

SECTION 26 01 00 - GENERAL REQUIREMENTS FOR ELECTRICAL WORK

**PART 1-GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Provisions of the General Conditions, Supplementary Conditions and Division 01 - General Requirements, and applicable provisions elsewhere in the Contract Documents apply to the work Division 26- Electrical.

**1.2 SUMMARY OF WORK**

- A. Provide all labor, materials, supervision, tools, services, equipment and incidentals necessary for complete and operational systems as specified under this division, as shown on the Contract Drawings or as required.

**1.3 DRAWINGS AND SPECIFICATIONS**

- A. Prior to submitting a bid:
  - 1. Examine the Drawings.
  - 2. Read the Specifications and other Contract Documents, including Addenda and referenced material.
  - 3. Visit the site of work.
  - 4. Become informed prior to bidding as to existing conditions and limitations of the project.
- B. Bring exceptions and inconsistencies in Drawings, specifications, addenda, referenced material, other Contract Documents and site conditions to the attention of the Architect in writing seven days before the bid opening; otherwise be responsible for changes and additions that become necessary during construction.
- C. Interpretation or correction of the Contract Documents will be made by Addendum and will be mailed or delivered to each Contract Bidder of Record.
- D. Location of material, equipment, devices and appliances shown in the Contract Drawings are approximate and are subject to such revisions as may be necessary or desirable at the time the work is installed. Install the work in relation to existing conditions and be responsible for the correctness of the work with reference to finish elevations and surrounding conditions.
- E. The Contract Documents show the general arrangements of work. Should project conditions require any rearrangement, or if equipment or accessories can be installed to better advantage in a different manner, the Contractor may, before proceeding with the work, prepare and submit five copies of shop drawings of the proposed rearrangement for the Architect's review.
- F. If the Contractor proposes to install equipment requiring space conditions other than those shown, he shall assume responsibility for the rearrangement of the space and shall have the Architect review the change before proceeding with the work. The request for such changes shall be accompanied by shop drawings of the space affected.

- G. The accompanying Drawings do not indicate the existing electrical installations other than to identify modifications to the extensions thereto. Visit the site and ascertain the conditions to be met and the work to be accomplished in removing and modifying the existing work, and installing the new work. Failure to comply with this shall not constitute grounds for any additional payment in connection with removing or modifying any part of the existing installations and/or installing any new or temporary work under this Division.

#### **1.4 CODES AND STANDARDS**

- A. Execute the work in accordance with local, state and national codes, ordinances and regulations having jurisdiction or authority over the work. Make any and all adjustments required by these agencies without further cost to the Owner. In addition, conform to the applicable provisions and recommendations of the following standards:
1. National Electrical Manufacturer Association (NEMA)
  2. American Society for Testing and Materials (ASTM)
  3. National Fire Protection Association (NFPA)
  4. National Electrical Safety code (NESC)
  5. Institute of Electrical and Electronic Engineers (IEEE)
  6. National Electrical Code (NEC)
  7. Underwriters' Laboratories (UL)
  8. American National Standards Institute (ANSI)
  9. International Building Code (IBC)
  10. Occupational Safety and Health Administration (OSHA)
  11. Local utility companies
  12. Americans with Disabilities Act (ADA)
  13. City Codes and Amendments
  14. Texas Department of Aging and Disability Services (TxDADS)
- B. Execute the work in accordance with the most current codes and standards in effect at the time of bidding.
- C. In the event standards and codes conflict with each other, the most stringent shall apply.
- D. Conform to National Electrical Code rules, be listed approved by Underwriter's Laboratories, Inc. and acceptable by Factory Mutual.
- E. It is specifically understood, however, that in those instances where capacities sizes, etc., of electrical equipment, devices or material as designated in these Specifications or on the Drawings are in excess of the minimum requirements of the National Electrical Code, such designated capacities shall prevail.

#### **1.5 JOB SITE**

- A. Neither the professional activities of the DESIGN PROFESSIONAL, nor the presence of the DESIGN PROFESSIONAL or the DESIGN PROFESSIONAL's employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties, and responsibilities including, but not limited to, construction means, methods, sequences, techniques, or procedures necessary for performing, superintending, or coordinating all portions of the work construction in accordance with the contract documents and any health and safety precautions required by any regulatory agencies. The DESIGN PROFESSIONAL and DESIGN PROFESSIONAL's personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precaution.

**PART 2 - PRODUCTS**

**2.1 SHOP DRAWINGS AND SUBMITTALS**

- A. Submit Shop Drawings for all material furnished under this division of the work. Refer to the General Requirements for additional requirements. No material shall be fabricated, delivered to the job site, or installed which has not been reviewed by the Architect through Shop Drawing submittals.
- B. The submittals shall include sufficient descriptive material, such as catalog cuts, diagrams, and other data published by the manufacturer, as well as evidence of compliance with safety and performance standards, to demonstrate conformance to the specification requirements; catalog numbers alone will not be acceptable. The data shall include the name and address of the nearest service and maintenance organization that regularly stocks repair parts.
- C. Deliver Shop Drawings to the Architect in sufficient time to avoid delay of the project. Allow a minimum of one month for the Architect to review and return the submittals.
- D. Submit samples for review when requested by the Architect.
- E. Before submitting Shop Drawings for review, examine them and verify that they correctly represent the material or equipment intended for this project. The Contractor's review of Shop Drawings is not intended to take the place of the review of the Architect, and Shop Drawings which have not been reviewed by the Architect shall not be used in fabricating or installing any work.
- F. List deviations and exceptions from the specified equipment in writing. Failure to do so will be cause for rejection of submittals. Contractor agrees that if deviations discrepancies, or conflicts between Shop Drawings submittals and the Contract Documents are discovered either prior to or after Shop Drawings submittals are reviewed by the Architect, the Contract Documents shall control and shall be followed, unless deviations have been specifically approved by the Architect.
- G. The review of Shop Drawings or catalog data by the Architect shall not relieve the Contractor from responsibility for deviations from plans and specifications unless he has, in writing, specifically called attention to such deviations at the time of submission and has obtained the permission of the Architect thereon; nor shall it relieve him from responsibility for error of kind in Shop Drawings. When the Contractor does call such deviations to the attention of the Architect, he shall state in his letter whether or not such deviations involve any extra cost. If this is not mentioned, it will be assumed that no extra cost is involved for making the change.
- H. Contractor agrees that Shop Drawing submittals reviewed by the Architect are not change orders; that the purpose of Shop Drawing submittals by the Contractor is to demonstrate to the Architect that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use.
- I. Electronic files of the construction documents will not be provided and may not be used for shop drawing submittals.

**2.2 STANDARDS FOR MATERIALS**

- A. It is the intention of these specifications to indicate a standard of quality for all materials incorporated in this work. Manufacturer's names and catalog numbers are used to designate the item of equipment or material as a means of establishing grade and quality. Where several manufacturers are named, only the named manufacturer's products will be considered and the Contractor's bid shall be based on their product.
- B. Where the phrase 'or approved equal' or 'or equal' or 'equal to' or 'accepted substitute' is used in these specifications, the names or name mentioned are to be used as a basis of quality. Other manufacturers will be considered if the quality of the proposed material is equal to that of materials named, in the opinion of the Architect. Such unnamed manufacturers' products will, however, be considered as substitutions and shall not be used as a basis for bidding.
- C. Basis of quality shall include material, workmanship, weight, finishes, gauges of material, appearances, capacity and performance. Manufacturer's representation as to availability of equipment, replacement parts and service personnel in the area will be a factor in consideration of submittals.
- D. All materials shall be fully warranted.
- E. Furnish standard products of manufacturers regularly engaged in production of such equipment.
- F. Furnish manufacturer's latest standard design.
- G. All equipment shall conform to the applicable IEEE, UL, ANSI, and/or NEMA Standards.
- H. Obtain manufacturer's recommendations and instructions for all installed equipment including installation instructions, preparation cleaning, tests, pre-service checks and ensure all have been performed prior to completion of work.

**2.3 SUBSTITUTIONS**

- A. Substitutions of equipment shall be approved by the Architect prior to installation. Substitution of equipment shall be in accordance with Division 01 of the specifications.
- B. When alternate or substitute materials and equipment are used, the Contractor shall be responsible for space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, and other apparatus and trades that may be affected by their use.
- C. Contractor shall bear all additional costs resulting from the use of substituted materials. Such changes be at no additional cost to the Owner.

**PART 3 - EXECUTION****3.1 COORDINATION**

- A. Coordinate and direct the work under this division of the specifications with the work under other divisions of the specifications. Examine the Contract Documents and report any discrepancies between divisions of the work to the Architect and obtain written instructions for changes necessary in the work.

- B. Before installation, make proper provisions to avoid interference's with the work under other divisions of the specifications. Changes required in the work of the Contractor caused by his neglect to do so shall be made by him at his own expense.
- C. Harmonize the work under this division with the work under other divisions of the specifications such that it may be installed in the most direct and workmanlike manner without hindering, handicapping, or conflicting with the work under other divisions of the specifications. Piping interference's shall be handled by giving precedence to pipelines which require a stated grade for proper operation.
- D. Install all work/equipment in accordance with manufacturer's installation instructions.

### **3.2 PERMITS AND FEES**

- A. Secure and pay for all necessary permits, licenses and inspections required by law for the completion of the work. Secure and pay for all certificates of approval that are required and deliver them to the Architect before final acceptance of the work.
- B. If any charges are made by a utility company in connection with the work under this division, the Contractor shall advise the Owner, so that the Owner can pay these charges. Advise the Owner of these charges at the time of bid, so as not to delay construction on the project.

### **3.3 QUALITY ASSURANCE**

- A. Use adequate quantities of skilled workmen who are trained and experienced in their crafts and who are familiar with the specified requirements and methods needed to perform the work in this division.
- B. Install materials and equipment based upon actual dimensions and conditions at the project site. Field measure for materials or equipment requiring exact fit.
- C. Properly located and size all slots, holes or openings in the building structure pertaining to the work in this division, and for the correct location of pipe sleeves.
- D. Perform work in accordance with good commercial practice. The good appearance of the finished work shall be of equal importance with its operation.
- E. Isolate all conduit, transformers and motors to insure an acceptable noise level free from objectionable vibration for all systems.

### **3.4 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Follow the manufacturer's directions in the delivery, storage and handling of equipment and materials.
- B. Equipment and materials shall be tightly covered and protected against dirt, water, chemical or mechanical injury and theft. Damaged equipment will not be accepted.
- C. After materials are installed, protect the installation until the work is completed and accepted by the Owner.

**3.5 CLEANING UP**

- A. Remove all shipping labels, dirt, paint, grease and stains from all equipment under this division of the work. Remove debris as it accumulates. Upon completion of the Work, clean all electrical equipment and the entire electrical installations in order to present a first class electrical installation suitable for occupancy. No loose part, scraps, tools and debris shall be left on the premises.

**3.6 ELECTRICAL SERVICE FOR TESTING**

- A. Construct sufficient temporary electric service and connect to refrigeration machines, related pumps, fans, fan coil units, elevators and other equipment furnished under other divisions of the specifications such that the equipment installers may begin testing 30 workdays before job completion deadline.

**3.7 CUTTING AND PATCHING**

- A. Be responsible for the cost of cutting and patching required in connection with work under this division of the specifications.
- B. Coordinate the work to eliminate unnecessary cutting of construction. Where it becomes necessary to cut through walls floors, ceilings and other construction to permit installation of the work, or to repair defective work under this division, the costs for such cutting and patching shall be included in this division of the work. Comply with other applicable divisions of the specifications concerning the quality of cutting and patching.
- C. Provide lintels or structural supports where openings are cut through masonry walls to protect the remaining masonry. Provide adequate support during the cutting operation to prevent any damage to the affected masonry.
- D. Cutting of structural members is not permitted unless specific written permission is granted by the Architect.

**3.8 FLASHING, SLEEVES, INSERTS**

- A. Maintain the integrity of the waterproofing of conduit penetrations through roofs, exterior walls and floors.
- B. Install counter-flashing on roof penetrations to provide a weatherproof installation.
- C. Install 22 gauge galvanized sheet iron sleeves for each conduit passing through floors. Extend sleeves 1-1/2 inches above the floor slab and cement watertight. The sizes of sleeves shall be installed to permit the subsequent of the proper size conduits or raceways.
- D. Install galvanized wrought iron pipe sleeves around conduits and raceways that pass through concrete beams or walls and masonry exterior walls. The inside diameter of these sleeves shall be at least 1/2-inch greater than the outside diameters of the service pipes. After the pipes are installed in these sleeves, fill the annular space between pipes and sleeves with mastic. The completed installation shall be watertight.
- E. Maintain the fire rating of penetrations through walls, floors and ceilings.

- F. Waterproofing and fireproofing work shall conform to the requirements of other applicable sections of the specifications.

**3.9 FOUNDATIONS**

- A. Install steel reinforced concrete foundations below all floor mounted switchboards, panelboards, motor control centers, transformers and other floor mounted electrical equipment.
- B. Concrete foundations shall not be less than 4 inches high. All top edges shall be neatly chamfered.
- C. Concrete foundations shall be 6 inches wider and 6 inches longer than the base of the equipment being installed.
- D. All concrete work shall be steel reinforced with a minimum of 6 inches by 6 inches No. 6 mesh and shall conform entirely to the requirements of the other sections of the specifications describing this class of work.

**3.10 PAINTING**

- A. Maintain original factory finish on all material and equipment installed under this division of the work unless specifically noted otherwise within the Contract Documents. Should the finish be marred in transit or during installation, it shall be finished to present a neat, workmanlike appearance. Leave equipment clean and free from any grease, dirt and rust and in a suitable condition for painting.

**3.11 EXCAVATION AND BACKFILLING**

- A. Excavate and backfill as necessary for the installation of the work under this division. Include shoring and pumping in ditches to keep them in dry conditions until the work has been installed. Perform all shoring required to protect the excavation and safeguard employees.
- B. Excavate to the proper depth, with allowances made for floor slabs, forms, beams, etc. Compact the ground under conduits before conduits are installed.
- C. Install exterior conduits with a minimum of 30 inches of cover below the finished grade, unless otherwise indicated.
- D. Use selected soil for backfilling, free from rocks and debris, pneumatically tamped with 6 inch layers to secure a field density ratio of 90 percent as defined by ASTM Designation D698-57T (Proctor Soil Compaction Test).
- E. Remove from the site excavated materials not suitable for backfill and not used in the backfill.
- F. Field check and verify the locations of all underground utilities. Avoid disturbing these as far as possible. In the event existing utilities are damaged, they shall be repaired to make their operation equal to before any trenching was started.
- G. Replace concrete, curbs, paving and other surface improvements cut during excavation to their original condition. In a lime stabilized area, the lime stabilization shall be fully restored after the excavation is complete.

**3.12 IDENTIFICATION OF ELECTRICAL EQUIPMENT**

- A. Identify electrical equipment in accordance with NEC, local authorities and in accordance with the requirements of the Contract Documents.
- B. Use laminated three-ply engraved plastic nameplates with black surface and white interior core, at least 1/16-inch thick. Engraved lettering shall be Helvetica at least --1/4-inch high and properly spaced for legible and easy reading. Attach plates to equipment with chromium plated screws. Adhesive attachment is not acceptable. Identify the following items with engraved nameplates, located as follows:
  - 1. Switchgear, distribution panels, panelboards and transformer nameplates shall include panelboard/transformer they are fed from, voltage, phase and wire configuration.
  - 2. Each circuit breaker in each main panel and each distribution panel - adjacent to circuit breaker.
  - 3. Spares and Spaces shall be labeled accordingly.
  - 4. Each branch circuit panel - on trim cover immediately above panel door.
  - 5. Each exhaust fan switch, relay cabinet, time clock-on outside of cover.
  - 6. Each exhaust fan switch - custom engraved on outside of switch coverplate (high and low if required).
  - 7. Each motor starter - on outside of cover.
  - 8. Outside light switches - custom engraved on outside of switch coverplate.
  - 9. Any switch for load that cannot be seen from the control point - custom engraved on outside of switch coverplate.
  - 10. Pushbuttons and control devices.
  - 11. As noted on plans.
- C. Custom engraving on cover plates for items noted above shall be equal to custom engraving as performed by Hubbell, or accepted substitute.
- D. Branch circuit panelboard directories shall be completely and properly typewritten, including room numbers. Room numbers and names shall be as finally designated at the jobsite, coordinate with architect/owners representative.
- E. Identifying Tape for Buried Conduits: 6 inches wide, polyethylene, with printing continuous along length of tape, Brady Identoline.
  - 1. For buried electric power conduits - yellow with black letters.
  - 2. For buried electric communication conduits - green with black letters.
- F. Refer to other sections of the specifications for conductor color coding requirements.

**3.13 BALANCING OF PANELS**

- A. At the completion of the installation of the electrical system, check each phase of all panels under full load and arrange loads such that all phases carry the proper proportion of load.

**3.14 LOCKING OF ELECTRICAL FACILITIES**

- A. Provide padlocks for exterior electrical facilities subject to unauthorized entry.
- B. Furnish locks to match Owner's locking system. Key all locks alike.



- C. Furnish Owner with two keys per lock up to a quantity of ten keys.
- D. Install locks immediately upon installation of electrical facility.

**3.15 ACCESS DOORS**

- A. Whenever access is required in walls, ceilings, or soffits to concealed junction boxes, pull boxes or other electrical equipment installed under this division, provide and install access doors as indicated herein.
- B. Furnish and install hinged access door and frame with flush latch handle as follows:
  - 1. Plaster surfaces - Milcor Style K, or accepted substitute.
  - 2. Ceramic tile or drywall surface - Milor Style M (with 'B' label where required), or accepted substitute.
  - 3. Install panels in locations approved by the Architect and paint as directed.

**3.16 RECORD DOCUMENTS**

- A. Job set: Promptly following receipt of the Owner's Notice to Proceed, secure from the Architect at no charge to the Contractor, one complete set of all Documents comprising the Contract.
- B. Final Record Documents: At a time nearing the completion of the work, secure from the Architect at no charge to the contractor one complete set of sepia transparencies of all Drawings in the Contract.
- C. Maintenance of Job Set: Immediately upon receipt of the job set described in paragraph above, identify each of the Documents with the title, "RECORD DOCUMENTS - JOB SET".
- D. Preservation:
  - 1. Considering the Contract completion time, the probable number of occasions upon which the job set must be taken out of the new entries and for examination, and the conditions under which these activities will be performed, devise a suitable method for protecting the job set to the approval of the Architect.
  - 2. Do not use the job set for any purpose except entry of new data and for review by the Architect, until start of transfer of data to final Project Record Documents.
  - 3. Maintain the job set at the site of Work as that site is designated by the Architect.
- E. Making Entries on Drawings:
  - 1. Using erasable colored pencil (not ink or indelible pencil), clearly describe the change by graphic line and note as required.
  - 2. Date all entries.
  - 3. Call attention to the entry by a 'cloud' drawn around the area or areas affected.
  - 4. In the event of overlapping changes, use different colors for the overlapping changes.
  - 5. All equipment shall be clearly indicated in its installed location. Exposed items or those easily accessible, as above lay-in ceilings, may be located to scale. Concealed items not readily accessible, such as underground piping, shall be located by dimension.
- F. Transfer of Data to Final Project Documents;
  - 1. Approval of recorded data prior to transfer:

- a. Following receipt of the transparencies described above, and prior to beginning transfer of recorded data thereto, secure the Architect's approval of all recorded data.
  - b. Make required revisions.
2. Transfer of Data to Drawings:
- a. Carefully transfer change data shown on the job set of Record Drawings to the corresponding transparencies, coordinating the changes as required.
  - b. Clearly indicate at each affected detail and other drawing a full description of changes made during construction, and the actual location of items described above.
  - c. Call attention to each entry by drawing a 'cloud' around the area or areas affected.
  - d. Make changes neatly, consistently, and with the proper media to assure longevity and clear reproduction.

G. Review and Submittals:

1. Submit the completed set of Project Record Documents to the Architect as described above.
2. Participate in review meetings as required.
3. Make required changes and promptly deliver the final Project Record Documents to the Architect.

### **3.17 OPERATIONS AND MAINTENANCE DATA**

- A. Accumulate, as the job progresses, the following data, in duplicate, prepared in a 1 1/2"x11" stiff covered binder with clearly labeled filing tabs, and deliver to the Architect for checking and subsequent delivery to the Owner.
1. Manufactures' warranties, guarantees, service manuals, catalog brochure information and operating instructions on equipment and materials covered by this division of the specifications.
  2. Copies of approved Shop Drawings.
  3. Any and all other data and/or Drawings required during construction.
  4. Repair parts list of all major items and equipment including name, address, and telephone number of local supplier and agent.

### **3.18 INSTRUCTION OWNER'S PERSONNEL**

- A. Provide the services of competent engineers or technicians acceptable to the Architect to instruct representatives of the Owner in the complete and detailed operation of each item of equipment, and each system. These instructions shall be provided for whatever periods may be necessary to accomplish the desired results. Upon completion of these instructions, the Contractor shall obtain a Letter of Release, acknowledged by the Owner or his Authorized Representative, stating the dates on which the various kinds of instruction were given, and the personnel to whom the instructions were given.
- B. Be responsible for proper maintenance of equipment and systems until the instructions have been given to the Owner's personnel and the letter of release acknowledged.
- C. In providing the instructions to the Owner's personnel, follow the written operating and maintenance manuals in all instances, and familiarize the Owner's personnel with such manuals. Operating and maintenance manuals used for instructions shall include wiring diagrams, manufacturers' operation and maintenance manuals, parts lists (with sources identified), and other data as appropriate for each system, and as required elsewhere in the Specifications to be furnished to the Owner prior to final acceptance of the project.

**3.19 LOCAL PARTS AND SERVICE**

- A. Each item equipment furnished on this project shall have local representation, factory-authorized service, and an adequate stock or repair parts. "Local" shall be defined, for this purpose, as "within 150 miles of the project site".

**3.20 INSTALLATION INSPECTIONS AND CERTIFICATIONS**

- A. Obtain timely inspections of the installation by the constituted authorities. Remedy any deficiencies to the satisfaction of the inspection authority.
- B. Upon final completion of the Work, obtain certificates of acceptance from the constituted authorities. Deliver the certificates to the Architect for transmission to the Owner.

**3.21 OPERATION PRIOR TO ACCEPTANCE**

- A. When any equipment is operable, and it is to the advantage of the Contractor to operate the equipment, he may do so provided that he properly supervises the operation and retains full responsibility for the equipment operated. Regardless of whether or not the equipment has or has not been operated, clean the equipment properly, make required adjustments, and complete punchlist before final acceptance by the Owner.
- B. The date of acceptance by the Architect, for beneficial use by the Owner, shall be the beginning date of the warranty period.

**3.22 ACCEPTANCE OF THE WORK**

- A. The Work, when completed, will be accepted in a finished, perfect and undamaged state only. Provide for protection of the Work during its progress, and if damaged, do all patching or replacing necessary to its full and satisfactory completion.

**3.23 WARRANTY**

- A. Furnish a written certificate, guaranteeing all materials, equipment and labor to be free of all defects for a period of one year from the date of final acceptance by the Owner of the Work, and guarantee that if any defects appear within the stipulated guarantee period, such work shall be replaced without charge.
- B. This guarantee shall be extended to include the capacity and integrated performance of all component parts of the various systems.
- C. Lamps for light fixtures shall be excluded from the guarantee requirements of this section.

**3.24 TRAINING**

- A. Provide (1) 8 hour block of training and familiarization of the equipment installed with the owner's selected representative.
- B. Reference other sections for detailed training requirements.

**3.25 INTENT OF SPECIFICATIONS**

- A. It is the intention that this Specification provide a complete installation. Include all accessory construction and apparatus necessary to the operation and testing of the work under this division. The omission of specific reference to any part of the work necessary for such complete installation shall not relieve this Contractor from furnishing and installing such parts.

**END OF SECTION 26 01 00**

**SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Electrical equipment coordination and installation.
  - 2. Sleeves for raceways and cables.
  - 3. Sleeve seals.
  - 4. Grout.
  - 5. Common electrical installation requirements.

**1.3 DEFINITIONS**

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

**1.4 SUBMITTALS**

- A. Product Data: For sleeve seals.

**1.5 COORDINATION**

- A. Coordinate arrangement, mounting, and support of electrical equipment:
  - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
  - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
  - 3. To allow right of way for piping and conduit installed at required slope.
  - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".

## **PART 2 - PRODUCTS**

### **2.1 SLEEVES FOR RACEWAYS AND CABLES**

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
  - 1. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
    - b. 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), thickness shall be 0.138 inch (3.5 mm).

### **2.2 SLEEVE SEALS**

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following product by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. 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.
  - 3. Pressure Plates: Carbon steel include two for each sealing element.
  - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

### **2.3 GROUT**

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

**PART 3 - EXECUTION**

**3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION**

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

**3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- 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. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. 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.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
  - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe 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.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

### **3.3 SLEEVE-SEAL INSTALLATION**

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### **3.4 FIRESTOPPING**

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

**END OF SECTION 26 05 00**



**SECTION 26 05 04 - TEMPORARY ELECTRIC SERVICE**

**PART 1 - GENERAL**

**1.1 COORDINATION**

- A. Furnish all labor, materials, services, equipment and appliances required in conjunction with the installation of electric service entrance metering as required by the electric utility company and as indicated in the Contract Documents or as required.
- B. Refer to electrical section for directions concerning charges assessed by the electric utility company.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Determine the work that will be provided by the electric utility company and provide all other work required for a complete installation of the temporary electric service.
- B. Work shall include, but not be limited to, conductors, conduit, connectors, supports, wireways and disconnects.
- C. Temporary electric service to equipment to be as needed by electrical contractor.
- D. Material shall be as specified in other sections of the specifications and as required by the electric utility company. Furnish all materials required by Power Company for electric metering.
- E. Install all equipment furnished by Power Company and furnish other material and labor as required by the Power Company to receive temporary electric service.

**PART 3 - EXECUTION**

**3.1 INSPECTION**

- A. Fully inspect project site to determine the scope and check for any conflicts or obstructions in installing the temporary electrical service. Perform work necessary to accommodate conflicts and obstructions under this division.
- B. Provide work in accordance with other sections of the specifications, the National Electrical Code, the National Electrical Safety Code and the electric utility company. Coordinate the work under this section with the work under other divisions of the specifications.
- C. Electrical contractor shall contact utility company and Owner Representative to plan for shut down of electrical service. Close coordination to be made, in order to minimize down time.

**END OF SECTION 26 05 04**

**SECTION 26 05 05 - TRENCHING AND BACKFILL**

**PART 1 - GENERAL**

**1.1 SUMMARY OF WORK**

- A. This section includes the following:
1. Excavating and backfilling of trenches within building lines.
  2. Excavating and backfilling for underground mechanical and electrical utilities and buried mechanical and electrical appurtenances.

**1.2 REFERENCED STANDARDS**

- A. Standards referenced in the text of this Section are listed below according to source, designation, and title.
1. American Society for Testing and Materials (ASTM):
    - D1556-82 Test Method for Density of Soil In-Place by Sand-Cone Method.
    - D1557-78 Standard test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb. (4.54-Kg) Rammer and 18-in. (457-Mm) Drop.
    - D2167-84 Test Method for Density and Unit Weight of Soil In-Place by the Rubber Balloon Method.
    - D2487-85 Standard Test Method for Classification of Soils for Engineering Purposes.
    - D2922-81 Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
    - D3017-78 Test Methods for Moisture Content Of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
    - D4254-83 Standard Test Methods for Minimum Index Density of Soils and Calculations of Relative Density.
    - E699-79 Practice for Criteria for Evaluation of Agencies (1984) Involved in Testing, Quality Assurance, and Evaluating Building Components in Accordance with Test Methods Promulgated by ASTM Committee E-6.
  2. Society of Automotive Engineers:
    - SAE J 732-80 Specification Definitions - Loaders.

**1.3 DEFINITIONS**

- A. Excavation consist of removal of material encountered to subgrade elevations indicated in subsequent disposal of materials removed.
- B. Unauthorized excavation consist of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Architect/Engineer. Unauthorized excavation, as well as remedial work directed by Architect/Engineer, shall be at Contractor's expense.
- C. Subgrade: The undisturbed pavement, earth or the compacted soil layer immediately below pavement, granular subbase, drainage fill, or topsoil materials.

- D. Structure: Buildings, foundations, slabs, tanks, curbs or other man-made stationary features occurring above or below ground surface.

#### 1.4 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

#### 1.5 PROJECT CONDITIONS

- A. Existing Utilities: Locate existing underground utilities in areas of excavation work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
  - 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damages utilities to satisfaction of utility owner.
  - 2. Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Architect and then only after acceptable temporary utility services have been provided.
  - 3. Provide minimum of 48-hour notice to Architect, and receive written notice to proceed before interrupting any utility. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.
- B. Use of Explosives: Use of explosives is not permitted.
- C. Protection of Persons and Property: Protection of Persons and Property will be the responsibility of the contractor. Barricade open excavations occurring as part of this work.
  - 1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
  - 2. Perform excavation by hand within dripline of large trees to remain. Protect root systems from damage or dry out to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.

### PART 2 - PRODUCTS

#### 2.1 SOIL MATERIALS

- A. Satisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GW, GP, GC, GM, SM, SC, SW, SP, and CL.
- B. Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups ML, MH, CH, OL, OH, and PT.

- C. Subbase Material: Naturally or artificially graded mixtures of natural or crushed gravel, crushed stone, crushed slag, and natural or crushed sand.
- D. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2 inch sieve and not more than 5 percent passing a No.4 sieve.
- E. Backfill and Fill Materials: Satisfactory soil materials free of clay, rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.

### **PART 3 - EXECUTION**

#### **3.1 EXCAVATION**

- A. Excavation is unclassified and includes excavation to subgrade elevations indicated, regardless of character or materials and obstructions encountered.
- B. Excavation Classifications: The following classifications of excavation will be made when rock is encountered:
  - 1. Earth Excavation includes excavation of pavements and other obstructions visible of surface; underground structures, utilities, and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.
  - 2. Rock excavation for trenches and pits includes removal and disposal of materials and obstructions encountered that cannot be excavated with a track-mounted power excavator, equivalent to Caterpillar Model No. 215C LC, and rated at not less than 115 HP flywheel power and 32,000-pound drawbar pull and equipped with a short stick and a 42-inch wide, short tip radius rock bucket rated at 0.81 cubic yard (heaped) capacity. Trenches in excess of 10 feet in width and pits in excess of 30 feet in either length or width are classified as open excavation.

#### **3.2 STABILITY OF EXCAVATIONS**

- A. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction.
- B. Slope sides of excavation to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

#### **3.3 DEWATERING**

- A. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site surrounding area.
  - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

### **3.4 STORAGE OF EXCAVATED MATERIALS**

- A. Stockpile excavated materials acceptable for backfill and fill where directed. Place, grade, and shape stockpiles for proper drainage.
  - 1. Locate and retain soil materials away from edge of excavations. Do not store within dripline of trees indicated to remain.
  - 2. Dispose of excess excavated soil material and materials not acceptable for use as backfill or fill.

### **3.5 TRENCH EXCAVATION FOR PIPES AND CONDUITS**

- A. Excavate trenches to uniform width, sufficiently wide to provide ample working room and minimum of 6 to 9 inches of clearance on both sides of pipe or conduit.
- B. Excavate trenches and conduit to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on undisturbed soil. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
  - 1. Where rock is encountered, carry excavation 6 inches below required elevation and backfill with a 6-inch layer of crushed stone or gravel prior to installation of pipe.
  - 2. For pipes or conduit less than 6 inches in nominal size, and or flat-bottomed, multiple-duct conduit units, do not excavate beyond indicated depths. Hand excavated bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
  - 3. For pipes and equipment 6 inches or larger in nominal size, shape bottom of trench to fit bottom of pipe for 90 degrees (bottom 1/4 of the circumference). Fill depressions with tamped sand backfill. At each pipe joint, dig bell holes to relieve pipe bell of loads ensure continuous bearing of pipe barrel on bearing surface.

### **3.6 BACKFILL AND FILL**

- A. General: Place soil materials in layers to require subgrade elevations, for each area classification listed below, using materials specified in Part 2 of this Section.
  - 1. Under grassed areas, use satisfactory excavated or borrow material.
  - 2. Under walks and pavements, use subbase material, satisfactory excavated or borrow material, or a combination.
  - 3. Under steps, use subbase material.
  - 4. Under building slabs, use drainage fill material.
  - 5. Under piping, conduit and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation. Shape excavation bottom to fit bottom 90 degrees of cylinder.
  - 6. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings and that are carried below bottom of such footings or that pass under wall footings. Place concrete to level of bottom of adjacent footing.
    - a. Concrete is specified in Division 32.

- b. Do not backfill trenches until test and inspections have been made and backfilling is authorized by Architect. Use care in backfilling to avoid damage or displacement of pipe systems.

B. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade including, where applicable, damp-proofing, waterproofing, and perimeter insulation.
2. Inspection, testing, approval, and recording locations of underground utilities have been performed and recorded.
3. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structures or utilities, or leave in place if required.
4. Removal of trash and debris from excavation.
5. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

### **3.7 PLACEMENT AND COMPACTION**

- A. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill materials on surfaces that are muddy, frozen, or contain frost or ice.
- C. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.
- D. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by Architect if soil density tests indicate inadequate compaction.
  1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D 1557:
    - a. Under lawn or unpaved areas, compact top 6 inches of subgrade and each layer of backfill or fill material at (90) percent maximum density.
  2. Under walkways, compact top 6 inches of subgrade and each layer of backfill or fill material at 85 percent maximum density.
  3. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.
    - a. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

- b. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

### **3.8 FIELD QUALITY CONTROL**

- A. Quality Control Testing During Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.
  - 1. Perform field density tests in accordance with ASTM D 1556 (sand cone method) or ASTM D2167 (rubber balloon method), as applicable.
    - a. Field density tests may also be performed by the nuclear method in accordance with ASTM D 2922, providing that the calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. In conjunction with each density calibration check, check the calibration curves furnished with the moisture gages in accordance with ASTM D 3017.

### **3.9 EROSION CONTROL**

- A. Provide erosion control methods in accordance with requirements of authorities having jurisdiction.

### **3.10 MAINTENANCE**

- A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.
- D. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

### **3.11 DISPOSAL OF EXCESS AND WASTE MATERIALS**

- A. Removal from Owner's property: Remove excess excavated material, waste materials, including unacceptable excavated material, trash and debris, and dispose of it off Owner's property.
- B. Removal to Designated Areas on Owner's Property: Transport acceptable excess excavated material to designated soil storage areas by Owner's property. Stockpile soil or spread as directed by Architect.

**END OF SECTION 26 05 05**



**SECTION 26 05 10 - SEALING OF PENETRATIONS**

**PART 1-GENERAL**

**1.1 SUBMITTALS**

- A. Samples: Provide samples upon written request.
- B. Product Data: Manufacturer's specifications and installation instructions.

**1.2 SUMMARY OF WORK**

- A. Provide all labor, materials, supervision, tools, services, equipment and incidentals necessary for complete and operational systems as specified under this division, as shown on the Contract Drawings or as required.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Acceptable Manufacturers:
  - 1. Caulk and Putty: 3M's No. CP-25 and No. CP-303 synthetic elastomers.
  - 2. Wrap/Strip: 3M's No. FS-195 organic/inorganic, fire resistive sheet with aluminum foil on one side.
  - 3. Composite Sheet: 3M's No. CS-195 organic/inorganic fire resistive elastomeric sheet, bonded on one side with 28-gauge galvanized steel and the other side with reinforced hexagonal shaped steel wire mesh and covered with aluminum foil.
  - 4. Thunderline Model "LS/Link-Seal" seals, of the required size and number of links, shall be used on all conduit penetrations of exterior walls. Similar fittings by O.Z./Gedney shall be considered approved equivalents.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Review the detailed requirements of the UL through penetration firestop assembly to be used and verify dimensional requirements such as maximum conduit size, conduit spacing, maximum opening size, minimum length of sleeve, etc.
- B. For sealing of sleeves on or below grade and in wet locations, install line seals around all conduit penetrations properly sealing the annular space between the sleeve and the conduit to provide a waterproof seal.

- C. Attach an adhesive warning label identifying the firestop assembly and warning against removal without proper resealing.
- D. Provide sealing of penetrations in above and in dry/damp locations, both horizontal and vertical, utilizing intumescent (expand when heated) materials designed to be applied as a fire, cold smoke, noxious gas, and water sealant, and having a UL classified “through-penetration” firestop system meeting Nos. 33, 49, 61 through 66, and 90 through 105, inclusive.

**END OF SECTION 26 05 10**

**SECTION 26 05 19 - WIRES AND CABLE – 600 VOLTS AND UNDER**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Furnish and install electrical wires and cables for the distribution of electric power, controls, grounding and signals for a complete electrical system.

**1.2 REFERENCE DOCUMENTS**

- A. Section 26 0100 - General Requirements for Electrical Work

**1.3 SUBMITTALS**

- A. Submit complete manufacturers' specification data on each type of conductor to be supplied to the job.
- B. Include cable identification as a part of the submittal.

**1.4 QUALITY ASSURANCE**

- A. Electrical conductors shall be UL listed.
- B. Contractor is responsible to coordinate installation and review functionality of the MEP equipment at all phases during construction process to ensure that the facility functions as intended by the contract documents. The Contractor shall coordinate involvement of all parties throughout the construction process so that the installation of all building systems and assemblies comply with the requirements of the contract and it is achieved early enough in the construction phase to assure full operational check-out, testing and adjustment prior to Substantial Completion. The Contractor is responsible for documenting and demonstrating equipment and system installation as well as demonstrating operational performance of all integrated systems within the project. All reports such as field testing, pre-construction testing, equipment start-up test will be bound in duplicate and submitted to the Architect for final review process.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Provide conductors made of soft-drawn annealed copper with a conductivity not less than that of 98 percent pure copper.
- B. Utilize conductors with insulation rated at 600 volts and insulated with type "THHN" insulation in dry locations and type "THWN" in wet locations. Wire in fixture channels and other special locations shall be as specifically rated for temperature in Article 300 in the NEC.
- C. Minimum wire sizes shall be in accordance with other requirements of the specifications and as follows: For 20 ampere branch circuits #12 gauge, except that home runs greater than 50 feet from the panel to the first outlet box on 120/208 volt shall be #10 gauge.

- D. All wire shall be color coded. Mark conductors on each end with a 1 inch band of colored pressure-sensitive plastic tape or by the use of brilliant waterproof lacquer, applied according to manufacturers instructions. Colors for each phase and the neutral shall be consistent throughout the system in accordance with the requirements of this section.
- E. Conductor sizes shown on the Contract Documents are selected based upon use with 75°C termination's. Furnish terminations, which are UL listed for 75°C or debate conductors for use at 60°C. Use of 90°C conductors is acceptable, but conductor must be sized at the 75°C rating. Do not use 90°C rating of conductors.
- F. The Drawings and Schedules generally indicate the number of wires in a conduit. Where not shown on the drawings, provide the proper number of wires in each conduit to complete the entire electrical system.
- G. Where the conductor size is not indicated on plan, size the conductor per the over current device used upstream. Refer to NEC Article 310. Ampacity rating shall be based on the temperature rating of the conductor used or the temperature rating of the termination lugs whichever is lower.
- H. Type "MC" metal clad cable maybe used where acceptable to the authorities having jurisdiction.
- I. Type "NM" Romex maybe used where acceptable to the authorities having jurisdiction.

**PART 3 - EXECUTION**

**3.1 PHASING**

- A. Identify wire and cable for feeders and branch circuits for general power and lighting with a visible color code in accordance with the requirements of this section as follows:
 

<u>277/480 Volt</u>	<u>120/208 Volt</u>
Phase A-Brown	Phase A-Black
Phase B-Orange	Phase B-Red
Phase C-Yellow	Phase C-Blue
Neutral-Gray	Neutral-White
Ground-Green	Ground-Green
- B. Provide green or bare grounding conductor identification for grounding conductors. Identification of all ungrounded conductors at junction boxes, wireway, and/or termination's may be by means of colored tape or painting when color-coded conductors as specified above are not available.
- C. Phasing of the complete electrical installation shall be connected and maintained the same throughout the power distribution system. Where the project is an addition or modification to an existing facility, the electrical distribution system phasing shall be made the same as the existing.
- D. Switchgear, safety switches, motor starters, plug-in type bus duct, lighting and power panels and power receptacles shall have all the same phase arrangements throughout the facility.

**3.2 INSTALLATION**

- A. Deliver cable and wire to the project in original packages. Conductors with insulation showing deterioration within one year after final completion and acceptance of the Work shall be removed and replaced at no cost to Owner.

- B. When inserting conductors in raceways, comply with the following:
  - 1. Do not use cleaning agents and lubricants, which have a deleterious effect on the conductors.
  - 2. Completely and thoroughly swab raceway system before installing conductors. Do not install wires or pull lines in conduit unless the entire system of conduit and outlet boxes is permanently in place.
  - 3. Install conductors in a neat and workmanlike manner; neatly train and lace wiring inside boxes, equipment, and panelboards; and make runs continuous without weld, splice, or joint between boxes and/or outlets.
  - 4. Leave sufficient wire at all outlets to make connections without straining.
  - 5. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling #4 gauge and larger wires.
  - 6. Make conductor lengths for parallel circuits equal.
  - 7. Place an equal number of conductors for each phase, neutral and ground of a circuit in same raceway or cable.
  - 8. Run feeders and mains continuously without splice from load to line terminals and identify phases in each pull box and in the gutters of each switchboard and panel board in which they connect. Splices in feeders may be made only where designated on the Drawings or where specific prior approval is given.
  - 9. Provide a wiring color-coding legend at each over current protective device enclosure.
- C. Thoroughly clean wires before installing lugs and connectors.
- D. Splice only in junction or outlet boxes. Make splices, taps and termination's to carry full ampacity of conductors without perceptible temperature rise.
- E. Terminate spare conductors with electrical tape.
- F. Torque test conductor connections and terminations to manufacturer's recommended values.
- G. Where outlets only are indicated, leave 48 inch leads of conductors, for connection to equipment. Identify all conductors circuit numbers with Brady tape at terminals and junctions.
- H. Where more than three current-carrying conductors are installed in a raceway, use larger size conductor and appropriate larger size raceway to comply with Article 300 of the National Electrical Code.
- I. Where conductor is installed in an environment where the ambient temperature with exceed 79°F, use larger size conductor and appropriate larger size raceway to comply with Article 300 of the National Electrical Code.
- J. Test all circuits for grounds. Light and test each lamp. Prove and test energy available at the load side of disconnect switches and at the final point of connection to driven equipment. Make all necessary and reasonable tests as required by the Architect to prove the integrity of work and leave the complete electrical installation ready for operation.

### **3.2 SUPPORTS**

- A. Install supports to hold conductors in place in each panel board, cabinet, pull box, junction box and wire-way.
- B. Install cable supports in vertical runs of conductors in cabinets and pull boxes.

**END OF SECTION 26 05 19**

**SECTION 26 05 20 - WIRE CONNECTIONS AND DEVICES**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Furnish labor, materials and equipment necessary to install wire connections and devices.

**1.2 REFERENCE SECTIONS**

- A. Section 26 0100 - General Requirements for Electrical Work
- B. Section 26 0519 - Wires and Cable - 600-Volt

**1.3 SUBMITTALS**

- A. Submittals shall be in accordance with Section 26 0100 and Division 1. Submit copies of the manufacturer's specifications and catalog cut sheets for products to be used.

**PART 2 - PRODUCTS**

**2.1 CONNECTOR, COMPRESSION**

- A. For splicing and termination; 600 volt wiring; connectors for cable sized #8 AWG and larger shall be the long barrel type for double indentation. Soldered connections shall not be permitted.

**2.2 CONNECTOR, 600 VOLT TWIST-ON**

- A. Spring insulated may be used for #14 through #10 gauge conductors.

**2.3 CONNECTOR, 600 VOLT TERMINAL**

- A. Connector shall have two holes in the tongue for use on conductor sizes 250 kcmil or larger; not required for connections to the branch circuit breaker in electrical panels.

**2.4 INSULATION**

- A. Insulate any connection made with non-insulated connectors. Provide sufficient amount of tape to equal wire insulation. Half lap each layer. Use UL listed electrical tape.

**2.5 GROUNDING CONNECTION**

- A. Provide exothermic connection to ground rod and underground connection to the grounding systems.

- B. The exothermic welding system furnished under these specifications shall meet the applicable requirements of IEEE-80, Chapter 9.
- C. Two styles of exothermic connection shall be available: One primarily for indoor and the other for outdoor application.
  - 1. Exothermic connection to be used outdoors shall be suitable for exposure to the elements or direct burial.
  - 2. Exothermic connection to be made in finished buildings or confined spaces shall use the double filtered, low smoke, low emission, process which is metallurgically equal to the above connection.
- D. Molds shall be made from material withstanding welding temperatures. The molds shall bear permanent marking, indicating the name of the manufacturer, the mold model, the type and size of welding mixture compatible with the welding process, and the size of the conductor. The installer is prohibited from using a mold from one manufacturer with a different manufacturer's welding mixture.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Splice 600 Volt conductors in junction boxes or at outlets only. Splices, excluding those made with insulated wire nuts, shall be insulated with electrical tape or heat-shrink tubing to a level equal to the 600-volt rating of the factory insulated conductors. Electrical connections utilizing lugs with threaded set screws and wire sizes of 1/0 AWG and larger shall have an oxide inhibitor applied to prevent oxidation.
- B. Connection to electrically operated equipment is included in this contract, whether or not specifically mentioned.

**END OF SECTION 26 05 20**



**SECTION 26 05 26 - GROUNDING**

**PART 1 - GENERAL**

**1.1 SUBMITTALS**

- A. Manufacturer's Data: Submit copies of manufacturer's specifications for products used.

**1.2 SUMMARY OF WORK**

- A. Provide all labor, materials, supervision, tools, services, equipment and incidentals necessary for complete and operational systems as specified under this division and as shown on the Contract Drawings.

**1.3 TESTS**

- A. Measure ground grid resistance with earth test megger. Submit test results to Architect.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Provide a grounding system that includes all connections and testing of ground rods, cables, ground buses, conduits, fittings, anchors, supports, thermite process materials and equipment, and other materials as required for a complete installation.
- B. Provide ground cables composed of stranded bare copper of 98 percent conductivity encased in conduits above grade, or buried to a depth not less than 12 inches below grade. Install as required to provide sufficient mechanical protection.
- C. Provide Burndy Corp., Type NE, Thomas & Betts Co., Inc., Catalog No. 3951, or approved equal, ground fittings for bonding ground cable to its encasing conduit.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Ground electrical work in accordance with NEC Article 250.
- B. Install ground cables continuous between connections. Splices will not be allowed. Where ground cables pass through slabs, building walls, etc., and are not in metallic enclosures, provide with sleeves of approved metallic material.
- C. Do not use rigid metal conduit and electrical metallic tubing as equipment grounding conductors.
- D. Install equipment grounding conductors in all raceways.

- E. Ground interior lighting fixtures to grounding conductor serving them. Flexible metal conduit in lengths less than 6 feet 0 inches may not be used as grounding conductor.
- F. Where connections are made to motors or equipment with flexible metal conduit, grounding conductor shall be stranded copper conductor within the conduit, bonded to the equipment.
- G. At each convenience outlet, install a sufficient length of #12 wire with green colored insulation to connect to the grounding terminal of the receptacle.

**3.2 COMMUNICATION GROUNDING**

- A. Telephone:
  - 1. Provide one No. 4 THW to ground bus from each telephone equipment room. Leave 12” pigtail at telephone board
- B. Fire Alarm and Detection:
  - 1. Provide one No. 6 THW in 1/2-inch conduit to nearest ground bus.
- C. Television Distribution System:
  - 1. Provide one No. 6 THW in 1/2-inch conduit to nearest ground bus.

**3.3 TESTING**

- A. Upon completion of installation of grounding and lighting protection systems, the ground resistance shall be tested with a ground resistance tester according to IEEE 81, “Guide for Measuring Earth Resistivity”. Where tests show resistance to ground is over the values listed in Table 1, take appropriate action to reduce the ground resistance to the specified value by driving additional ground rods and/or applying ground enhancement material to the rods and below grade grounding conductor. The ground enhancement material shall have a maximum receptivity of 20 OHM-centimeters, shall be permanent and shall not leach chemicals into the soil. All results shall be recorded and submitted.

Table 1

Equipment	Equipment to Earth Ground Resistance (Ohms)
Pad Mount Transformer	5
Secondary neutrals and other ground	10

**END OF SECTION 26 05 26**

**SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
  - 1. Division 26 Section "Vibration And Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

**1.3 DEFINITIONS**

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

**1.4 PERFORMANCE REQUIREMENTS**

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

**1.5 SUBMITTALS**

- A. Product Data: For the following:
  - 1. Steel slotted support systems.
  - 2. Nonmetallic slotted support systems.

- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze hangers. Include Product Data for components.
  - 2. Steel slotted channel systems. Include Product Data for components.
  - 3. Nonmetallic slotted channel systems. Include Product Data for components.
  - 4. Equipment supports.
- C. Welding certificates.

**1.6 QUALITY ASSURANCE**

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

**1.7 COORDINATION**

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

**PART 2 - PRODUCTS**

**2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS**

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. 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:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation.
    - f. Unistrut; Tyco International, Ltd.
    - g. Wesanco, Inc.
  - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  - 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  - 6. Channel Dimensions: Selected for applicable load criteria.

- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
  - 1. 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:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. Fabco Plastics Wholesale Limited.
    - d. Seasafe, Inc.
  - 3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
  - 4. Fitting and Accessory Materials: Same as channels and angles.
  - 5. Rated Strength: Selected to suit applicable load criteria.
- C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - 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:
    - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Hilti Inc.
      - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      - 3) MKT Fastening, LLC.
      - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
  - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

- a. 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:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
  - 2) Empire Tool and Manufacturing Co., Inc.
  - 3) Hilti Inc.
  - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
  - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

## **2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES**

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

## **PART 3 - EXECUTION**

### **3.1 APPLICATION**

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacing less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

### **3.2 SUPPORT INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
  - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69, Spring-tension clamps.
  - 7. To Light Steel: Sheet metal screws.
  - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### **3.3 INSTALLATION OF FABRICATED METAL SUPPORTS**

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### **3.4 CONCRETE BASES**

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section Cast-in-Place Concrete.
- C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

**3.5 PAINTING**

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION 26 05 29**



**SECTION 26 05 31 - EMPTY CONDUIT SYSTEMS**

**PART 1-GENERAL**

**1.1 SUMMARY**

- A. Refer to section for General Requirements for Electrical Work.
- B. Furnish all labor, materials, services, equipment and appliance required in conjunction with the installation of empty conduit systems for telephone, communication, data, fire alarm, HVAC controls, security, door access and other systems as indicated in the Contract Documents or as required by other trades.

**1.2 SUBMITTALS**

- A. Manufacturer's Data: Submit copies of manufacturer's specifications for products used.

**1.3 REFERENCE**

- A. This section refers to any empty conduit system installed on this project, including telephone systems.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Provide 3/4-inch thick marine plywood boards painted with one coat of primer and two coats of latex enamel color to match surroundings.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. At each telephone board, install #6 copper ground wire from nearest cold water pipe to telephone board and leave 12-inch pigtail at telephone board.
- B. Install pull wire in all empty conduits or conduit systems. Label pull wire indicating the locations of the other end.
- C. Limit number of bends and radius of each bend for telephone conduit system to comply with requirements of the telephone company.
- D. Install junction and pull boxes in empty conduits for telephone system in accordance with telephone company requirements.
- E. Coordinate the work under this section with the work under other divisions of the specifications.

**END OF SECTION 26 05 31**

**SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
  - 1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

**1.3 DEFINITIONS**

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.
- D. FMC: Flexible metal conduit.
- E. IMC: Intermediate metal conduit.
- F. LFMC: Liquidtight flexible metal conduit.
- G. LFNC: Liquidtight flexible nonmetallic conduit.
- H. RNC: Rigid nonmetallic conduit.

**1.4 SUBMITTALS**

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Custom enclosures and cabinets.

**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. Comply with NFPA 70.

**PART 2 - PRODUCTS**

**2.1 METAL CONDUIT AND TUBING**

- 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Alflex Inc.
  - 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - 5. Electri-Flex Co.
  - 6. Manhattan/CDT/Cole-Flex.
  - 7. Maverick Tube Corporation.
  - 8. O-Z Gedney; a unit of General Signal.
  - 9. Wheatland Tube Company.
- C. Rigid Steel Conduit: ANSI C80.1.
- D. Aluminum Rigid Conduit: ANSI C80.5.
- E. IMC: ANSI C80.6.
- F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit IMC.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- G. EMT: ANSI C80.3.
- H. FMC: Zinc-coated steel or aluminum.
- I. LFMC: Flexible steel conduit with PVC jacket.
- J. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
  - 2. Fittings for EMT: Steel type.
  - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

- K. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## **2.2 NONMETALLIC CONDUIT AND TUBING**

- 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
  - 3. Arnco Corporation.
  - 4. CANTEX Inc.
  - 5. CertainTeed Corp.; Pipe & Plastics Group.
  - 6. Condux International, Inc.
  - 7. ElecSYS, Inc.
  - 8. Electri-Flex Co.
  - 9. Lamson & Sessions; Carlon Electrical Products.
  - 10. Manhattan/CDT/Cole-Flex.
  - 11. RACO; a Hubbell Company.
  - 12. Thomas & Betts Corporation.
- C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
- D. LFNC: UL 1660.
- E. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.
- F. Fittings for LFNC: UL 514B.

## **2.3 METAL WIREWAYS**

- 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper B-Line, Inc.
  - 2. Hoffman.
  - 3. Square D; Schneider Electric.
- C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type [1] [12] [3R], unless otherwise indicated.
- D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Wireway Covers: Hinged type.

- F. Finish: Manufacturer's standard enamel finish.

## **2.4 SURFACE RACEWAYS**

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
  - 1. 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:
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Thomas & Betts Corporation.
    - b. Walker Systems, Inc.; Wiremold Company (The).
    - c. Wiremold Company (The); Electrical Sales Division.

## **2.5 BOXES, ENCLOSURES, AND CABINETS**

- 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  - 2. EGS/Appleton Electric.
  - 3. Erickson Electrical Equipment Company.
  - 4. Hoffman.
  - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  - 6. O-Z/Gedney; a unit of General Signal.
  - 7. RACO; a Hubbell Company.
  - 8. Robroy Industries, Inc.; Enclosure Division.
  - 9. Scott Fetzer Co.; Adalet Division.
  - 10. Spring City Electrical Manufacturing Company.
  - 11. Thomas & Betts Corporation.
  - 12. Walker Systems, Inc.; Wiremold Company (The).
  - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- C. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- D. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy aluminum, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- F. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

- I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- J. Cabinets:
  - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  - 2. Hinged door in front cover with flush latch and concealed hinge.
  - 3. Key latch to match panelboards.
  - 4. Metal barriers to separate wiring of different systems and voltage.
  - 5. Accessory feet where required for freestanding equipment.

**2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING**

- A. Description: Comply with SCTE 77.
  - 1. Color of Frame and Cover: Green.
  - 2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
  - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
  - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 5. Cover Legend: Molded lettering, "ELECTRIC." "TELEPHONE." as indicated for each service.
  - 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two. Furnish as specified on the drawings or approved equal.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. CDR Systems Corporation.
    - d. NewBasis.
- C. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
  - 1. Basis-of-Design Product: Provide the product indicated on Drawings or a comparable product by one of the following:
    - a. Armorcast Products Company.
    - b. Carson Industries LLC.
    - c. Christy Concrete Products.
    - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

**2.7 SLEEVES FOR RACEWAYS**

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

**2.8 SLEEVE SEALS**

- 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
  - 1. Advance Products & Systems, Inc.
  - 2. Calpico, Inc.
  - 3. Metraflex Co.
  - 4. Pipeline Seal and Insulator, Inc.
- D. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
  - 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: Carbon steel. Include two for each sealing element.
  - 3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

**PART 3 - EXECUTION**

**3.1 RACEWAY APPLICATION**

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
  - 1. Exposed Conduit: Rigid steel conduit or IMC.
  - 2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC, EMT.
  - 3. Underground Conduit: RNC, Type EPC-40 PVC, direct buried.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.



- B. Comply with the following indoor applications, unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage: EMT.
  - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
    - a. Exposed and Subject to Severe Physical Damage: Rigid steel conduit IMC.
  - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  - 5. Damp or Wet Locations: Rigid steel conduit or IMC.
  - 6. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
  - 7. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
  - 8. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
  - 9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, in damp or wet locations.
- C. Minimum Raceway Size: 1/2-inch (16-mm) trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
  - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
  - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.
  - 3. Furnish and install insulated bushings on the ends of empty conduits stubbed for telephone, communication, data, fire alarm, HVAC controls, security, door access and other systems.
  - 4. Furnish threaded grounding bushings for panel and switchgear feeders at each end.
  - 5. Cast metal, set screw or indenture fittings are prohibited.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Do not install aluminum conduits in contact with concrete.

### **3.2 INSTALLATION**

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
  - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  - 3. Do not embed conduit in slabs unless approved by Structural engineer.
- I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
  - 1. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
  - 2. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
  - 3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where otherwise required by NFPA 70.
- N. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors. Install flex connections on all conduit entering from the exterior unless concrete encased, and at all conduits entering from water park building.
  - 1. Use LFMC in damp or wet locations subject to severe physical damage.
  - 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- O. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
- P. Set metal floor boxes level and flush with finished floor surface.

- Q. Recessed lighting fixtures installed in ceilings tile systems shall have an independent length of flexible conduit extended from accessible junction box to the fixture. The flexible conduit (MC cable is allowed for this application only) shall be of sufficient length to allow the connection point to the fixture to drop at least 12" below the finished ceiling, and shall be at least 48" long but not more than 72" long. Daisy chaining of light fixtures is not acceptable.

### **3.3 INSTALLATION OF UNDERGROUND CONDUIT**

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
  - b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

### **3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES**

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below the frost line, 18" below grade.
- E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

**3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- 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. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
  - 1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
  - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
- E. 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.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. 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. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- K. 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 Division 07 Section "Penetration Firestopping."
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, 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.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals.

**3.6 SLEEVE-SEAL INSTALLATION**

- A. Install to seal underground, 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 FIRESTOPPING**

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

**3.8 PROTECTION**

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION 26 05 33**

**SECTION 26 05 34 - OUTLET, PULL AND JUNCTION BOX**

**PART 1-GENERAL**

**1.1 SUBMITTALS**

- A. Manufacturer's Data: Submit copies of manufacturer's specifications for products to be used.

**1.2 SUMMARY OF WORK**

- A. Provide all labor, materials, supervision, tools, services, equipment and incidentals necessary for complete and operational systems as specified under this division, as shown on the Contract Drawings or as required.

**PART 2 - PRODUCTS**

**2.1 OUTLET BOXES**

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, with 1/2-inch male fixture studs where required.
- B. Cast Boxes: Cast metal, deep type, gasketed cover, threaded hubs. Use cast boxes for damp and outdoor installation.
- C. Provide boxes with plaster ring where required. Boxes for installation in masonry walls shall be special square corner masonry type.
- D. Furnish boxes with proper covers and device plates.

**2.2 PULL AND JUNCTION BOXES**

- A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.
- B. Pull boxes and junction boxes used on concealed runs of conduit in walls and over ceilings shall be of code gauge galvanized steel with sheet steel covers. Pull boxes in floors shall be of galvanized malleable cast iron, with gasketed covers. Exposed pull boxes or junction boxes installed outdoors shall be weatherproof and shall be provided with watertight gasketed covers fastened with corrosion resistant screws.
- C. Pull Boxes and Junction Boxes: Metal construction conforming to National Electrical Code, with screw-on or hinged cover. Use hinged enclosure for sheet metal boxes larger than 12 inches in any dimension.
- D. Flush-Mounted Pull Boxes: Provide overlapping covers with flush-head cover retaining screws, prime coated.
- E. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Cast metal box screws, prime coated.

**2.3 FLOOR BOXES**

- A. Boxes for installation in concrete floors, on grade shall be galvanized steel cast iron with threaded conduit entrances, waterproof type, with means of adjusting cover plate to finished floor level. Where these boxes occur in floors above grade, which are not designed for waterproof membrane, they shall be stamped, galvanized steel boxes with concrete proof inlets and adjustable tops. Where flush-type floor box outlets are indicated, covers shall be polished brass, waterproof type with threaded outlets to receive devices scheduled. Where flush type power outlets are shown, they shall be of the duplex type with threaded covers for each half of the receptacle. Provide Steel City Series 600, or equal.

**PART 3 - EXECUTION**

**3.1 COORDINATION OF BOX LOCATIONS**

- A. Provide electrical boxes shown on the Drawings and as required for splices, taps, wire pulling, equipment connections and code compliance.
- B. Determine from dimensions shown on the Contract Documents and by actual measurements on the site, the exact location of each outlet. Outlet locations may be modified from those shown on the plans to accommodate changes in door swings, space changes or to clear other interferences that arise or from job modifications. Make such modifications at no cost to the Owner as a matter of job coordination. Coordinate job conditions and notify the Architect of discrepancies before proceeding with the installation of the work. Set wall boxes in advance of wall construction blocked in place, and secure. Set wall boxes flush with the finish. Install extension sleeves as required to extend boxes to finished surfaces.
- C. The locations of equipment and outlets shown on the Contract Documents are approximate. Check and verify exact locations in the field.
- D. Unless otherwise noted or modified by ADA/TAS, device location of outlet boxes shall be as follows:

Equipment or Outlets	Elevation (above finished floor)
Toggle Switches	4 feet -0 inches
Receptacles	1 foot -4inches
Clocks and Clock outlets	7 feet -6 inches
Control stations	4 feet -0 inches
Thermostats	4 feet -0 inches
Data/Telephone outlets	1 foot -4 inches
Circuit protective devices	6 feet -6 inches to top of enclosure
Water Cooler Receptacles	Out of sight, when possible
Audio Visual Signaling Devices and Visual Signaling Devices	6 feet -8 inches
Fire alarm Pullstation	4 feet -0 inches

- E. Located and install boxes to allow access. Where installation is inaccessible, coordinate locations and sizes of required access doors in accordance with other sections of the specifications.
- F. Locate and install to maintain headroom and to present a neat appearance.

**3.2 OUTLET BOX INSTALLATION**

- A. Do not install boxes back-to-back in walls. Provide minimum 6 inch separation, except provide minimum 24 inch separation in acoustic rated walls or as directed.
- B. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
- C. Install knockout closures for unused openings.
- D. Use multiple-gang boxes where more than one device is installed together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- E. Install boxes in walls without damaging wall insulation.
- F. Coordinate mounting heights and locations of outlets mounted above counters, benches and back splashes.
- G. Position outlets to coordinate luminaire locations with ceilings.
- H. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.
- I. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- J. Align wall-mounted outlets boxes for switches, thermostats and similar devices.

**3.3 PULL AND JUNCTION BOX INSTALLATION**

- A. Use separate pull boxes and junction boxes for electrical power, control, computer and communication system.
- B. Install pull boxes and junction boxes where required by the National Electrical Code and wherever required to overcome mechanical difficulties.
- C. Install pull boxes in interior conduit at not more than 100 feet apart when conduit runs are not broken by junction or outlet boxes.
- D. Size pull boxes and junction boxes to best meet the needs of the particular situation and/or location and to comply with the National Electrical Code.

**END OF SECTION 26 05 34**



**SECTION 26 05 35 - PULL AND JUNCTION BOXES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Manufacturer's Data: Submit copies of manufacturer's specifications for products to be used.

**1.2 SUMMARY OF WORK**

- A. Provide all labor, materials, supervision, tools, services, equipment and incidentals necessary for complete and operational systems as specified under this division and as shown on the Contract Drawings.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Pull boxes and junction boxes used on concealed runs of conduit in walls and over ceilings shall be of code gauge galvanized steel with sheet covers. Pull boxes in floors shall be of galvanized malleable cast iron, with gasketed covers. Exposed pull boxes or junction boxes installed outdoors shall be weatherproof and shall be provided with watertight gasketed covers fastened with corrosion resistant screws.
- B. Pull Boxes and Junction Boxes: Metal construction conforming to National Electrical Code, with screw-on or hinged cover.
- C. Flush-Mounted Pull Boxes: Provide overlapping covers with flush-head cover retaining screws, prime coated.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Use separate pull boxes and junction boxes for electric power, control, computer and communication systems.
- B. Install pull boxes and junction boxes where required by the National Electrical Code and wherever required to overcome mechanical difficulties.
- C. Install pull boxes in interior conduit at not more than 100 feet apart when conduit runs are not broken by junction or outlets boxes.
- D. Size pull boxes and junction boxes to best meet the needs of the particular situation and/or location and to comply with the National Electrical Code.
- E. Coordinate the work in this section with the work under other divisions of this specification.

**END OF SECTION**

**SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Identification for raceway and metal-clad cable.
  - 2. Identification for conductors and communication and control cable.
  - 3. Underground-line warning tape.
  - 4. Warning labels and signs.
  - 5. Instruction signs.
  - 6. Equipment identification labels.
  - 7. Miscellaneous identification products.

**1.3 SUBMITTALS**

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

**1.4 QUALITY ASSURANCE**

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

**1.5 COORDINATION**

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

## **PART 2 - PRODUCTS**

### **2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Color for Printed Legend:
  - 1. Power Circuits: Black letters on an orange field.
  - 2. Legend: Indicate system or service and voltage, if applicable.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

### **2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS**

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.
- E. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

**2.3 UNDERGROUND-LINE WARNING TAPE**

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
  - 1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
  - 2. Compounded for permanent direct-burial service.
  - 3. Embedded continuous metallic strip or core.
  - 4. Printed legend shall indicate type of underground line.

**2.4 WARNING LABELS AND SIGNS**

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).
- E. Warning label and sign shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

**2.5 INSTRUCTION SIGNS**

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
  - 1. Engraved legend with white letters on red face.
  - 2. Punched or drilled for mechanical fasteners.
  - 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

**2.6 EQUIPMENT IDENTIFICATION LABELS**

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

**2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS**

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
  2. Tensile Strength: 50 lb (22.6 kg), minimum.
  3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
  4. Color: Black, except where used for color-coding.
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

### **PART 3 - EXECUTION**

#### **3.1 APPLICATION**

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl tape applied in bands.
- B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
1. Fire Alarm System: Red.
  2. Fire-Suppression Supervisory and Control System: Red and yellow.
  3. Combined Fire Alarm and Security System: Red and blue.
  4. Security System: Blue and yellow.
  5. Telecommunication System: Green and yellow.
  6. Control Wiring: Green and red.
- C. Power-Circuit Conductor Identification: For secondary conductors No. 1/0 AWG and larger in pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape.
- E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

- a. Power transfer switches.
  - b. Controls with external control power connections.
2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- H. Instruction Signs:
1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
  2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.
- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
    - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.
    - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
  2. Equipment to Be Labeled:
    - a. Panelboards, electrical cabinets, and enclosures.
    - b. Access doors and panels for concealed electrical items.
    - c. Electrical switchgear and switchboards.
    - d. Transformers.
    - e. Emergency system boxes and enclosures.
    - f. Motor-control centers.
    - g. Disconnect switches.
    - h. Enclosed circuit breakers.
    - i. Motor starters.
    - j. Push-button stations.
    - k. Power transfer equipment.
    - l. Contactors.
    - m. Remote-controlled switches, dimmer modules, and control devices.
    - n. Battery inverter units.
    - o. Battery racks.
    - p. Power-generating units.
    - q. Voice and data cable terminal equipment.
    - r. Intercommunication and call system master and staff stations.
    - s. Television/audio components, racks, and controls.
    - t. Fire-alarm control panel and annunciators.

- u. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
- v. Monitoring and control equipment.
- w. Uninterruptible power supply equipment.
- x. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

### **3.2 INSTALLATION**

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
- G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for under-grounded service, feeder, and branch-circuit conductors.
  - 1. Color shall be if authorities having jurisdiction permit, field applied.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
    - d. Neutral: White
    - e. Ground: Green
  - 3. Colors for 480/277-V Circuits:
    - a. Phase A: Yellow.
    - b. Phase B: Brown.
    - c. Phase C: Purple.
    - d. Neutral: White with colored stripe or gray.
    - e. Ground: Green
  - 4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.



- H. 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 or concrete envelope exceeds 16 inches (400 mm) overall.

**END OF SECTION 26 05 53**

**SECTION 26 09 30 – LIGHTING CONTROL DEVICES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. Section includes lighting controls based on Dimmable lighting controls.

**1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Floor Plans: Location, orientation, and coverage area of each sensor; group designations; and other specific design symbols and designations as required to define the installation, location, and configuration of all control devices.
  - 2. Address Drawing: Reflected ceiling plan and floor plans, showing data-bus-connected devices, address for each device, and device groups. The plans shall be based on construction plans, using the same legend, symbols, and schedules.
  - 3. Point List and Data Bus Load: Summary list of all control devices, sensors, ballasts, and other loads connected to each data bus and total connected load for each data bus. Include percentage of rated connected load and device addresses.
  - 4. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.

**1.3 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
  - 1. Show interconnecting signal and control wiring, and interface devices that prove compatibility of inputs and outputs.
- B. Field quality-control reports.
- C. Sample Warranty: For manufacturer's special warranty.
- D. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

1.4 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Software: Failure of input and output to execute switching or dimming commands.
    - b. Failure of modular relays to operate under manual or software commands.
    - c. Ballast failure.
    - d. Damage of electronic components due to transient voltage surges.
  - 2. Warranty Periods:
    - a. For Ballasts: **Three** years from date of Substantial Completion.
    - b. For Control Components That Are Not Part of Ballasts: **Three** years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 SYSTEM DESCRIPTION

- A. Operation: Input signal from digital signal sources switches or dims devices associated with ballasts or lighting fixtures, or switches field-deployed, control relays.
  - 1. Each device and relay is connected to a digital data bus.
  - 2. Each device and relay has a digital address and can be operated by a digital signal.
  - 3. Each device or relay can be assigned to any or all of 16 available groups connected to a single data bus.
  - 4. Each dimming ballast may have as many as 16 preset lighting levels or scenes. Scenes can be programmed to ballasts and may be applied to groups.
- B. Approved manufacturers;
  - 1. Eaton Control Keeper
  - 2. Lutron
  - 3. Digital Lighting Systems
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- E. Comply with UL 916.

## **2.2 PERFORMANCE REQUIREMENTS**

- A. Surge Suppression: Factory installed as an integral part of control components or field-mounted surge suppressors complying with UL 1449, SPD Type 2.

## **2.3 BUS POWER SUPPLY**

- A. Description: Supply power to data bus for 64 addressable devices, suitable for use with NFPA 70, Class 2 control circuit.
  - 1. Primary Power: Field selectable, 120 and 277 V.
  - 2. Power Supply: Regulated to maintain the operating voltage above 15-V dc under full load, and rated for full charging load of 250 mA and a minimum maintained connected load of 190 mA.
  - 3. Pilot Lights: Indicate data bus ground fault and data bus traffic.

## **2.4 CONTROLLER/GATEWAYS**

- A. Description: The controller/gateways link the distributed data buses with an Ethernet network to provide computer configuration, control, analysis, and maintenance. The controller/gateways operate independently and continue to process local inputs and schedules when disconnected from the LAN. The controller/gateways shall provide local intelligence and features including the following:
  - 1. Integrated real-time clock with automatic daylight savings adjustment and leap-year correction.
  - 2. Integrated sunrise/sunset support based on the site location (latitude and longitude).
  - 3. Automatic time schedules, to control groups for scheduled occupancy with support for holiday exceptions.
  - 4. Two digital outputs for additional control and interlocking with external equipment such as fans, valves, and security panels.
  - 5. Support **one** data bus(es).
  - 6. Computer Monitoring and Configuration: The controller/gateway shall allow configuration, monitoring, and analysis from PCs on the Ethernet LAN.
- B. Each data bus shall have the capacity to control 64 addressable devices, using NFPA 70, Class 2 control circuit.
  - 1. Each data bus shall have the capacity to control up to 16 groups and scenes.
  - 2. LED indicator lights for Ethernet status (link, send, and receive), power-on, and LAN failure.
  - 3. Linking of switch and sensor inputs to relay and ballast outputs.
  - 4. Viewing relay and ballast output status.
  - 5. Controlling relay and ballast outputs.
  - 6. Setting device addresses.
  - 7. Assigning switch and sensor inputs and relay and ballast output modes.

- C. Allow connection of the following compliant addressable devices:
  - 1. Fluorescent fixture switching and dimming, for linear and compact lamps.
  - 2. Incandescent fixture switching and dimming.
  - 3. HID and HPS fixture switching and dimming.
  - 4. LED fixture switching and dimming.
  - 5. Occupancy and photoelectric sensors.
  - 6. Emergency lighting interface complying with UL 924.

## **2.5 USER INTERFACE**

- A. TouchScreen user interface on panel.

## **2.6 FIXTURE SWITCHING AND DIMMING MODULES.**

- A. Description: Comply with exponential dimming curve calibrated for the connected lamp type, group, and scene settings, and with light-level and configuration commands. Dimmer rise time shall be not less than 15 mic.sec.

## **2.7 FLUORESCENT FIXTURE SWITCHING AND DIMMING**

- A. Each ballast or group shall be addressable and shall include on-off, fade, dimming, scene settings, and other standard control functions and as required to meet the sequence of operation.
- B. Ballasts: Comply with requirements in Section 265100 "Interior Lighting" for ballasts for linear fluorescent lamps, electronic programmed-start, and the following:
  - 1. Starting Method: Programmed rapid start with antiflash (turns on at previously set light level).
  - 2. Dimming Range: 100 to 10 percent of rated lumens unless otherwise indicated.
  - 3. Ballast Factor: 1.0 at full output; 0.01 at full dim.
  - 4. Input Voltage Range: 108 to 305 V.

## **2.8 SENSORS**

- A. Comply with requirements in Section 260923 "Lighting Control Devices." All sensors shall be protocol compliant.
- B. Indoor Occupancy Sensors: Sensors may be powered directly from the lighting control network or with a standalone power supply. Units powered with a standalone power supply shall interface with the lighting control system through an electrically isolated digital input.

## 2.9 RELAYS

- A. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating shall be not less than 5 kA. With pilot light indicating when relay is closed and latched. Control shall be by digital data bus. Relay status shall be displayed when queried by lighting management software.
- B. Relay Panel: A single enclosure with incoming lighting branch circuits, relays, and connection to the digital control network.
  - 1. Enclosure: NEMA 250, Type 1, unless otherwise indicated.
  - 2. Barriers to separate low-voltage and line-voltage components.
  - 3. Directory: Cover mounted, identifying each relay with its device address and naming the load controlled.
- C. Individually Mounted Relays:
  - 1. Enclosure: Standard outlet box or NEMA 250, Type 1, unless otherwise indicated.
  - 2. Directory: Cover mounted, identifying each relay with its device address.

## 2.10 MANUAL SWITCHES AND PLATES

- A. Connection Type: RS-485 protocol, **Category 5** UTP cable, using RJ-45 connectors. Power shall be from the control unit.
- B. Push-Button Switches: Modular, operating over the digital data bus.
  - 1. Each switch shall control the following functions, in coordination with programmed sequence of operation and related sensors:
    - a. On.
    - b. Off.
    - c. Dimming, increase light level.
    - d. Dimming, decrease light level.
    - e. Return to preset light level.
  - 2. LED Pilot Lights: On to indicate that the control is active, or when the manual control is operated.
  - 3. Match color and style specified in Section 262726 "Wiring Devices."
  - 4. Integral IR receiver for programming.
- C. Wall Plates: Single and multigang plates as specified in Section 262726 "Wiring Devices."
- D. Legend: Engraved or permanently silk-screened on wall plate where indicated. Use designations indicated on Drawings.

## 2.11 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than [No. 18] [No. 22] [No. 24] AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than [No. 14] [No. 16] [No. 18] AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, **Category 5e** for horizontal copper cable and with Section 271500 "Communications Horizontal Cabling."

## PART 3 - EXECUTION

### 3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters[ **and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables except in unfinished spaces.
  - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
  - 2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
  - 3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

### 3.2 IDENTIFICATION

- A. Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Section 260553 "Identification for Electrical Systems."

- B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Section 260553 "Identification for Electrical Systems."
- C. Identify all ceiling-mounted controls with data bus number and device address.
- D. Label each device cable within **6 inches (152 mm)** of connection to bus power supply or termination block.

### **3.3 FIELD QUALITY CONTROL**

- A. Acceptance Testing Preparation:
  - 1. Test continuity of each circuit.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Test each bus controller using a portable PC.
  - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Field Test Reports:
  - 1. Printed list of all points created from actual queries of all addressed control points to include ballasts, manual controls, and sensors.
  - 2. Event log verifying the performance of all devices generating event messages to include occupancy sensors, control buttons, alarm messages, and any other change of value messages.
  - 3. Trend data for all daylight zones covering a period of not less than one week and demonstrating performance consistent with the submitted computer models for those spaces.
- D. Lighting controls will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies bus controllers included and describes query results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

### **3.4 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Activate light fixtures and verify that all lamps are operating at 100 percent.
  - 3. Burn-in fluorescent lamps at 100 percent for 100 hours.



4. Confirm correct communications wiring, initiate communications between devices and controller/gateways, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

**3.5 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

**END OF SECTION**

**SECTION 26 24 13 - SWITCHBOARDS**

**PART 1 - GENERAL**

**1.1 SECTION INCLUDES**

- A. Main Switchboard - Furnish and install the Service Entrance switchboard(s) as herein specified and shown on the associated electrical drawings.
- B. Distribution Switchboard - Furnish and install the Distribution Switchboard(s) as herein specified and shown on the associated electrical drawings.

**1.2 RELATED SECTIONS**

- A. Drawings and General Provisions of the contract, including general and supplementary conditions and Division 1 Specification Sections, apply to this section.

**1.3 REFERENCES**

- A. The switchboard(s) and overcurrent protection devices referenced herein are designed and manufactured according to the following appropriate specifications.
- B. ANSI/NFPA 70 - National Electrical Code (NEC).
- C. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
- D. NEMA KS 1 - Enclosed Switches.
- E. NEMA PB 2 - Dead front Distribution Switchboards, File E8681
- F. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Dead front Switchboards Rated 600 Volts or less.
- G. NEMA PB 2.2 - Application Guide for Ground Fault Protective Devices for Equipment.

**1.4 SUBMITTALS**

- A. Shop Drawings shall indicate front and side enclosure elevations with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; wiring diagrams; one-line diagrams showing main and branch current ratings and short circuit ratings; equipment schedule; and switchboard instrument details.

**1.5 QUALIFICATIONS**

- A. Listing and labeling: Provide switchboard assemblies specified in this section that are listed and labeled as defined in the national Electrical Code Article 100.

- B. Furnish products listed by Underwriters Laboratories Incorporated and in accordance with standards listed in Article 1.3 - References.
- C. The manufacturing facility shall be registered by Underwriters Laboratories inc. to the International Organization for Standardization ISO 9002 series Standards for quality.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.
- B. Inspect and report concealed damage to carrier within their required time period.
- C. Store in a clean, dry space. Maintain factory protection and/or provide and additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.
- D. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

**1.7 PROJECT CONDITIONS**

- A. Verify dimensions by field measurements.
- B. Determine suitable path for moving switchboard into place considering project condition.

**1.8 MAINTENANCE MATERIALS**

- A. Provide one (1) set of installation and maintenance instructions with each switchboard. Instructions are to be easily identified and affixed within the incoming or main section of the line-up.

**1.9 WARRANTY**

- A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for the lesser of one (1) year from date of installation or eighteen (18) months from date of purchase.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Shall be:
  - 1. Square D; Groupe Schneider
  - 2. GE
  - 3. Eaton Cutler Hammer
  - 4. Siemens

- B. Substitutions must be submitted in writing three (5) days prior to original bid date with supporting documentation demonstrating that the alternate manufacturer conforms to all aspects of the specifications herein.

## 2.2 MANUFACTURED UNITS

- A. Front-Connected, Front-Accessible Switchboard: Fixed or Panel-mounted main device as required, panel-mounted branches, and sections rear aligned.
  - 1. Main Device 2000 amps or larger: Individually fixed mounted.
  - 2. Main Device less than 2000 amps: Panel mounted.
  - 3. Branch Devices: Panel mounted.
- B. Ratings: Provide nominal system voltage, continuous main-bus amperage, and short-circuit current ratings as indicated.
- C. Nominal System Voltage: 480/277V, 60 Hz.
- D. Main-Bus Continuous: As indicated.

## 2.3 FABRICATION AND FEATURES

- A. Enclosure: Steel; NEMA 250, Type 1, Indoor.
- B. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust inhibiting primer on treated metal surface.
- C. Barriers: Between adjacent switchboard sections.
- D. Insulation and isolation for main and vertical buses of feeder sections.
- E. Bus Transition and Incoming Line Pull Sections: Matched and aligned with basic switchboard.
- F. Doors: Door-in-Door hinged on panelboard housing. The main panelboard door shall expose complete panelboard interior. Secure with flush catch and tumbler lock, all keyed alike.
- G. Buses and Connections: 3 phase, 4 wire, except as otherwise indicated. Features as follows:
  - 1. Phase and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
  - 2. Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
  - 3. Ground Bus:  $\frac{1}{4}$  by 2 inch minimum size, drawn temper copper of 98 percent conductivity; equipped with pressure connectors for feeder and branch circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
  - 4. Contact Surfaces of Buses: Silver plated.
  - 5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity the entire length of the switchboard main and distribution sections. Provide for future extensions from both ends.
  - 6. Isolation Barrier Access Provisions: Permit checking bus bolt tightness.

7. Neutral Buses: 100 percent of the ampacity of the phase buses, except as indicated, and equipped with approved pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus is braced.

## **2.4 OVERCURRENT PROTECTIVE DEVICES**

- A. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, handle lockable:
  1. Characteristics: Ampere ratings below 2000 amps, frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
  2. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.
  3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
  4. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings.
  5. Lugs: Mechanical lugs and power-distribution connectors for number, size and material of conductors indicated.
  6. Shunt Trip: Where indicated.
- B. Enclosed, Insulated-Case Circuit Breaker: Fully rated, encased power circuit breaker:
  1. Characteristics: 2000 amperes and larger, frame size, trip rating, number of poles and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
  2. Features: Include the following:
    - a. 2-step stored-energy closing
    - b. Microprocessor-based trip units with interchangeable rating plug and selectable I-squared-t response.
    - c. LED trip indicators
    - d. Remote trip indication and control
    - e. Undervoltage trip
  3. Control Voltage: 125 V, ac.
  4. Lugs: Mechanical lugs and power-distribution connectors for number, size and material of conductors indicated.
- C. Future Devices: Where indicated, equip compartments with mounting brackets, supports, bus connections, and appurtenances designed for overcurrent protective device types and ampere ratings indicated.

## **PART 3 - EXECUTION**

### **3.1 INSTRUMENTATION**

- A. Multifunction Digital Metering Monitor: Microprocessor-based unit suitable for 3- or 4-wire systems and with the following features:
  1. Switch selectable digital display of the following values with maximum accuracy tolerances as indicated:

- a. Phase Currents, Each Phase: Plus or minus 1 percent.
  - b. Phase-to-Phase Voltages, 3 Phase: Plus or minus 1 percent.
  - c. Phase-to-Neutral Voltages, 3 Phase: Plus or minus 1 percent.
  - d. Megawatts: Plus or minus 2 percent.
  - e. Megavars: Plus or minus 2 percent.
  - f. Power Factor: Plus or minus 2 percent.
  - g. Frequency: Plus or minus 0.5 percent.
  - h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
  - i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

### **3.2 CONTROL POWER**

- A. Control Circuits: 120 V, supplied through secondary disconnect devices from control power transformer.
- B. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, complete with bundling, lacing and protection. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

### **3.3 IDENTIFICATION**

- A. Nameplates and label products are specified in Division 16 Section "Basic Electrical Materials and Methods".
- B. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and lettered designations consistent with approved final mimic-bus diagram. Coordinate mimic-bus segments with devices in switchboard sections to which applied. Produce a concise visual presentation of principal switchboard components and connections.
  1. Medium: Painted graphics in approved color contrasting with equipment factory-finish background to represent bus and components, complete with lettered designations.

### **3.4 INSPECTION**

- A. Examine area to receive switchboard to provide adequate clearance for switchboard installation.
- B. Check that concrete pads are level and free of irregularities.
- C. Start work only after unsatisfactory conditions are corrected.

### **3.5 INSTALLATION**

- A. Install switchboard in accordance with manufacturer's written guidelines, NEMA PB2.1, the NEC, and local codes.

- B. Support switchboards on concrete housekeeping bases, 4-inch nominal thickness.

### 3.6 FIELD QUALITY CONTROL

- A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.
- B. Measure, using a Megger, the insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute each, at minimum test voltage of 1000 VDC; minimum acceptable value for insulation resistance is 1 megohms. NOTE: Refer to manufacturer's literature for specific testing procedures.
- C. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.
- D. Provide the services of a qualified independent testing agency to perform specified acceptance testing.
- E. Test ground fault systems by operating push-to-test button.

### 3.7 ADJUSTING

- A. Adjust all operating mechanisms for free mechanical movement per manufacturer's specifications.
- B. Adjust circuit breaker trip and time delay settings to values [indicated.] [as instructed by the Architect/engineer.]

### 3.8 CLEANING

- A. Touch up scratched or marred surfaces to match original finish

**END OF SECTION 26 24 13**

**SECTION 26 24 16 - PANELBOARDS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V and less.
- B. Related Sections include the following:
  - 1. Section 26 01 00 – General Requirements for Electrical Work

**1.3 SUBMITTALS**

- A. Product Data: For each type of panelboard, accessory item, and component specified.
- B. Shop Drawings: For panelboards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage ratings. Including the following:
  - 1. Enclosure type with details for types other than NEMA 250, Type 1.
  - 2. Bus configuration and current rating.
  - 3. Short-circuit current rating of panelboard.
  - 4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.
  - 5. Wiring Diagram: Details of schematic diagram including control wiring and differentiating between manufacturer-installed and field-installed wiring.
- C. Qualification Data: For firms and persons specified in “Quality Assurance” Article.
- D. Field Test Reports: Indicate/interpret test results for compliance with performance requirements.
- E. Panelboard Schedules: For installation in panel boards. Submit final versions after load balancing.
- F. Maintenance Data: For panelboard components to include in the maintenance manuals specified in Division 1. Include manufacturer’s written instructions for testing circuit breakers.

**1.4 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: In addition to the requirements specified in Division 1 Section “Quality Control,” an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the International Electrical Testing Association.



1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.
- B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
  1. The terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
- C. Comply with NFPA 70.
- D. Comply with NEMA PB 1.

## 1.5 EXTRA MATERIALS

- A. Keys: 6 spares of each type for panelboard cabinet lock.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  1. Square D; Groupe Schneider
  2. GE
  3. Eaton Cutler Hammer
  4. Siemens

### 2.2 PANELBOARD FABRICATION

- A. Enclosures: Flush- of surface-mounted cabinets as indicated. NEMA PB 1, Type 1 unless otherwise indicated to meet environmental conditions at installed location.
  1. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
  2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
- B. Front: Secured to box with concealed trim clamps, unless otherwise indicated. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush panelboards shall overlap box, unless otherwise indicated.
- C. Directory Frame: Metal, mounted inside each panelboard door.
- D. Bus: Hard drawn copper of 98 percent conductivity.
- E. Main and Neutral Lugs: Compression type.
- F. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.
- G. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the overcurrent protective device ampere ratings indicated for future installation of devices.
- H. Special Features: Include the following features for panelboards as indicated:

1. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors, insulated from box.
2. Computer Grade Panelboards: Provide with 2X-sized neutral for K13 type loads.

### 2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Door-in-Door hinged on panelboard housing. The main panelboard door shall expose complete panelboard interior. Secure with flush catch and tumbler lock, all keyed alike.

### 2.4 DISTRIBUTION PANELBOARDS

- A. Doors: Door-in-Door hinged on panelboard housing. The main panelboard door shall expose complete panelboard interior. Secure with flush catch and tumbler lock, all keyed alike.
- B. Branch-Circuit Breakers: Where overcurrent protective devices are indicated to be circuit breakers, use bolt-on circuit breakers, except circuit breakers 225-A frame size and greater may be plug-in type where individual positive-locking device requires mechanical release for removal.

### 2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AM 1, handle lockable.
  1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
  2. Application Listing: Appropriate for application, including, Type SWD for switching fluorescent lighting loads and Type HACR for heating, air-conditioning, and refrigerating equipment.
  3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
  4. Circuit Breakers, 400 A and larger: Field-adjustable short-time and continuous current settings.
  5. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
- G. Shunt Trip: Where indicated.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install panelboards and accessory items according to NEMA PB 1.1.
- B. Mounting Heights: Top of trim 74 inches) above finished floor, unless otherwise indicated.
- C. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.
- D. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing.

- E. Install filler plates in unused spaces.
- F. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panelboard into accessible ceiling space designated to be ceiling space in the future.
- G. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

### 3.2 IDENTIFICATION

- A. Panelboard Namplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws.

### 3.3 GROUNDING

- A. Make equipment grounding connections for panelboards as indicated.
- B. Provide ground continuity to main electrical ground bus as indicated.

### 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

### 3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
  - 1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.
  - 2. Make continuity test of each circuit.
- B. Testing Agency: Provide services of a qualified independent testing agency to perform specified testing.
- C. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
  - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.
- D. Balancing Loads: After substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:
  - 1. Perform measurements during period of normal working load as advised by Owner.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
  4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, in not acceptable. Rebalance and recheck as required to meet this minimum requirement.
- E. Infrared Scanning: After Substantial Completion, but not more than 2 months after Final Acceptance, perform an infrared scan of each panelboard. Remove fronts and connections accessible to a portable scanner.
1. Follow-up infrared Scanning: Perform an additional follow-up infrared scanning of each panelboard 11 months after date of Substantial Completion.
  2. Instrument: Use an approved infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.
  3. Record of Infrared Scanning: Prepare a certified report identifying panelboards checked and describing results of scanning. Include notation of detected, remedial action taken, and observations after remedial action.

### **3.6 ADJUSTING**

- A. Set field-adjustable circuit-breaker trip ranges as directed by Engineer.

### **3.7 CLEANING**

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

**END OF SECTION 26 24 16**

**SECTION 26 27 13 - ELECTRICITY METERING**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes equipment for utility company's electricity metering.

**1.3 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.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Receive, store, and handle meter.

**1.5 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 Architect no fewer than two days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Architect's written permission.

**1.6 COORDINATION**

- A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
  - 1. Comply with requirements of utilities providing electrical power and communication services.
  - 2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

**2.2 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY**

- A. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.
- B. Meter Sockets: Comply with requirements of electrical power utility company.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Comply with equipment installation requirements in NECA 1.
- B. Install equipment for utility company metering. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

**END OF SECTION 26 27 13**

**SECTION 26 27 26 - WIRING DEVICES**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. Furnish and install wiring devices and cover plates of the type and kind as hereinafter indicated on the drawings.

**1.2 REFERENCE DOCUMENTS**

- A. Section 16010 - General Provisions for Electrical Work

**1.3 SUBMITTALS**

- A. Submit complete manufacturer's specification data on each wiring device proposed to be furnished to the job.

**1.4 QUALITY ASSURANCE**

- A. Each wiring device shall be of design, type and configuration established by NEMA Standards for the application used.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Devices shall be specification grade, UL and CSA certified, listed NEMA Standard, and suitable for the service required in the intended use of the device in this installation.
- B. Where devices manufactured by Arrow Hart, Bryant, Hubbell, Leviton, or Sierra are named, only equivalent devices by the other of these manufacturers will be acceptable. Unless otherwise indicated, devices shall be as follows:
  - 1. Coverplates shall be 302 stainless steel with matching screws.
  - 2. Wall Switches: 20 ampere, 120/277 volt AC, Pass & Seymour PS20AC1-I, PS20AC2-I, PS20AC3-I and PS20AC4-I for single pole, double pole, three-way and four-way respectively.
  - 3. Security Switch (key operated): 20 ampere, 120/277 volt AC, Pass & Seymour PS20AC1-KL, PS20AC2-KL, PS20AC3-KL and PS20AC4-KL for single pole, double pole, three-way and four-way respectively. Provide 2 keys for every switch location.
  - 4. Pilot Lighted Switches: 20 Ampere, 120 Volt AC Pass & Seymour PS20AC1-RPL with red handle (glow when "on").
  - 5. Convenience Outlets: Duplex receptacles Pass & Seymour 5362-AI 20 Ampere, 125 Volts side and back wired with a pair of NEMA 5-20R Standard 3 contact grounded parallel slot contacts.
  - 6. Isolated Ground Receptacles: Pass & Seymour IG6300-I NEMA 5-20R 20 Ampere, 125 Volts (ivory with orange open triangle) 3 contact Grounded parallel slot contacts.

7. Ground Fault Circuit Interrupter Convenience Outlets: Pass & Seymour 2094-SI 20 Ampere, 125 Volts, NEMA 5-20R with appropriate wall plate.
  8. Weatherproof/Exterior Duplex Receptacle Cover: Pass & Seymour #4510.
  9. Clock Hanger Receptacle: Pass & Seymour S3713-I, 20 Ampere, 125 Volts, NEMA 5-15R with appropriate wall plate
  10. Wiremold Wall Source Boxes #WSA and WSC series 4 and 6 compartment type with electrical devices as noted on drawings. Refer to plans for additional information.
  11. Manual Motor Starters Square D Class 2510 with overload heater sized to the motor nameplate rating and two available auxiliary contacts for monitoring and control from HVAC Energy Management System.
  12. Recessed floor boxes with electrical devices as noted on drawings shall be Wiremold RFB9 Series with mounting brackets as required.
  13. Other receptacles: Other receptacles shall be of type and characteristics and NEMA configuration to provide service as indicated for the special service as indicated elsewhere.
  14. Wall timer switches: Paragon ET2000F Series, adjustable or equivalent as manufactured by Wattstopper or P&S.
- C. Coverplates
1. General: Opening in Plates shall properly fit the wiring Devices associated with the outlets. Plates shall overlap outlet box edges for installation over finished room surfaces and shall be the non-over hanging type to fit conduit boxes used with exposed conduit runs.
  2. Future or abandoned outlet: 302 stainless steel with matching screws

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Each device shall be suitable for the type of service for which it is installed. Device shall be of NEMA configuration and of Specification Grade and/or Hospital Grade for those services to which the device is installed where those standards are established. Devices indicated adjacent to each other shall be in the same box and set under a common plate. Suitable barriers shall be provided in the box for separation of each device from adjacent devices where required by code.
- B. Install suitable cover plates on all wiring devices.
- C. Device colors shall be Ivory unless selected and installed to match the decor of the occupancy and other standard colors as set forth elsewhere in these contract documents or as selected by the Owner. Other colors shall be provided when so directed by the Owner. All devices connected to essential system shall be red.
- D. Wire all devices with proper polarity and suitably grounded. Provide Appleton or equal SCR 1032 PTL1 green head grounds screw and 6-inch pigtail in every box.
- E. All Receptacles Boxes shall have permanent circuit identification.

**END OF SECTION 26 27 26**



**SECTION 26 28 13 - FUSES**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Cartridge fuses rated 600 V and less for use in switches, controllers and motor-control centers.
  - 2. Spare-fuse cabinets.

**1.3 SUBMITTALS**

- A. Product Data: Include the following for each fuse type indicated:
  - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  - 2. Let-through current curves for fuses with current-limiting characteristics.
  - 3. Time-current curves, coordination charts and tables, and related data.
  - 4. Fuse size for elevator feeders and elevator disconnect switches.
- B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
  - 1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
  - 2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
    - a. Let-through current curves for fuses with current-limiting characteristics.
    - b. Time-current curves, coordination charts and tables, and related data.
    - c. Ambient temperature adjustment information.

**1.4 QUALITY ASSURANCE**

- A. Source Limitations: Obtain fuses from a single manufacturer.

- B. 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.
- C. Comply with NEMA FU 1.
- D. Comply with NFPA 70.

### 1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

### 1.6 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

### 1.7 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: Quantity equal to 5 percent of each fuse type and size, but no fewer than 3 of each type and size.

## PART 2 - PRODUCTS

### 2.1 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Bussman, Inc.
  - 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
  - 3. Ferraz Shawmut, Inc.
  - 4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

### 2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

### 2.3 SPARE-FUSE CABINET

- A. Cabinet: Wall-mounted, 0.05-inch- (1.27-mm-) thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
4. Fuse Pullers: For each size of fuse.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 FUSE APPLICATIONS**

- A. Feeders: Class L, time delay.
- B. Motor Branch Circuits: Class RK1 and RK5, time delay.
- C. Other Branch Circuits: Class RK1, time delay, RK5, time delay, J, fast acting, J, time delay.

#### **3.3 INSTALLATION**

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s).

#### **3.4 IDENTIFICATION**

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

**END OF SECTION 26 28 13**

**SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Bolted-pressure contact switches.
  - 4. High-pressure, butt-type contact switches.
  - 5. Molded-case circuit breakers.
  - 6. Molded-case switches.
  - 7. Enclosures.

**1.3 DEFINITIONS**

- A. GD: General duty.
- B. GFCI: Ground-fault circuit interrupter.
- C. HD: Heavy duty.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

**1.4 SUBMITTALS**

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current rating.
  - 4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports including the following:

1. Test procedures used.
  2. Test results that comply with requirements.
  3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Manufacturer's field service report.
- F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
  2. Time-current curves, including selectable ranges for each type of circuit breaker.

### **1.5    QUALITY ASSURANCE**

- A. 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) as defined by OSHA in 29 CFR 1910.7, 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.
- B. 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.
- C. Comply with NFPA 70.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Ratings: Systems shall be fully rated: Series ratings shall not be incorporated to meet short circuit requirements.

### **1.6    PROJECT CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
  2. Altitude: Not exceeding 6600 feet (2010 m).

### **1.7    COORDINATION**

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

**1.8      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.    Spares: For the following:
    - a.    Potential Transformer Fuses: two.
    - b.    Control-Power Fuses: two.
    - c.    Fuses for Fusible Switches: one per each size used.
    - d.    Fuses for Fused Power Circuit Devices: one per each size used.
  - 2.    Spare Indicating Lights: Six of each type installed.

**PART 2 - PRODUCTS**

**2.1      MANUFACTURERS**

- A.    In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1.    Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  - 2.    Manufacturers: Shall be the same as the provider of switchboards and panelboards.

**2.2      FUSIBLE AND NONFUSIBLE SWITCHES**

- A.    Fusible Switch, 600 A and Smaller: NEMA KS 1, HD with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- B.    Nonfusible Switch, 600 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C.    Accessories:
  - 1.    Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2.    Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
  - 3.    Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

**2.3      MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES**

- A.    Manufacturers shall be the same as the provider of the switchboards/panelboards.
- B.    Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  3. Electronic Trip-Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with 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.
  4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.
  5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
  6. GFCI Circuit Breakers: Single- and two-pole configurations with 4 – 6 mA trip sensitivity.
- C. Molded-Case Circuit-Breaker Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
  2. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.
  3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
  4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
  5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
  6. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
  8. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
- D. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- E. Molded-Case Switch Accessories:
1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
  2. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.

## **2.4 ENCLOSURES**

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
1. Outdoor Locations: NEMA 250, Type 3R.
  2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
  3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
  4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

**3.3 IDENTIFICATION**

- A. Enclosure Nameplates: Label each enclosure with laminated-plastic nameplate as specified in Division 26 Section "Identification for Electrical Systems."

**3.4 FIELD QUALITY CONTROL**

- A. Provide testing as follows:
  - 1. Inspect mechanical and electrical connections.
  - 2. Verify switch and relay type and labeling verification.
  - 3. Verify rating of installed fuses.
  - 4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

**3.5 ADJUSTING**

- A. Set field-adjustable switches and circuit-breaker trip ranges.

**3.6 CLEANING**

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.



**END OF SECTION 26 28 16**