.

C. Wiring system: Class B in accordance with NFPA 72.

3.1 INSTALLATION, GENERAL

A. Factory-authorized service representative, as required in "Quality Assurance" in Part 1 above, shall supervise installation, software documentation, adjustment, preliminary testing, final testing, and certification of the system, and provide the operating instructions.

B. Provide wiring, conduit, and outlet boxes required for the complete system, in accordance with system manufacturer's instructions and with requirements specified in Division 26 for wiring, conduit, and boxes. Provide 12 inches of slack at each outlet.

1. Install all wiring in conduit.
2. Identification: Paint fire alarm junction box covers red.

C. Wires, cables, conduits, and wiring connections are specified in Division 26, Electrical. Include in the work of this section, wiring, conduits, and equipment connections complying with the requirements of Division 26, so that the fire alarm system will function as specified and indicated on the drawings.

D. Wiring: Free from grounds or crosses between conductors.

1. Identification: Color code wiring, not duplicating building wiring colors. Tag each wire at each junction point.

E. Final connections between equipment and the wiring system shall be made under the direction and supervision of the qualified supplier.

F. Provide 20 percent spare capacity for each notification appliance circuit.

3.2 INTERFACE WITH OTHER WORK

A. Coordinate with installation of Emergency Generator.

3.3 INSPECTION, TEST, ADJUSTMENT AND REPORT

A. Furnish equipment and appliances for testing the complete system during progress of the work and after completion of the installation, including a megger test of wiring. The tests generally shall demonstrate the following:

1. Circuits are continuous and free from short circuits.
2. Circuits are free from unspecified grounds.
3. Resistance to ground of non-grounded circuits is not less than one megohm.
4. Circuits are properly connected in accordance with the applicable wiring diagrams.

B. Defects or omissions observed during general and system tests shall be repaired as quickly as possible and the tests reconducted.

C. Submit report as required in Part 1 above.

3.4 OPERATING INSTRUCTIONS

A. As specified in Section 26 0500, provide operating instructions.

B. Provide at least 8 hours of additional instruction time for the systems and equipment specified in this section, consisting of 2 periods of 4 consecutive hours, during a period of not more than 60 days.

END OF SECTION