

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL:

1.1 RELATED DOCUMENTS:

- A. All drawings associated with the entire project, including general provisions of the Contract, including The General Conditions of the Contract for Construction, General and Supplementary Conditions and Division-1 Conditions specification sections shall apply to the Division 26 specifications and drawings. The Contractor shall be responsible for reviewing and becoming familiar with the aforementioned and all other Contract Documents associated with the project.
- B. Where contradictions occur between this section and Division 1, the more stringent requirement shall apply.
- C. Contractor shall be defined as any and all entities involved with the construction of the project.

1.2 SUMMARY:

- A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26 and Division 28. It expands and supplements the requirements specified in sections of Division 1 through 50.

1.3 ELECTRICAL INSTALLATIONS:

- A. Drawings are diagrammatic in character and do not necessarily indicate every required conduit, box, fitting, etc.
- B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both. Report any discrepancies to the Engineer and obtain written instructions before proceeding. Where any contradictions occur between the specifications and the drawings the more stringent requirement shall apply. The contractor shall include pricing for the more stringent and expensive requirements.
- C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, take the necessary measurements and prepare the drawings.
- D. The exact location for some items in this specification may not be shown on the drawings. The location of such items may be established by the Engineer during the progress of the work.
- E. The contractor shall make the installation in such a manner as to conform to the structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or costs to the Owner. All equipment shall be installed so access is maintained for serviceability.
- F. Before any work is begun, determine that equipment will properly fit the space and that conduit can be run as contemplated without interferences between systems, with structural elements or with the work of other trades.

- G. Verify all dimensions by field measurements.
- H. Arrange for chases, slots, and openings in other building components to accommodate electrical installations.
- I. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring an access path for positioning prior to closing-in the building or space.
- J. Where mounting heights are not detailed or dimensioned, install electrical conduits, boxes, and overhead equipment to provide the maximum headroom possible. In general, keep installations tight to structure.
- K. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components as much as practical, and connect equipment for ease of disconnecting and removal with minimum of interference with other installations.
- L. Make allowance for expansion and contraction for all building electrical components and conduit systems that are subject to such.
- M. The ceiling space shall not be "layered". It is the contractor's responsibility to offset and coordinate any systems as required to allow installation within the identified ceiling cavity. The contractor shall include labor and material in the base bid to accommodate such offsets.
- N. In general, all conduit systems shall be routed as high as possible. Keep all equipment in accessible areas such as corridors and coordinate with systems and equipment from other sections.
- O. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- P. Coordinate the installation of electrical materials and equipment above and below ceilings with suspension system, luminaires and other building components. Ductwork and piping shall not be installed above electrical panelboards, switchboards, motor control centers, and transformers.

1.4 COORDINATION:

- A. Work out all installation conditions in advance of installation. The Contractor shall be responsible for preparing coordination drawings, showing all work, in all areas. The Contractor shall be responsible for providing all labor and material, including but not limited to all fittings, hangers, control devices, lighting, low voltage equipment, cable tray, conduit, transformers, disconnects, etc., necessary to overcome congested conditions at no increase in contract sum. The Contractors base bid shall include any and all time and manpower necessary to develop such coordination efforts and drawings. Increases to contract sum or schedule shall not be considered for such effort.
- B. Provide proper documentation of equipment, product data and shop drawings to all entities involved in the project. Coordination shall include, but not be limited to the following:
 - 1. Automatic Temperature Controls, Building Management and Testing, Adjusting and Balancing Contractors shall be provided with equipment product data and shop drawings

from other Division 23 and Division 26 Contractors and shall furnish the same information involving control devices to the appropriate Contractor.

C. Coordination Drawings:

1. Coordination drawings shall be prepared by the Contractor for his utilization and are his responsibility to assure systems will be installed in a manner to allow all systems to function properly.
2. Prepare and submit a set of coordination drawings showing major elements, components, and systems of electrical equipment and materials in relationship with other building components. Prepare 11"x17" or 24"x36" / 30"x42" drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for servicing and maintaining equipment. Indicate movement and positioning of large equipment into the building during construction.
3. Coordination drawings are informational submittals. Submit coordination drawings to Engineer for information only to document proper coordination of all portions of work and that coordination issues have been identified and resolved prior to submitting to the Engineer and prior to commencing construction in each affected area. The review of the coordination drawings by the Engineer does not constitute a relief of responsibility of the Contractor or a change to the contract documents. The Contractor shall have sole responsibility in developing a fully coordinated and integrated ceiling cavity.
4. Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the Work.
5. Clearly indicate solutions to space problems. Identification of space problems without solutions is not acceptable. Only areas clearly identified will be reviewed.
6. Prepare coordination drawings and other Shop Drawings at a suitable scale, showing the required dimension. In addition to the mentioned areas and systems above, also submit specific equipment installations, including, but not limited to the following:
 - a. Equipment connections
 - b. Circuit and motor disconnects
7. CADD Drawings: Electronic AutoCAD drawings are available for purchase by the Contractor from the Engineer. Contact Engineer for further information in acquiring CADD drawings. The Engineers Construction documents cannot be used directly for coordination drawings. They are for information and initial coordination only.
8. Wiring Diagrams: Provide wiring diagrams indicating: field installed electrical power; control wiring; cabling layouts; overcurrent protective devices; equipment, and equipment connections.

D. Existing Conditions:

1. Contractor shall carefully survey existing conditions prior to bidding work. In addition, Contractor shall complete a thorough ceiling cavity survey prior to developing Coordination drawings.
2. Contractor shall be responsible for showing all existing conditions on the coordination drawings.
3. Provide proper coordination of electrical work with existing conditions.
4. Contactor shall report any issues or conflicts immediately to Engineer before commencing with work and prior to purchasing equipment and materials.

1.5 COORDINATION WITH OTHER DIVISIONS:

A. General:

1. Coordinate all work to conform to the progress of the work of other trades.
 2. Complete the entire installation as soon as the condition of the building will permit. No extras will be allowed for corrections of ill-timed work, when such corrections are required for proper installation of other work.
- B. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electrical systems within the cavity space allocation in the following order of priority:
1. Equipment and required clearances
 2. Plumbing waste, cooling coil drain piping and roof drain mains and leaders.
 3. Ductwork mains.
 4. Plumbing vent piping.
 5. Low pressure ductwork and air devices.
 6. Electrical and communication conduits, raceways and cable tray.
 7. Domestic hot and cold water.
 8. Hydronic piping.
 9. Fire sprinkler mains, branch piping and drops (locate as tight to structure as possible).
 10. DDC control wiring and other low voltage systems.
 11. Fire alarm systems.
- C. Chases, Inserts and Openings:
1. Provide measurements, drawings and layouts so that openings, inserts and chases in new construction can be built in as construction progresses.
 2. Check sizes and locations of openings provided, including the access panels for equipment in hard lid ceilings and wall cavities.
 3. Any cutting and patching made necessary by failure to provide measurements, drawings and layouts at the proper time shall be done at no additional cost in contract sum.
- D. Support Dimensions: Provide dimensions and drawings so that concrete bases and other equipment supports to be provided under other sections of the specifications can be built at the proper time.
- E. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- F. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
- G. Modifications required as result of failure to resolve interferences, provide correct coordination drawings or call attentions to changes required in other work as result of modifications shall be paid for by responsible Contractor/Subcontractor.
- 1.6 DESIGN WORK REQUIRED BY CONTRACTOR:
- A. The construction of this project requires the Contractor to include the detailing and design of several systems and/or subsystems. All such design work associated with the development of the coordination drawings shall be the complete responsibility of the Contractor.
- B. The Contractor shall take the full responsibility to develop and complete routing strategies which will allow fully coordinated system to be installed in a fully functional manner. The Engineers contract drawings shall be for system design intent and general configurations.

- C. Systems or subsystems which require design responsibility by the contractor include but are not limited to:
 - 1. Temporary Facilities.
 - 2. Final coordinated distribution systems within the ceiling cavity and under raised computer floor.
 - 3. Any system not fully detailed.
 - 4. Equipment supports, hangers, anchors and seismic systems not fully detailed nor specified in these documents, or catalogued by the manufacturer.
 - 5. Seismic restraint systems.

1.7 PROJECT CONDITIONS:

- A. The contractor shall be required to attend a pre-bid walk-thru if required and shall make themselves familiar with the existing conditions. No additional costs to the Owner shall be accepted for additional work for existing conditions.
- B. Field verify all conditions prior to submitting bids.
- C. Report any damaged equipment or systems to the Owner prior to any work.
- D. Protect all work against theft, injury or damage from all causes until it has been tested and accepted.
- E. Be responsible for all damage to the property of the Owner or to the work of other contractors during the construction and guarantee period. Repair or replace any part of the work which may show defect during one year from the final acceptance of all work, provided such defect is, in the opinion of the Architect, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.
- F. The Contractor shall coordinate and co-operate with Owner at all times for all new to existing connections.
- G. Provide temporary electrical connections where required to maintain existing areas operable.
- H. Coordinate all services shut-down with the Owner; provide temporary services. Coordinate any required disruptions with Owner, at a minimum one week in advance.
- I. Minimize disruptions to operation of electrical systems in occupied areas.

1.8 SAFETY:

- A. Refer to Division 1.

1.9 EQUAL EMPLOYMENT OPPORTUNITY REQUIREMENTS:

- A. Refer to Division 1 and conform with the Owners requirements.

1.10 REQUIREMENTS OF REGULATORY AGENCIES:

- A. Refer to Division 1.
- B. Execute and inspect all work in accordance with Underwriters Laboratories (UL), and all local and state codes, rules and regulations applicable to the trade affected as a

minimum, but if the plans and/or specifications call for requirements that exceed these rules and regulations, the more stringent requirement shall be followed. Follow application sections and requirements and testing procedures of NFPA, IEEE, NEMA, CBM, ANSI, NECA, ICEA, NETA, and IETA.

- C. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.
- D. Energy Codes: All equipment and installations shall conform to Federal, State, and local Energy Conservation Standards.
- E. The handling, removal and disposal of regulated liquids or other materials shall be in accordance with U.S. EPA, state and local regulations.
- F. The handling, removal and disposal of lead based paint and other lead containing materials shall comply with EPA, OSHA, and any other Federal, State, or local regulations.
- G. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.
- H. All material used on this project shall be UL listed and labeled and be acceptable to the authority having jurisdiction as suitable for the use intended.

1.11 PERMITS AND FEES:

- A. Refer to Division 1.
- B. **Contractor** shall pay all fees required for connection to municipal and public utility facilities.
- C. Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the work.

1.12 PROJECT SEISMIC REQUIREMENTS:

- A. Installation shall comply with the local seismic requirements for the area of installation. Provide restraints, bracing, anchors, vibration isolation, seismic snubbers, and all other components required for the installation.
- B. All electrical systems shall be installed to meet NFPA and IBC Seismic requirements.
 1. Where any conflicts arise the more stringent requirements shall be applicable.
 2. The design of the seismic requirements shall be the responsibility of the contractor.

1.13 TEMPORARY FACILITIES:

- A. Light, Heat, Power, Etc. Responsibility for providing temporary electricity, heat and other facilities shall be as identified in these specifications, as shown on the drawings and as specified in Division 1.
- B. Building distribution equipment and devices (existing or new) shall not be used without written permission of the Owner. If used for temporary power, the equipment shall be properly maintained and any damage resulting from use shall be repaired by the

Contractor. The guarantee period for new equipment shall not begin until the equipment is turned over to the Owner.

- C. If AC power systems or their backup systems serving telecommunications, computer equipment, or their associated HVAC equipment and controls are taken out of service, for any reason, the Contractor shall be responsible for providing temporary systems during the period when the AC power systems or their backup systems are out of service. The Contractor shall be responsible for providing temporary power to all loads being interrupted.

1.14 PRODUCT OPTIONS AND SUBSTITUTIONS:

- A. Refer to the Instructions to Bidders and Division 1.
- B. The burden of proof that proposed equipment is equal in size, capacity, performance, and other pertinent criteria for this specific installation, or superior to that specified is up to the Contractor. If substitutions are not granted, the specified materials and equipment must be installed. Where substituted equipment is allowed, it shall be the Contractor's responsibility to notify all related trades of the accepted substitution and to assume full responsibility for all costs caused as a result of the substitution.
- C. Materials and equipment of equivalent quality shall be submitted for substitution prior to bidding. This may be done by submitting to the Architect/Engineer at least ten (10) working days prior to the bid date requesting prior review. This submittal shall include all data necessary for complete evaluation of the product.
 - 1. Substitutions shall be allowed only upon the written approval of the Architect/Engineer
NO EXCEPTIONS.
 - 2. The Contractor shall be responsible for removal, replacement and remedy of any system or equipment which has been installed which does not meet the specifications and scheduled performance or which does not have prior approval.
- D. Bidders opting to bid or propose comparable products (either a product by a listed acceptable manufacturer in the respective specification section or a substitution request) are responsible for:
 - 1. Confirming the equipment they are bidding will fit in the space available, incorporating equipment's clearance requirements.
 - 2. Coordination of any variance from basis-of-design in weight, electrical requirements, other utility requirements, etc. with other trades.
 - 3. Inclusion in the bid of any applicable costs for changes in prime bidder's and their sub bidders' work required to accommodate the utilization of the comparable product.
 - 4. The contractor shall bear any and all responsibility including any changes to mechanical, plumbing, electrical, structural or architectural design. These changes shall be clearly identified and presented to the Design Team.

1.15 SUBMITTALS:

- A. General
 - 1. Refer to the Conditions of the Contract (General and Supplementary), Division 1.
 - 2. Contractor shall provide a submittal schedule appropriate for the size and schedule of the project. Limit the number of large submittals being reviewed at one time and coordinate timing of sections that are dependent on each other i.e. submit coordination

- and short circuit study prior to or together with gear, overcurrent protection devices, ATS, etc.
3. The Contractor shall identify any "long lead time" items which may impact the overall project schedule. If these submittal requirements affect the schedule, the Contractor shall identify the impacts and confer with the Engineer within two weeks of entering into the contract.
 4. The front of each submittal package shall be identified with the specification section number, job name, Owner's project number, date, Prime Contractor and Subcontractor's names, addresses, and contact information, etc. Each Specification Section shall be submitted individually and submittal shall be tabbed for the equipment/materials/etc. within the section. Submittals that are not complete with the required information will not be reviewed and will be sent back to be corrected.
 5. Submittals shall be provided electronically. All electronic submittals need to be complete with all design information and stamped for conformity by the contractor. Submittals will be reviewed, marked appropriately and returned by the same means received.
 6. An index shall be provided which includes:
 - a. Product
 - b. Plan Code (if applicable)
 - c. Specification Section
 - d. Manufacturer and Model Number
 7. Submittal schedule shall be provided for review within four (4) working weeks from award of contract to successful bidder.
- B. Basis of Design: The manufacturer's material or equipment listed first in the specifications or on the drawings are the basis of design and are provided for the establishment of size, capacity, grade and quality. If the contractor proposes alternates or substitutions in lieu of the first names, the cost of any changes in construction required by their use shall be borne by this Contractor.
- C. All equipment shall conform to the State and/or local Energy Conservation Standards
- D. Contractor Review: Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Each submittal shall be reviewed by the contractor for general conformance with contract requirements and stamped by the respective contractor prior to submittal to the Architect/Engineer. Any submittal not stamped or complete will be sent back. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed unless written prior approval is obtained by the Contractor.
- E. Submittal Review Process: Before starting work, prepare and submit to the Architect/Engineer shop drawings and descriptive product data required for the project. Continue to submit in the stated format after each Architect/Engineer's action until a "No Exception Taken" or "Make Correction Noted" action is received. When a "Make Corrections Noted" is received, make the required corrections for inclusion in the operation and maintenance manual (O&M). Submittals marked "Make Corrections Noted" shall not be resubmitted during the submittal process. Unless each item is identified with specification section and sufficient data to identify its compliance with the specifications and drawings, the item will be returned "Revise and Resubmit". Where an entire submittal package is returned for action by the Contractor, the Engineer may summarize comments in letter format and return the entire set. Submittals shall be prepared per the ELECTRICAL SUBMITTAL CHECKLIST, at the end of this section; supplemental requirements are listed in each Division 26 Section.

- F. The Design Professional's review and appropriate action on all submittals and shop drawings is only for the limited purpose of checking for conformance with the design concept and the information expressed in the contract documents. This review shall not include:
1. Accuracy or completeness of details, such as quantities, dimensions, weights or gauges, fabrication processes
 2. Construction means or methods
 3. Coordination of the work with other trades
 4. Construction safety precautions
- G. The Design Professional's review shall be conducted with reasonable promptness while allowing sufficient time in the Design Professional's judgment to permit adequate review. Review of a specific item shall not indicate that the Design Professional has reviewed the entire assembly of which the item is a component.
- H. The Design Professional shall not be responsible for any deviations from the contract documents not brought specifically to the attention of the Design Professional in writing by the Contractor. This shall clearly identify the design and the specific element which vary from the Design. The Contractor shall be responsible for all remedy for lack of strict conformance associated with this criteria.
- I. The Design Professional shall not be required to review partial submissions or those for which submissions of correlated items have not been received.
- J. If more than two submittals (either for product data, shop drawings, record drawings, test reports, or O&M's) are made by the Contractor, the Owner reserves the right to charge the Contractor for subsequent reviews by their consultants. Such extra fees shall be deducted from payments by the Owner to the Contractor.
- K. The contractor shall cloud all changes made on submittals that are marked "Revise and Resubmit."
- L. Required Submittals: Provide submittals for each item of equipment specified or scheduled in the contract documents. See table at the end of this section.
- M. Submit letters certifying compliance with ANSI standards for medium or high voltage gear. These letters shall be signed by a corporate officer and shall list applicable standards. Letters signed by local representatives will not be acceptable.
- N. Submit proposed changes to electrical room or other equipment room layouts when revised from contract documents prior to installation.
- O. Mark submittals with designations as shown on the drawings and identify as required by Specification Sections. Identification shall contain the information as required in details and each label shall be submitted in list form with disconnects, MCC's, panelboards, switchboards, overcurrent protection devices and utilization equipment.
- 1.16 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS:
- A. Product Listing:
1. Prepare listing of major electrical equipment and materials for the project, within (2) two weeks of signing the Contract Documents and transmit to the Architect

- a. Provide all information requested.
 - b. Submit this listing as a part of the submittal requirement; see Paragraph 1.15 "PRODUCT OPTIONS AND SUBSTITUTIONS."
 2. Unless otherwise specified, all materials and equipment shall be of domestic (USA) manufacture and shall be of the best quality used for the purpose in commercial practice.
 3. When two or more items of same material or equipment are required (lighting, wiring devices, switchgear, panelboards, protective devices, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials steel bar stock, welding rods, solder, fasteners, except as otherwise indicated.
 - a. Provide products which are compatible within systems and other connected items.
 4. For conduit, wire and fittings, the Contractor shall select a prime and alternate manufacturer from the list of acceptable manufacturers provided in the appropriate sections of this Division. The prime and alternate manufacturers shall be identified in the product listing. The contractor shall make every effort to use the prime manufacturer for the entire project. If products from this manufacturer are unavailable, the Contractor shall use the listed alternate with the following provisions.
 - a. Wire: All wire placed in a single conduit or installed in multiple conduits making up parallel feeders shall be of the same manufacturer.
 - b. Conduit and Fittings: All conduits and fittings installed exposed within the same room or immediate area shall be of the same manufacturer.
- B. Schedule of Values
1. Provide Preliminary Schedule of Values to Engineer with product data submittal within four (4) weeks from award of contract to successful bidder. Provide according to the following descriptions:
 - a. General Construction (total)
 - b. Demolition
 - c. Service/Distribution
 - d. Basic Materials/Devices/Equipment Connections (Mechanical)
 2. Provide a final Schedule of Values at close-out of project including updated values based on actual installation.
- C. Product Data:
1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided.
 2. Delete or mark-out portions of pre-printed data which are not applicable.
 3. Where operating ranges are shown, mark data to show portion of range required for project application.
 4. For each product, include the following:
 - a. Sizes.
 - b. Weights.
 - c. Speeds.
 - d. Capacities.
 - e. Conduit and electrical connection sizes and locations.
 - f. Statements of compliance with the required standards and regulations.

- g. Performance data.
 - h. Manufacturer's specifications.
 - i. Housing and proposed Finishes.
 - j. NEMA or other ratings that apply.
5. Checklist: Where identified in ELECTRICAL SUBMITTAL CHECKLIST or within individual Division 26 Sections or necessary for confirmation of products, submit a detailed checklist which acknowledges compliance or a reason for non-compliance to each of the specification requirements. Arrange the checklist according to the headings of each item identified in each specification (i.e. Shop Drawings, Wiring Diagrams, Product requirements, individual line items, etc.) Mark items as "N/A" where the item is not applicable.
- D. Shop Drawings:
- 1. Shop Drawings are defined as electrical system layout drawings prepared specifically for this project, or fabrication and assembly type drawings of system components to show more detail than typical pre-printed materials.
 - 2. Prepare Electrical Shop Drawings, except diagrams, to accurate scale, min 1/8"-1'-0", Electrical rooms shall be 1/4"-1'-0" unless otherwise noted.
 - 3. Shop drawings shall include:
 - a. Proposed equipment installations.
 - b. Electrical characteristics and connection requirements.
 - c. Clearance dimensions at critical locations.
 - d. Dimensions of spaces required for operation and maintenance.
 - e. Interfaces with other work, including structural support.
 - f. Elevations when necessary in areas with multiple pieces of equipment on common walls or to clarify incoming/exiting methods/clearances, etc.
 - g. Wall and floor penetrations.
 - h. Wiring diagrams shall showing all components, internal connecting wiring, and contractor connection requirements including terminal blocks/lugs, wire sizes, etc.
- E. Coordination Drawings: See separate paragraph of this specification section.
- F. Test Reports:
- 1. Submit test reports which have been signed and dated by the accredited firm or testing agency performing the test.
 - 2. Prepare test reports in the manner specified in the standard or regulation governing the test procedure (if any) as indicated.
 - 3. Submit test reports as required for O & M manuals.
- G. Operation and Maintenance Data: See separate paragraph of this specification section.
- H. Equipment Settings Report: Where identified in the ELECTRICAL SUBMITTAL CHECKLIST or within individual Division 26 Sections or necessary for confirmation of products, submit Equipment Settings Report for each device indicating final configurations and settings.
- 1. Provide report of settings, parameters, programing inputs and parameters, etc., installed at each piece of electrical equipment that allows adjustments to be made in the field and those set at the factory. The report shall be arranged by specification section and each piece of equipment broken out individually or by listing of equipment if the same settings are installed in multiple pieces of equipment.

2. In addition to the requirements above, include within this report any individual ground fault system settings; zone interlock operational settings; Arc Flash reduction schemes and levels; transfer switch settings including time delays and upstream protection device settings with copies of listed OCPD's for each ATS; settings of monitoring equipment including trip levels and alarm levels; Generator settings and parameters; UPS settings and parameters; relay settings; transformer tap settings; phase rotation documentation; lighting control settings with associated timer settings; electrical interlock and/or kirk key system descriptions; posted operational signage; and any other pertinent information.
 3. Report shall be submitted and received by the Engineer at least fifteen calendar days prior to the contractor's request for final observation. Include in the O & M Manual after review and "No Exceptions Taken" has been accomplished.
- I. Software Licenses: Provide documentation of ownership under the owner's corporate name (coordinate with owner's representative for exact ownership wording) for Software Licenses provided as part of the work. Include information for updates, subscription requirements if applicable, backup, support, login, passwords, date when purchased, expiration date if applicable, version, etc. Include in the O & M Manual after review and "No Exceptions Taken" has been accomplished.
 - J. Record Drawings: See separate paragraph of this specification section.
- 1.17 DELIVERY, STORAGE AND HANDLING:
- A. Refer to the Division 1, Sections on Transportation and Handling and Storage and Protection.
 - B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
 - C. Check delivered equipment against contract documents and submittals.
 - D. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage and weather.
 - E. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.
- 1.18 DEMOLITION/REMODEL WORK:
- A. Refer to Division 1 Section on Summary of work for requirements on working in Owner-occupied areas of the existing building and Division 2 section on selective demolition. The following paragraphs supplement the requirements of other Divisions.
 - B. During the demolition phase of this contract it is the responsibility of this Contractor to carefully remove existing equipment, conduits, boxes, and related items either as shown on the demolition drawings as being removed, or as required for the work. These items shall be tagged, protected from damage and stored as directed by the Owner. A list of all items stored shall be turned over to the Architect/Engineer. At the completion of the remodeling work or when directed by the Architect, all stored items not reused or wanted by the Owner shall be removed from the premises.

- C. The project involves renovation and remodel of the existing building. On the drawings, work may be denoted by showing items as bold or light line weight and certain renovation symbols are used. These indications and symbols are amplified as follows:
1. **Bold Print** (when used): Work included in this contract is denoted in bold print or darker line weight.
 2. Light Print (when used): Work shown lightly indicates existing conditions to remain.
- D. Existing equipment that is removed and not scheduled to be reused shall remain the property of the Owner and be delivered for disposition unless specifically indicated otherwise and shall be stored in a location designated by the Owner. Items which are removed and not wanted by the Owner shall become the property of the Contractor and shall be removed from the site.
- E. Existing equipment that is removed and is to be reused shall be cleaned, serviced and operable before being reinstalled.
- F. Revise panelboard schedules to reflect removal or relocation of equipment. Circuit integrity of equipment in adjacent areas shall be left intact.
- G. Where remodeling interferes with existing circuits and equipment which are not to be removed, such circuits and equipment shall be reworked and relocated as required to complete the project.
- H. The Contractor shall remove all distribution equipment, conductors, etc., which are indicated to be removed or which must be removed to accommodate demolition. Equipment to be removed may require reworking conduit and wiring in order to maintain service to other equipment.
- I. Where remodeling interferes with circuits serving areas outside of the project or phase limits or which are remodeled in later phases of the project, circuits shall be reworked or temporary circuits provided as required.
- J. Existing equipment and circuiting shown are based on field surveys and/or Owner furnished drawings. The Contractor shall verify conditions as they exist with necessary adjustments being made to the drawing information.
- K. Coordinate the routing of all conduits with the existing mechanical and plumbing systems in order to avoid conflicts with ducts, pipes, etc. Where existing electrical boxes, conduit, or equipment interfere with installation of new ducts, plumbing, walls, soffits, luminaires, outlets, etc., the Contractor shall resolve the conflict with the appropriate trade.
- L. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated on the drawings or allowed under the appropriate section of the specifications.
- M. Electrical Outages: Electrical outages must be held to a minimum. The Contractor shall submit a Method of Procedure (MOP) for each outage to the Owner, detailing the reasons for the outage, areas affected, sequence of procedures to accomplish work, estimated maximum length of time along with the date and time of day outage will occur. The Contractor shall meet with the Owner to set a schedule and date for the outage based on the MOP. Due to the critical implications of power outages, the Owner may direct the Contractor as to the time of day or night and date an outage may take place.

1. The Contractor will be responsible for providing temporary power required for the duration of the outages. The required outages to connect and disconnect the temporary power will require a MOP as described above.
 2. Log each approved and implemented MOP and submit with O&M Manuals.
- N. PCB Ballasts: PCB type ballasts may be present in existing luminaires. If PCB ballasts are discovered by the Contractor, report such occurrence to the Owner immediately. The Contractor shall remove and dispose of PCB type ballasts at an E.P.A. (Environmental Protection Agency) approved site in the prescribed manner acceptable to the EPA. The Contractor shall pay all fees associated with this work.
- O. Hazardous Material: If suspected hazardous material, in any form, is discovered by this Contractor in the process of his work, he shall report such occurrence to the Owner immediately. The Owner will determine the action to be taken. Hazardous material removed is not a part of the work to be done under this Division.
- P. Lamp Disposal: Contractor is responsible for sending removed lamps to be recycled. The Contractor shall ensure the recycling agency meets RCRA and CERCLA regulations. Provide certificate of compliance in O&M Manuals.
- Q. On Site Metering: When called for in the specifications or on the drawings, the Contractor shall meter the points indicated for a period of 30 days prior to start of construction to verify existing load. Meter shall record voltage; amperage; KVA; and Power Factor for each phase and sum of the phases. The meter shall continually average the power demand over maximum 15 minute intervals as required by NEC 220.87. Compile a metering summary report and deliver results to engineer after 7 days and after 30 days. Verify existing loads at and downstream of the metering location and provide list to engineer of what loads are not on during the 30 day metering and the reason why. Organize list by equipment name. If any loads have been removed or permanently abandoned, Turn circuit breaker off and relabel as SPARE.
- 1.19 CUTTING AND PATCHING:
- A. Cutting and patching of electrical equipment, components, and materials may be required for removal and legal disposal of selected materials, components, and equipment. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
 - B. Refer to the Division 1 Section covering cutting and patching for general requirements.
 - C. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
 - D. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.
 - E. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.
 - F. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 1. Uncover Work to provide for installation of ill-timed Work;
 2. Remove and replace defective Work;
 3. Remove and replace Work not conforming to requirements of the Contract Documents;
 4. Remove samples of installed Work as specified for testing;

5. Install equipment and materials in existing structures;
 6. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.
- G. Cut, remove and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to removal of conductors, conduit, luminaires, boxes, devices and other electrical items made obsolete by the new Work.
- H. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- I. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- J. Locate, identify, and protect electrical services passing through remodel or demolition area and serving other areas required to be maintained operational.
- K. When coring is required or identified, an x-ray of the area is to be taken prior to the performance of the work operation. X-ray work requires an MOP and protection.
- 1.20 ROUGH-IN:
- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
 - B. Refer to equipment shop drawings and manufacturer's requirements for actual provided equipment for rough in requirements.
 - C. Work through all coordination before rough-in begins.
- 1.21 ACCESSIBILITY:
- A. Install equipment and materials to provide required code clearances and access for servicing and maintenance. Coordinate the final location with piping, ducts, and equipment of other trades to insure proper access for all trades. Coordinate locations of concealed equipment, disconnects, and boxes with access panels and doors. Allow ample space for removal of parts, fuses, lamps, etc. that require replacement or servicing.
 - B. Extend all conduits so that junction and pull boxes are in accessible locations.
 - C. Provide access panel or doors where equipment or boxes are concealed behind finished surfaces.
 - D. Furnish hinged steel access doors with concealed latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed valves, shock absorbers, air vents, motors, fans, balancing cocks, and other operating devices requiring adjustment or servicing. Refer to Division 1 for access door specification and requirements.
 - E. The minimum size of any access door shall not be less than the size of the equipment to be removed or 12 inches x 12 inches if used for service only.
 - F. Furnish doors to trades performing work in which they are to be built, in ample time for building in as the work progresses. Whenever possible, group valves, cocks, etc., to permit use of minimum number of access doors within a given room or space.

- G. Factory manufactured doors shall be of a type compatible with the finish in which they are to be installed. In lieu of these doors, approved shop fabricated access doors with DuroDyne hinges may be used.
- H. Access doors in fire rated walls and ceilings shall have equivalent U.L. label and fire rating.

1.22 TESTING:

- A. Submit test reports as outlined in Division 1 Sections on Quality Control Services and each Division 26 Section.
- B. Testing as required by these specifications shall pertain to all equipment, wiring, devices, etc. installed under this contract and being reused.
- C. General Scope:
 - 1. Perform all tests and operational checks to assure that all electrical equipment, both Contractor and Owner-supplied, is operational within industry and manufacturer's tolerances and is installed in accordance with design specifications.
 - 2. The tests and operational checks shall determine the suitability for energization.
 - 3. Schedule tests and give a minimum of two weeks advance notice to the Architect/Engineer. Reschedule testing for Owner convenience if required.
- D. Test Report: Submit the completed report to the Architect/Engineer no later than fifteen (15) days after completion of test unless directed otherwise. The test report shall be bound and its contents certified. A final compilation of all Test Reports shall be submitted with the Testing and Equipment Settings Report (Refer to Operation and Maintenance Data paragraphs).
- E. Each test report shall include the following:
 - 1. Project information including: Building, name, address, date, and other pertinent information.
 - 2. List of equipment tested.
 - 3. Description of test.
 - 4. List of test equipment used and calibration date.
 - 5. Baseline, acceptable, or published target value for test with code or standard reference indicating where value was derived.
 - 6. Test results that summarize all measured values with baseline values.
 - 7. Conclusions and recommendations.
 - 8. Appendix, including appropriate test forms that show all measured values.
- F. Failure to Meet Test:
 - 1. Any system material or workmanship which is found defective on the basis of performance tests shall be reported directly to the Architect/Engineer.
 - 2. All failed tests shall be sent immediately by email to Architect/Engineer with proposed corrective action and proposed re-test date and time.
 - 3. Contractor shall replace the defective material or equipment as necessary, and have test repeated until test proves satisfactory without additional cost to the Owner.
- G. The testing agency shall have a calibration program which maintains all applicable test instrumentation within rated accuracy. The accuracy shall be traceable to the National

Institute of Standards and Technology (NIST) in an unbroken chain. Instruments shall be calibrated in accordance with the following frequency schedule:

1. Field Instruments: 6 months
2. Laboratory Instruments: 12 months
3. Leased specialty equipment: 12 months. (Where accuracy is guaranteed by lessor
4. Dated calibration labels shall be visible on all test equipment.

1.23 NAMEPLATE DATA:

- A. Provide equipment with permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Install equipment so that nameplate is readily visible.
- B. Phase Rotation
 1. Existing Building: Match existing phase rotation.

1.24 CLEANING:

- A. Refer to the Division 1 Section on project closeout or final cleaning for general requirements for final cleaning.
- B. Clean all luminaires, lamps and lenses per manufacturer's recommendations prior to final acceptance. Replace all inoperative lamps.

1.25 RECORD DOCUMENTS:

- A. Refer to the Division 1 Section on Project Closeout or Project Record Documents for requirements. The following paragraphs supplement the requirements of Division 1.
- B. Keep a complete set of record document prints in custody during entire period of construction at the construction site. Documents shall be updated on a weekly basis.
- C. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; concealed control system devices, and any other relevant deviations from the Contract Documents.
- D. Mark shop drawings to indicate approved substitutions; Addenda; Change Orders; actual equipment and materials used.
- E. Schedules:
 1. Mark luminaire schedule on drawings to indicate manufacturer and complete catalog numbers of installed equipment.
 2. Mark schedules including panelboard, switchboard, motor control center, mechanical, kitchen and similar equipment schedules on drawings to indicate installed equipment and materials used, and any deviations or revisions to electrical load data and calculations.
- F. Revisions to the Contract Documents shall be legible and shall be prepared using the following color scheme.

1. Red shall indicate new items, deviations and routing.
 2. Green shall indicate items removed or deleted.
 3. Blue shall be used for relevant notes and descriptions.
- G. At the completion of the project, obtain from the Architect a complete set of the Contract Documents in a read-only electronic format (.pdf unless otherwise noted). This set will include all revisions officially documented through the Architect/Engineer. Using the above color scheme, transfer any undocumented revisions from the construction site record drawings to this complete set. Submit marked up and completed documents to the Architect/Engineer. This contract will not be considered completed until these record documents have been received and reviewed by the Architect/Engineer.
- H. Contractor may propose methods of maintaining record documents on electronic media. Obtain approval of Engineer and Owner prior to proceeding. Marked-up .pdf format readable by Bluebeam is preferred.
- I. One full size set of record drawing one line diagrams shall be posted in the electrical room and one half size set of the remaining electrical record drawings shall be bound with 3 Hole inserts and plastic cover and stored in the electrical room.

1.26 OPERATION AND MAINTENANCE DATA:

- A. Refer to the Division 1 Section on project closeout or operation and maintenance data for procedures and requirements for preparation and submittal of maintenance manuals.
- B. No later than four (4) weeks prior to the completion of the project provide complete set of operating and maintenance manuals, or as specified in Sections of Division 1 (whichever is more stringent). Operation and Maintenance Data shall be submitted in electronic format.
- C. Operation and Maintenance Data: Submit operation and maintenance data in maintenance manual in accordance with requirements of applicable Division 26 Sections and Division 1. Provide Operating and Maintenance Instructions in electronic format covering all equipment furnished. Manuals shall include all information required below, as indicated in each Division 26 Section, and the following for each piece of equipment:
1. The job name and address, contractor's name, address, and phone number, and each subcontractor's name, address, and phone number shall be identified at the front of the electronic submittal.
 2. Name, address and telephone number to be contacted of the local authorized service organization/company and individual to be contacted for service and maintenance for each item of equipment.
 3. Submit operation and maintenance data, schedule of recommended service and parts lists for all materials and products specified and intended for installation. Include description of function, normal operating characteristics and limitations, fuse curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
 4. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
 5. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 6. Servicing instructions and lubrication charts and schedules.
 7. Manufacturer's service manuals for all electrical equipment provided under this contract.

8. Complete equipment and protection wiring diagrams. All wiring diagrams shall show color coding of all connections and mounting dimensions of equipment.
9. Equipment identification numbers and adjustment clearly indicated for each piece of equipment.
10. Electrical System and Equipment Warranties.
11. Provide manuals tabbed and divided into major sections and special equipment. Mark the individual equipment when more than one model or make is listed on a page. Provide detailed table of contents.
12. Record Set of Shop Drawings: Shop drawings corrected to show as-built conditions. Transfer modifications from field set.
13. Equipment Testing Report including all test reports and Equipment Settings Report indicating final configurations and settings.

- D. This contract will not be considered completed nor will final payment be made until all specified material, including test reports, settings reports, and final Schedule of Values with all Electrical and Information Technology change order costs included and identified is provided and the manual is reviewed by the Architect/Engineer.

1.27 PROJECT CLOSEOUT LIST:

- A. In addition to the requirements specified in Division 1, complete the requirements listed below.
1. The contractor shall be responsible for providing the items listed on the Electrical Submittal Checklist prior to applying for certification of substantial completion. Refer to individual specification sections for additional requirements (Checklist is located at the end of this section.)
 2. Final payment will not be authorized until all items on the final punch list have been complete.

1.28 WARRANTIES:

- A. Refer to the Division 1 Section on Warranties and Bonds for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In no case shall the warranty for the total electrical system be less than one year from date of acceptance by the Owner.
- B. Compile and assemble the warranties specified in Division 26, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item. Information to include product or equipment description, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.29 CONSTRUCTION REQUIREMENTS:

- A. The contractor shall maintain and have available at the jobsite current information on the following at all times:
1. Up to date record drawings.
 2. Addenda
 3. Change Orders
 4. Submittals
 5. Site observation reports with current status of all action items.

- 6. Test results; including recorded values, procedures, and other findings.
- 7. Outage information.

1.30 ELECTRICAL SUBMITTAL CHECKLIST:

- A. Provide submittals including shop drawings, product data, product checklists, tests and reports, training, extra material, coordination drawings, record drawings, O&M manuals, device setting reports, and software licenses per the following schedule:

Division 26

C – Product Checklist; Q – Qualifications, CD – Coordination Drawings, RD - Record Drawings, D – Device Setting Report; S – Software License, W – Special Project Warranty											
SPEC Section	TITLE	Requirements									
		Report Data		Test	Factory Test	Report	Factory Rep Supervision at Site	Training Req'd at Site	Extra Material	O&M	Other
		Shop Drawings	Product Data								
26 05 00	Common Work Results For Electrical										
	Electrical Coordination Drawings	X									
	Existing Conditions Survey Drawings	X									
	Seismic Design Parameters per Local Authority	X	X			X				X	
	Temporary Facilities	X	X			X					
	Product Listing		X							X	C
	Preliminary Schedule Of Values					X					
	Final Schedule Of Values					X				X	
	Lamp disposal Certificates /PCB/Hazardous Material			X		X				X	
	Electrical On-Site Metering Reports			X		X				X	
	Tests	X	X	X	X	X	X	X		X	D
	Record Drawings including changes to existing Equip.	X								X	
	O&M Manuals	X	X	X	X	X			X	X	C,D,S
	Project Closeout List					X				X	
	Contractor/Equipment Warranties					X				X	
26 05 19	Low Voltage Electrical Power Conductors And Cables		X	X		X				X	
26 05 26	Grounding And Bonding For Electrical Systems	X	X	X		X				X	
26 05 29	Hangers And Supports For Electrical Systems	X	X							X	
26 05 33	Raceway And Boxes For Electrical Systems	X	X								CD, RD
	Electrical Metallic Tubing		X								CD, RD
	Flexible Metal Conduit		X								CD, RD
	Intermediate Metal Conduit		X								CD, RD

C – Product Checklist; Q – Qualifications, CD – Coordination Drawings, RD - Record Drawings, D – Device Setting Report; S – Software License, W – Special Project Warranty

SPEC Section	TITLE	Requirements									
		Report Data		Test	Factory Test	Report	Factory Rep Supervision at Site	Training Req'd at Site	Extra Material	O&M	Other
		Shop Drawings	Product Data								
	Liquid-Tight Flexible Conduit		X								CD, RD
	Non-Metallic Conduit PVC		X								CD, RD
	Rigid Metal Conduit		X								CD, RD
	Wireways	X	X							X	CD, RD
	Rigid Aluminum Conduit		X								CD, RD
26 05 34	Cabinets, Boxes & Fittings	X	X								CD, RD
26 05 53	Identification For Electrical Systems	X	X							X	
26 05 83	Wiring Connections	X	X	X							D
26 27 26	Wiring Devices		X	X		X				X	
26 28 00	Low Voltage Circuit Protective Devices	X	X	X		X		X	X	X	C, D.S

END SECTION 260500

SECTION 260519 – LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY:

- A. This section includes wires, cables, and connectors for power, lighting, signal, control, and related systems rated 600 volts and less.

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electrical wiring and cabling work similar to that required for this project.
- C. Conform to applicable code regulations regarding toxicity of combustion products of insulating materials.

1.3 SUBMITTALS:

- A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.
- B. Product Data: Submit manufacturer's data on electrical wires, cables and connectors.

1.4 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver wire and cable properly packaged in factory- fabricated type containers, or wound on NEMA-specified type wire and cable reels.
- B. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.
- C. Handle wire and cable carefully to avoid abrading, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following (for each type of wire, cable, and connector):

- 1. Wire and Cable:
 - a. American Insulated Wire
 - b. Belden
 - c. Cerrowire
 - d. Encore Wire
 - e. General Cable Corporation.
 - f. Southwire Company

- g. Okonite
- h. Superior Essex:
 - 1) Triangle
 - 2) Excel
 - 3) Royal

2. Connectors:

- a. O-Z/Gedney Co.
- b. AMP, Inc.
- c. Burndy Corporation.
- d. Ideal Industries, Inc.
- e. 3M Company
- f. Thomas and Betts Corp.

2.2 WIRES AND CABLES:

A. General: Provide wire and cable suitable for the temperature, conditions, and location where installed.

B. Conductors: Provide stranded conductors and approved connectors for all power, control, and lighting circuits.

C. Conductor Material: Provide copper for all wires and cables.

1. Metal Clad Cable - Type MC: Sizes 12 AWG and 10 AWG, copper conductors with 600 volt thermoplastic insulation rated 90 degrees C, **galvanized steel or aluminum** interlocked metal type covering. Fitting shall have double grip saddle and locking nut.
2. Portable Cord:
 - a. Type SO: Sizes 12 AWG through 2 AWG, copper conductors with 600 volt thermoset insulation 0.1 resistant insulation.
 - b. Type G-GC: Sizes 1 AWG through 500 KCMIL, copper conductors with 600/2000 volt, 90 degrees C, ethylene-propylene insulation.
3. Cables: Provide the following types of cables in NEC approved locations and applications where permitted by the contract documents. Cables shall be U.L. listed and approved by the local building authority. All cables shall contain a green insulated equipment ground conductor of the same size as the neutral conductor.

2.3 CONNECTORS:

- A. Description: Provide UL-type factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperatures equal to or greater than those of the wires upon which used.
- B. Provide 2-hole compression lugs for all power feeder, neutral, and grounding connections when installed on bus bars. (Including phase, neutral and grounding conductors).
- C. Provide connectors that are designed to accept stranded conductors where stranded conductors are used.

PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION SCHEDULE:

- A. Building Wire: Install all building wire in raceway regardless of location.
- B. Metal Clad Cable:
 - 1. Maximum of 6 feet unsupported length for connecting luminaires in accessible ceilings to the local junction box.
 - 2. Maximum of 6 feet unsupported length for connecting luminaires in non-accessible ceilings to the local junction box.
 - 3. In stud walls and casework for horizontal branch circuit runs between devices.
 - 4. For vertical branch circuit drops from a local junction box in each room above an accessible ceiling to the direct or single device in a stud wall, casework, under counter lighting.
 - 5. May not be used for branch circuit home runs, feeders, motor feeder circuits or in the following locations:
 - a. Emergency Systems
 - 6. Branch circuit conductors shall match color coding schedule within this specification section.
- C. Portable Cord: Use for flexible pendant leads to luminaires, outlets, and equipment where indicated and in compliance with codes.

3.2 INSTALLATION OF WIRES AND CABLES:

- A. General: Install electrical cables, wires and connectors in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Coordinate wire/cable installation work, including electrical raceway and equipment connection work, with other work.
- C. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation.
- D. Use pulling means including, fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway. Do not use rope hitches for pulling attachment to wire or cable.
- E. Keep conductor splices to minimum. Splice only in accessible junction boxes. No splices are allowed in feeder, control or fire alarm wiring. Connect unspliced wire to numbered terminal strips at each end.
- F. Install splices and taps which possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
- G. Use splice and tap connectors which are compatible with conductor material.
- H. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A for copper and 486B for aluminum.

- I. Support cables above accessible ceilings. Independent from the ceiling suspension system to support cables from structure, do not rest on ceiling tiles.
- J. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled to individual circuits. Make terminations so there is no bare conductor at the terminal.
- K. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger. For 10 AWG and smaller, use insulated screw on type spring wire connectors with plastic caps, push on type are not acceptable.
- L. Use copper compression connectors for copper wire splices and taps, 1/0 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the conductor.
- M. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- N. Thoroughly tape the ends of spare conductors in boxes and cabinets.
- O. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.
- P. Make all ground, neutral and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to individual ground terminal of devices.
- Q. Branch circuits whose length from panel to first outlet exceeds 100 feet for 120 volt circuits or 175 feet for 277 volt circuit shall be #10 or larger, as required to comply with the National Electrical Code.
- R. Parallel conductors shall be cut to the same length.
- S. All splices in control panels, terminal junction boxes, low voltage control circuits, fire alarm, etc., conductors shall be on numbered terminal strip.
- T. Where conduit is not required, plenum rated cable shall be provided in ceiling, floor or other air plenum spaces.
- U. Provide wire training, lacing, labeling, and terminal blocks as required in panelboards and all control cabinets including, but not limited to, lighting, transfer switch, fire alarm, and security cabinets. All wiring shall be installed neat and be labeled to match wiring diagrams, control devices, etc.
 - 1. Make temporary connections to panelboard devices with sufficient slack conductor to facilitate reconnections required for balancing loads between phases.
- V. Color coding of switch legs, travelers, etc. shall be different and distinct from phase and neutral conductors. Where systems utilize two (2) different voltages, the color coding of switch legs, travelers, etc. shall be different and distinct for each voltage system.

3.3 FIELD QUALITY CONTROL:

- A. Test installed wires and cables with 1000 VDC megohm meter to determine insulation resistance levels to ensure requirements are fulfilled. Test shall be made on all feeders regardless of size and on all branch circuits with No. 4 AWG and larger conductors. The megger values obtained shall be compared to the minimum values listed in NETA. All phase conductors and cables shall be meggered after installation, and prior to termination. Submit test report.
- B. Prior to energization, test wires and cables for electrical continuity and for short-circuits.
- C. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

3.4 COLOR CODING SCHEDULE:

- A. Color code secondary service, feeder, and branch circuit conductors as follows:

<u>120/208 Volts</u>	<u>Phase</u>	<u>277/480 Volts</u>
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

- B. Conductors shall be solid color for entire length.
- C. If solid color conductor insulation is not available and specific acceptance is given by the engineer for use of black conductor insulation, provide the following:
 - 1. Conductors 6 AWG and smaller shall be solid color for the entire length.
 - 2. Conductors 4 AWG and larger shall have either solid color insulation as specified above for the entire length or be black with color coding at each termination and in each box or enclosure. For a distance of 6 inches use half-lapped 3/4 inch plastic tape in the above specified color. Do not cover cable identification markings. Adjust tape locations to prevent covering of markings.

END OF SECTION 260519

SECTION 260526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.2 SUBMITTALS:

- A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.
- B. Product data for ground rods, connectors and connection materials, and grounding fittings.
- C. Wiring Diagrams: Submit wiring diagrams for electrical grounding and bonding work which indicates layout of ground rings, location of system grounding electrode connection, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding connections.

1.3 QUALITY ASSURANCE:

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled. The terms "listed" and "labeled" shall be defined as they are in the National Electrical Code, Article 100.
- B. Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 5 years.
- C. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical grounding work similar to that required for project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Burndy Corporation
 - 2. Cadweld Div.; Erico Products Inc.
 - 3. Ideal Industries
 - 4. OZ Gedney Div.
 - 5. Thermoweld
 - 6. Thomas and Betts Corp.

2.2 GROUNDING AND BONDING PRODUCTS:

- A. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.
- B. Conductor Materials: Copper.

2.3 WIRE AND CABLE CONDUCTORS:

- A. General: Comply with Division 26 Section on Wires and Cables. Conform to NEC, except as otherwise indicated, for conductor properties, including stranding.
- B. Equipment Grounding Conductor: Green insulated.
- C. Grounding Electrode Conductor: Stranded cable.
- D. Bare Copper Conductors: Conform to the following:
 - 1. Solid Conductors: ASTM B-3
 - 2. Assembly of Stranded Conductors: ASTM B-8
 - 3. Tinned Conductors: ASTM B-33

2.4 MISCELLANEOUS CONDUCTORS:

- A. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.
- B. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

2.5 CONNECTOR PRODUCTS:

- A. General: Listed and labeled as grounding connectors for the materials used.
- B. Pressure Connectors: High-conductivity-plated units.
- C. Bolted Clamps: Heavy-duty units listed for the application.
- D. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

2.6 GROUNDING ELECTRODES:

- A. Ground Rods: Copper-clad steel with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core.
 - 1. Size: ¾" by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATION:

- A. Equipment Grounding Conductor Application: Comply with NEC for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.

1. Install separate insulated equipment grounding conductors with circuit conductors for the following in addition to those locations where required by Code:
 - a. Feeders and branch circuits.
 - b. Provide individual grounding and neutral conductors for each isolated ground receptacle. When individual or groups of isolated ground receptacles are on dedicated circuits, individual ground and neutral conductors for each circuit is acceptable.
 - B. Underground Conductors: Bare, tinned, stranded copper except as otherwise indicated.
 - C. Signal and Communications: For telephone, alarm, and communication systems, provide a #6 AWG minimum green insulated copper conductor in raceway from the grounding electrode system to each terminal cabinet or central equipment location.
 - D. All systems shall be grounded in accordance with the NEC.
- 3.2 INSTALLATION:
- A. General: Ground electrical systems and equipment in accordance with NEC requirements except where the Drawings or Specifications exceed NEC requirements. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.
 - B. Ground Rods: Locate a minimum of two-rod lengths from each other and at least the same distance from any other grounding electrode. Interconnect ground rods with bare conductors buried at least 24 inches below grade. Connect bare-cable ground conductors to ground rods by means of exothermic welds except as otherwise indicated. Make these connections without damaging the copper coating or exposing the steel. Drive rods until tops are 6 inches below finished floor or final grade except as otherwise indicated.
 - C. Braided-Type Bonding Jumpers: Install to connect ground clamps on water meter piping to bypass water meters electrically. Use elsewhere for flexible bonding and grounding connections.
 - D. Route grounding conductors along the shortest and straightest paths possible without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.
 - E. Labeling: Provide a phenolic tag for all grounding electrode conductors as described in section on Electrical Identification.
 - F. Where grounding conductors, grounding electrode conductors, or bonding conductors are non-exposed, identify each with a 6-inch band of green tape at each end and at 10 foot intervals. When run in conduits, provide color banding on conduit per section on Electrical Identification.
- 3.3 CONNECTIONS:
- A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.

2. Make connections with clean bare metal at points of contact.
 3. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.
- B. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Where metallic raceways terminate at metallic housings without mechanical and electrical connection to the housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus in the housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors. Terminate each conductor on an individual ground lug terminal.
- C. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torqueing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A.
- D. Compression-Type Connections: Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.
- E. Moisture Protection: Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.

3.4 FIELD QUALITY CONTROL:

- A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance-to-ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.
- B. Ground Resistance Test:
1. Grounding electrode resistance testing shall be accomplished with a ground resistance direct-reading single test meter utilizing the fall-of-potential method and two reference electrodes. Perform test prior to interconnection to other grounding systems. Orient the ground electrode to be tested and the two reference electrodes in a straight line spaced fifty (50) feet apart. Drive the two reference electrodes five (5) feet deep.
- C. Correct Deficiencies, Retest and Report:
1. Correct unsatisfactory conditions and retest to demonstrate compliance; replace conductors, units and rods as required to bring system into compliance.
 2. Prepare a written report and show temperature, humidity and condition of soil at time of tests. Report shall be certified by testing agency that identifies components checked and describes results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.

3.5 CLEANING AND ADJUSTING:

- A. Restore surface features at areas disturbed by excavation and reestablish original grades except as otherwise indicated. Where sod has been removed, replace it as soon as possible

after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other Work to their original condition. Include necessary top-soiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Restore vegetation and disturbed paving to original condition.

END OF SECTION 260526

SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.2 SUBMITTALS:

- A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.
- B. Product data for each type of product specified.
 - 1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.
- C. Shop drawings indicating details of fabricated products and materials.
- D. Engineered Design consisting of details and engineering analysis for supports for the following items:
 - 1. Trapeze hangers for multiple conduit runs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit
 - b. B-Line Systems, Inc.
 - c. Unistrut Diversified Products
 - 2. Conduit Sealing Bushings:
 - a. O-Z/Gedney
 - b. Cooper Industries, Inc.
 - c. Killark Electric Mfg. Co.
 - d. Madison Equipment Co.
 - e. Raco, Inc.
 - f. Spring City Electrical Mfg. Co.
 - g. Thomas & Betts Corp.

2.2 COATINGS:

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES:

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: All steel springhead type.
 - 3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. U-Channel Systems: 12-gage steel channels, with 9/16 inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.
- E. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:
 - 1. One-Hole Conduit Straps: For supporting 1 inch and smaller rigid metal conduit; galvanized steel.
 - 2. Two-Hole Conduit Straps: For supporting 1 inch and larger rigid metal conduit, galvanized steel; 3/4 inch strap width; and 2-1/8 inch between center of screw holes.

2.4 FABRICATED SUPPORTING DEVICES:

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide pipe sleeves of one of the following:
 - 1. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
 - 2. EMT, IMC, or Rigid Conduit.

2.5 FIRE SEALS:

- A. Material: Fire stopping material shall be asbestos free, 100 percent intumescent, have code approval under BOCA, ICBO, SSBC, NFPA 101, NFPA 70, and be capable of maintaining an effective barrier against flame and gases in compliance with the following requirements.
- B. Flame Spread: 25 or less, ASTM E84
- C. Fire Resistance and Hose Stream Tests: Fire stopping materials shall be rated "F" and "T" in accordance with ASTM E 814 or UL 1479. Rating periods shall conform to the following:
 - (F) 3 (T) 3 Time-rated floor or wall assemblies.

(F) 3 (T) 3 Openings between floor slabs and curtain wall.

D. Manufacturers: Subject to compliance with requirements, provide fire seals of the following:

1. 3M Company
2. STI
3. Tremco
4. Hilti

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Junction Box Supports: Comply with the NEC and the following requirement:
1. Use 1/4" all-thread rod from structure to support junction boxes.
- D. Raceway Supports: Comply with the NEC and the following requirements:
1. Conform to manufacturer's recommendations for selection and installation of supports.
 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs. safety allowance in the strength of each support.
 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 4. Use #9 ceiling wire to support individual conduits up to 3/4inch with spring steel fasteners. Use of ceiling support wires is unacceptable.
 5. Support parallel runs of horizontal raceways together on trapeze-type hangers. Use 3/8 inch diameter or larger threaded steel rods for support.
 6. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4 inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing. For hanger rods supporting 1-1/2 inch or larger conduits provide 3/8 inch minimum threaded steel rods with pipe hangers.
 7. Space supports for raceways in accordance with NEC. When there are 4 or more 2 inch conduits in a trapeze, supports shall be spaced 5 feet O.C.
 8. In all runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
 9. Threaded rod supports to have bottoms cut off at a maximum length equal to rod diameter below bottom nut.
 10. Attachment of electrical supports to piping, ductwork, mechanical equipment or conduit is not allowed.
- E. Conductor or Cable Supports: Comply with the NEC and the following requirements:

1. Support individual conductors or cables by separate clamps with rubber or plastic grommet, fasten using a non-metallic bolt and nut, and secure clamps to unistrut supports anchored to structure (multiple clamps may be secured to a single unistrut support). Individual conductors or cables may be served utilizing a vinyl or fiberglass clamp which shall be anchored to the structure.
 2. Space supports as follows:
 - a. Horizontal conductors not more than 3 feet o.c.
 - b. Vertical conductors not more than 5 feet o.c.
 3. Install simultaneously with installation of conductors.
 4. MC Cable shall be supported by UL listed clip or clamp. Cable tie support is not acceptable.
- F. Miscellaneous Supports: Support miscellaneous electrical components separately and as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- G. In overhead spaces, support metal boxes directly from the building structure via 1/4" minimum all-thread or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box. Supporting metal boxes utilizing ceiling type wire is not acceptable.
- H. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for cable installations as required. Where sleeves through floors are installed, extend above finish floor. For sleeves through fire rated-wall or floor construction, apply UL-listed fire stopping sealant in gaps between sleeves and cables in accordance with "Fire Resistant Joint Sealers" requirement of Division 7 Section "Joint Sealers." See Architectural plans for location and extent of fire rated assemblies.
- I. Conduit Seals: Install seals for conduit penetrations of exterior walls below grade. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- J. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
1. Fasten by means of wood screws on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts or self-drilling masonry anchors on concrete or solid masonry, cast in inserts on precast structures, spring-tension clamps on steel. Drilling of structural steel members is prohibited. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws, where authorized by the Owner and structural engineer. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 2. Coordinate with the owner and structural engineer and obtain written prior approval of all work on concrete beams. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

- K. Communication and Telephone Cable Supports: Use No. 9 ceiling wire to support individual or small bundles of cables run above accessible ceilings.

3.2 PERSONNEL PROTECTION:

- A. Where U-channel systems, angles, brackets or other standard structural metal shapes are readily accessible and exposed to personnel, provide plastic or rubber end caps.
- B. Where threaded rod supports are readily accessible and exposed to personnel, provide plastic or rubber end caps.

3.3 FIRE STOPPING LOCATIONS:

- A. Preparation:
 - 1. Coordination: Coordinate the work with other trades. Fire stopping materials at penetrations of insulated pipes and ducts can be applied after insulation is in place. If insulation is composed of combustible material, the thickness of fire stopping materials must be equivalent to that of the insulation. If the insulation is composed of non-combustible material, it may be considered as part of the penetrating item.
 - 2. Surface Preparation: Surface Preparation to be in contact with fire stopping materials shall be free of dirt, grease, oil, loose material or other substances that may affect proper fitting or the required fire resistance.
- B. Installation: Install fire stopping materials in accordance with the manufacturer's instructions.
- C. Cleaning: After completion of fire stopping work in any area, equipment shall be reviewed and walls, ceilings and all other surfaces shall be cleaned of deposits of firestop materials.
- D. Inspection: The architect may select and the Owner will pay an independent testing laboratory to examine fire stopped areas to ensure proper installation prior to concealing or enclosing the fire stopped areas.

END OF SECTION 260529

SECTION 260533 RACEWAY AND WIREWAY FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

- A. Extent of raceway work is indicated by drawings and schedules. Provide complete conduit systems for all conductors unless otherwise specified.
- B. Types of raceways specified in this section include the following:
 - 1. Electrical metallic tubing (EMT).
 - 2. Flexible metal conduit.
 - 3. Intermediate metal conduit (IMC).
 - 4. Liquid-tight flexible metal conduit.
 - 5. Non-metallic Conduit and Ducts.
 - 6. Rigid metal conduit (RGC).
 - 7. Wireways.
 - 8. Rigid Aluminum Conduit.

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical raceway work similar to that required for this project.

1.3 SUBMITTALS:

- A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.
- B. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required. Include data substantiating that materials comply with requirements.
- C. Shop Drawings: Submit dimensioned drawings of surface metal raceway systems showing layout of raceways and fittings, spatial relationships to associated equipment, and adjoining raceways, if any. Show connections to electrical power panels and feeders.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Subject to compliance with requirements, provide products by the following:
 - 1. Rigid Metal Conduit:
 - a. Allied
 - b. Wheatland
 - c. Triangle
 - d. Western Tube & Conduit

2. Intermediate Metal Conduit (IMC):
 - a. Allied
 - b. Triangle
 - c. Western Tube & Conduit

3. PVC Coated:
 - a. Rob Roy
 - b. Perma Cote
 - c. OCAL
 - d. Calbond

4. EMT Conduit:
 - a. Allied
 - b. Republic
 - c. Triangle
 - d. LTV
 - e. Western Tube & Conduit

5. Non-Metallic Conduit:
 - a. Carlon
 - b. MPF
 - c. Can-Tex
 - d. PW

6. Steel Fittings:
 - a. O/Z Gedney
 - b. Raco
 - c. Appleton
 - d. EPT
 - e. Midwest
 - f. Picoma
 - g. Steel City

7. Conduit Bodies:
 - a. O/Z Gedney
 - b. Killark
 - c. Regal
 - d. Appleton
 - e. Crouse Hinds

8. Wireway:
 - a. Square D. Co.
 - b. Circle AW Products
 - c. Erickson Electric Equipment Co.
 - d. G.S. Metals Corp.
 - e. Hoffman Engineering Co.
 - f. Wadsworth Electric Mfg. Co., Inc.

2.2 METAL CONDUIT AND TUBING:

A. Rigid Galvanized Steel Conduit (RGC):

1. Conduit: Rigid steel, zinc-coated inside and outside, threaded ends.
2. Fittings: Threaded galvanized steel, bushings shall have nylon insulated throat.

B. Intermediate Metal Conduit (IMC):

1. Conduit: Rigid intermediate grade galvanized inside and outside, threaded ends.
2. Fittings: Threaded galvanized steel, bushings shall have nylon insulated throat.

C. PVC Externally Coated Rigid Steel Conduit:

1. Conduit: Rigid steel zinc-coated with external coating of PVC.
2. Fittings: Threaded galvanized steel with external PVC coating, bushings shall have nylon insulated throat.

D. Electrical Metallic Tubing (EMT):

1. Conduit: Galvanized steel tubing.
2. Fittings: Steel compression fittings for all applications. Connectors shall have insulated throat or threaded nylon bushing.

E. Rigid Aluminum Conduit:

1. Not allowed unless otherwise noted.

F. Flexible Metal Conduit:

1. Conduit: Continuous spiral wound, interlocked, zinc-coated steel, approved for grounding.
2. Fittings: Zinc coated, malleable iron. Straight connector shall be one-piece body, female end with clamp and deep slotted machine screw for securing conduit, and threaded male end provided with a locknut. Angle connectors shall be two piece body with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and threaded male end provided with a locknut. All fittings shall be terminated with threaded bushings having nylon insulated throats.

G. Liquid-Tight Flexible Metal Conduit:

1. Conduit: Continuous spiral wound, interlocked zinc-coated steel with polyvinyl chloride (PVC) jacket, approved for grounding.
2. Fittings: Zinc coated malleable iron. Straight and angle connectors shall be the same as used with flexible metal conduit but shall be provided with a compression type steel ferrule and neoprene gasket sealing rings.

2.3 NON-METALLIC CONDUIT AND DUCTS:

A. Rigid Non-Metallic Conduit (RNC):

1. Conduit: Schedule 40 or 80 polyvinyl chloride (PVC), 90°C for direct burial or concrete encasement.
2. Fittings: Mate and match conduit type and material. Cement as recommended by manufacturer.

B. PVC and ABS Plastic Utilities Duct:

1. Conduit: Type 2 (EB) for encased burial in concrete; Type II (DB) for direct burial.
2. Fittings: Mate and match conduit type and material. Cement as recommended by manufacturer.

2.4 CONDUIT BODIES:

- A. General: Types, shapes and sizes, as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use malleable iron conduit bodies. Use bodies with threaded hubs for threaded raceways and in hazardous locations.
- C. Nonmetallic Conduit: Use nonmetallic conduit bodies.

2.5 WIREWAYS:

- A. General: Provide electrical wireways of types, grades, sizes, and number of channels for each type of service as indicated. Provide complete assembly of raceway including, but not limited to, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other components and accessories as required for complete system.
- B. Lay-In Wireways: Construct lay-in wireways with hinged covers in accordance with UL 870 with components UL listed. Construct units to be capable of sealing cover in closed position with sealing wire.
1. Connectors: Provide wireway connectors suitable for "lay-in" conductors, with connector covers permanently attached so that removal is not necessary to utilize the lay-in feature.
 2. Finish: Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Plate finish hardware to prevent corrosion. Protect screws installed toward inside of wireway with spring nuts to prevent wire insulation damage.
- C. Rain-tight Troughs: Construct in accordance with UL 870, with components UL listed.
1. Construction: 16-gauge galvanized sheet metal parts for 4" x 4" to 6" x 6" sections, and 14 gauge parts for 8" x 8" and larger sections. Provide knockouts only in bottom of troughs, with suitable adapters to facilitate attaching to other NEMA 3R enclosures. Do not use Gasketing that can rip or tear during installation, or would compromise rain-tight capability of the trough. Do not use cover screws that will protrude into the trough area and damage wire insulation.
 2. Finish: Provide 14-gauge and 16-gauge galvanized sheet metal parts with corrosion-resistant phosphate primer and baked enamel finish. Plate hardware to prevent corrosion.

2.6 CONDUIT SIZES:

- A. Conduit sizes shall be as shown on the drawings. If the conduit size is not given on the drawings, the conduit shall be sized in accordance with NEC based on the number of conductors enclosed plus a parity sized equipment ground conductor and be subject to the following minimum sizes:
1. Rigid, Intermediate, and EMT Conduit: $\frac{3}{4}$ " for all runs except lighting switch legs, 277 volt lighting branch circuits, temperature control and fire alarm which may be $\frac{1}{2}$ inch.
 2. Flexible and Liquid-Tight Flexible Conduit: $\frac{1}{2}$ " for all runs.

3. MC Cable: 3/8" to under-counter luminaires, 1/2" for all other runs.
4. Conduits used for home runs shall contain only the conductors for the circuits indicated on the drawings. Combining multiple home runs into a single conduit will not be permitted.

2.7 RACEWAY SEALING COMPOUND:

- A. Non-hardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35 deg. F (1 deg. C), withstands temperature of 300 deg. F (149 deg. C) without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials and the common metals.

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Provide notification in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 CONDUIT SCHEDULE:

- A. Raceways in all other areas shall be electrical metallic tubing unless otherwise noted.
- B. Raceways in locations subject to mechanical injury: Rigid steel galvanized conduit or intermediate metal conduit. Locations subject to mechanical injury include, but are not limited to, the following:
 1. Exposed conduits outdoors and in parking garages up to 8' A.F.G.
 2. Exposed conduits in dock areas and high/medium bay locations up to 25 feet above finished floor.
 3. Exposed conduits in a Fire Pump Room.
 4. Exposed service entrance feeders.
- C. Motor and equipment connections: Flexible metal conduit.
- D. Use flexible metal conduit inside movable partition wireways, from junction boxes to devices and between devices in casework, from outlet boxes to recessed luminaires, and for "fishing" of existing walls.
- E. Under raised computer floor: Jacketed liquid-tight flexible metallic conduit with liquid tight connectors. Jacket shall be rated for plenum application.
- F. Emergency Electrical System Circuits: All emergency and Essential Electrical system circuits shall be run totally in non-flexible metal conduit.
- G. UPS Circuits: All UPS circuits shall be run in metal conduit and shall be a completely separate raceway system from all other circuits.
- H. Rework or extensions of existing conduit shall include the use of similar materials to the existing conduit type unless otherwise noted.

3.3 INSTALLATION OF CONDUITS:

- A. General: Install electrical raceways in accordance with manufacturer's written installation instruction, applicable requirements of NEC, and as follows:
1. Conceal all conduits unless indicated otherwise, within finished walls, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.
 2. Elevation of Raceway:
 - a. Where horizontal raceway is installed near water and steam piping, route raceway above piping and as close to structure as possible and practical.
 - b. Route raceway as close to structure as possible.
 3. Complete installation of electrical raceways before starting installation of conductors within raceways.
 4. Provide supports for raceways as specified elsewhere in Division 26.
 5. Prevent foreign matter from entering raceways by using temporary closure protection.
 6. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bend is not visible above the finished slab.
 7. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
 8. Use raceway fittings that are types compatible with the associated raceway and suitable for the use and location. Install expansion fittings across all structural construction joints and expansion/deflection couplings across all structural expansion joints.
 9. Run raceways parallel and perpendicular to building elements and other equipment with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.
 10. Raceways embedded in slabs: (Allowed only by written authorization of Structural Engineer/Architect): Install with a minimum of bends, in the shortest practical distance, in middle third of the slab thickness where practical, and leave at least 1 inch concrete cover. Tie raceways to reinforcing rods or otherwise secure them to prevent sagging or shifting during concrete placement. Space raceways laterally to prevent voids in the concrete. Run conduit larger than 1 inch trade size, parallel with or at right angles to the main reinforcement; where at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Where nonmetallic conduit is used, raceways must be converted to PVC coated rigid steel conduit before rising above floor.
 11. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.
 12. Install vertical feeder conduits in exterior walls, core walls, or chase spaces. Do not install in interior wall partition areas.
 13. Run exposed and parallel raceways together. Make bends in parallel runs from the same center line so that the bends are parallel. Factory elbows may be used only where they can be installed parallel. In other cases provide field bends for parallel raceways.
 14. Make raceway joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Joints in non-metallic conduits shall be made with solvent cement in strict accordance with manufacturer's recommendations.
 15. Tighten set screws of thread less fittings with suitable tool.
 16. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. RGC and IMC shall be secured with double locknuts and an insulated metallic bushing. EMT shall be secured with one locknut and shall have nylon insulated throats or threaded

- nylon bushings from 1/2" to 1". 1-1/4" and above shall be metal with nylon insulated throats. Use grounding type bushings for feeder conduits at switchboards, panelboards, pull boxes, transformers, motor control centers, VFD's, etc.
17. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
 18. Provide nylon pull string with printed footage indicators having not less than 200 pounds tensile strength. Leave not less than 12 inches of slack at each end of the pull string. Identify with tags at each end the origin and destination of each empty conduit and indicate same on all empty or spare conduits on the as-built drawings.
 19. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-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 and elsewhere as indicated:
 - a. Where conduits enter or leave hazardous locations.
 - b. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
 - c. Where conduits enter through a foundation wall or stub-up through a slab on grade floor.
 - d. Where required by the NEC.
 20. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded plugs flush with floor.
 21. Flexible Connections: Use short length (maximum of 6 feet) of flexible conduit for recessed and semi-recessed luminaires, for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid-tight flexible conduit in wet locations. Install separate ground conductor across flexible connections. Where PVC conduit/couplings have been approved for exterior use and are exposed to sunlight, provide UV rated PVC coatings or protect with 2 coats of water based latex paint that is chemically compatible with the PVC products. Color selection shall be by Architect.
 22. PVC externally coated rigid steel conduit: Patch all nicks and scrapes in PVC coating after installing conduit.
 23. Where conduits are to be installed through structural framing members, the Contractor shall provide sleeves. The Architect/Engineer's written approval must be obtained prior to cutting, notching or drilling of structural framing members.
 24. Ream the ends of all cut and/or threaded conduit. Ends shall be cut square.
 25. Use of running threads for rigid or intermediate metallic conduit are not permitted. When threaded couplings cannot be used, provide 3 piece union or solid coupling.
 26. Route conduit through roof openings for piping and ductwork where possible; otherwise, rout through jack with pitch pocket.
 27. Conduit stub-ups from below grade or thru the slab shall be PVC coated or PVC taped rigid steel galvanized conduit and shall extend 6 inches above grade.
 28. Wherever conduits enter a structure through a foundation or basement wall below grade, grout around the conduit with water-proof grout or install entrance seals. Seals shall be OZ Type WS or approved equivalent for new construction and OZ type CSM Series for existing structures.
 29. Conduits shall not cross pipe shafts or ventilation duct openings. Where conduits must penetrate air-tight spaces or plenums, seal around the conduit with a mastic acceptable to the Architect/Engineer.

30. Install an insulated ground conductor in all conduits.
31. Where individual conduits penetrate existing fire-rated walls and floors, pack void around conduit with fire rated insulation and seal opening around conduit with UL listed foamed silicone elastomer compound. Where conduits penetrate exterior walls, new floors, or roof, provide pipe sleeve one size larger than conduit, pack void around conduit with fire rated insulation, and seal opening around conduit with UL listed foam silicone elastomer compound.
32. Where conduit sleeves penetrate fire rated floors or walls for installation of system cables, AC or MC cables, or modular wiring cables pack void around cables or empty sleeve with fire rated insulation and fill ends with fire-resistive compound. Seal opening around sleeve with UL listed foam silicone elastomer compound.
33. Use PVC-coated rigid steel or Fiberglass factory elbows for bends in plastic conduit runs longer than 100 feet, or in plastic conduit runs which have more than two bends regardless of length. Use long sweep bends for wiring larger than 350 mcm.
34. Wipe plastic conduit clean and dry before joining. Apply full even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum.
35. No PVC conduit shall be run exposed or inside stud or masonry walls unless specifically called for on the drawings. Transition from PVC to metal conduit shall be made below grade.
36. Provide separate raceway systems for each of the following:
 - a. Lighting
 - b. Power Distribution
 - c. Emergency Systems
 - d. UPS
 - e. Temperature Control
37. Paint new exposed conduits to match existing exposed conduits where installed in areas with existing painted conduits or where otherwise indicated.
38. Provide rebar and tie downs for all conduits and conduit racks to be installed with concrete or slurry to prevent conduit "float".

B. Install buried electrical line warnings per Division 26 section - "Electrical identification".

C. Install labeling as required in Division 26 section - "Electrical Identification".

3.4 INSTALLATION OF WIREWAYS:

- A. Wireways: Mechanically assemble metal enclosures and raceways to form continuous electrical conductor and connect to electrical boxes, fittings and cabinets as to provide effective electrical continuity and rigid mechanical assembly.
1. Where practicable, avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.
 2. Install expansion fittings in all raceways wherever structural expansion joints are crossed.
 3. Make changes in direction of raceway run with proper fittings, supplied by raceway manufacturer. Field bends of raceway sections are not permitted.
 4. Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any space unsupported.
 5. Use boxes as supplied by raceway manufacturer wherever junction, pull or device boxes are required. Standard electrical "handy" boxes, etc., are not permitted for use with surface raceway installations.
 6. Install an insulated grounding conductor in all wireways and surface raceways. Bond grounding conductor to all wireways and surface raceways.

7. Paint new exposed surface metal raceway to match adjacent surfaces where raceway is installed in finished areas such as lobbies, corridors, and normally occupied spaces.
8. Surface raceways and wireways are acceptable only where specifically indicated on the drawings. The proposed use of surface raceways and wireways shall be submitted for review by the Engineer prior to installation.
9. Common wireways are not acceptable for convergence of multiple circuits unless specifically indicated on the drawings. The proposed use of a common wireway shall be submitted for review by the Engineer prior to installation.
10. The proposed use of wireways above or below panelboards, switchboards, motor control centers, and other electrical equipment shall be submitted along with a layout drawing for review by the Engineer prior to installation.

3.5 ADJUSTING AND CLEANING:

- A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt and construction debris.

END OF SECTION 260533

SECTION 260534 CABINETS, BOXES, AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This section includes cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other sections. Types of products specified in this section include:
 - 1. Outlet and device boxes
 - 2. Pull and junction boxes
 - 3. Cabinets
 - 4. Hinged door enclosures
- B. Conduit-body-type electrical enclosures and wiring fittings are specified in the Division 26 Section on Raceways.

1.2 DEFINITIONS:

- A. Cabinets: An enclosure designed either for surface or for flush mounting and having a frame, or trim in which a door or doors may be mounted.
- B. Device Box: An outlet box designed to house a receptacle device or a wiring box designed to house a switch.
- C. Enclosure: A box, case, cabinet, or housing for electrical wiring or components.
- D. Hinged Door Enclosure: An enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with the walls of the box.
- E. Outlet Box: A wiring enclosure where current is taken from a wiring system to supply utilization equipment.
- F. Wiring Box: An enclosure designed to provide access to wiring systems or for the mounting of indicating devices or switches for controlling electrical circuits.

1.3 SUBMITTALS:

- A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.
- B. Submit product data for cabinets and enclosures with classification higher than NEMA 1.
- C. Shop drawings for boxes, enclosures, and cabinets that are to be shop fabricated (non-stock items). For shop fabricated junction and pull boxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Cabinets:

- a. Hoffman Engineering Co.
- b. Erickson Electrical Equipment Co.
- c. Electric Panelboard, Inc.
- d. Parker Electrical Mfg. Co.
- e. Spring City Electrical Mfg. Co.
- f. Square D Co.
- g. Circle AW

2.2 CABINETS, BOXES, AND FITTINGS, GENERAL:

- A. Electrical Cabinets, Boxes, and Fittings: Of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers including blank covers for unused boxes, knockout closures for unused openings and other accessories required for the intended use. Provide gaskets for units in damp or wet locations. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

2.3 MATERIALS AND FINISHES:

- A. Sheet Steel: Flat-rolled, code-gage, galvanized steel.
- B. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.
- C. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.
- D. Cast Metal for Boxes, Enclosures, and Covers; Copper-free aluminum except as otherwise specified.
- E. Exterior Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.
- F. Painted Interior Finish: Where indicated, white baked enamel. Emergency system cabinets and boxes shall be red.
- G. Fittings for Boxes, Cabinets, and Enclosures: Conform to UL 514B. Malleable iron or zinc plated steel for conduit hubs, bushings and box connectors.

2.4 METAL OUTLET, DEVICE, AND SMALL WIRING BOXES:

- A. General: Conform to UL 514A, "Metallic Outlet Boxes, Electrical," and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of type, shape, size, and depth to suit each location and application. For multiple device installations, use multi-gang boxes. Sectional boxes are not permitted. Provide barrier for different voltage conductors in the same box.
- B. Steel Boxes: Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports." Boxes shall be 4" square minimum with 2" depth minimum sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior/plaster rings and fixture studs.
- C. Cast-Aluminum Boxes: Copper free aluminum deep type, with threaded raceway entries/hubs, and features and accessories suitable for each location including mounting ears, threaded screw holes for devices and closure plugs.

- D. Malleable or Cast-Iron Boxes: Iron alloy, waterproof, with threaded raceway entries and features and accessories suitable for each location, including mounting ears, threaded screw holes for devices and closure plugs.

2.5 NONMETALLIC OUTLET, DEVICE, AND SMALL WIRING BOXES:

- A. General: Conform to NEMA OS 2, "Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports" and UL 514C, "Nonmetallic Outlet Boxes, Flush Device Boxes and Covers." Boxes shall be molded PVC units of type, shape, size, and depth to suit location and application.
- B. Boxes for Concealed Work: Mounting provisions and wiring entrances to suit installation conditions and wiring method used.
- C. Boxes for Exposed Work: Ultra-violet stabilized, nonconductive, high impact-resistant boxes with integrally molded raceway entrance hubs and removable mounting flanges. Boxes shall be equipped with threaded screw holes for device and cover plate mounting. Each box shall have a molded cover of matching PVC material suitable for the application.

2.6 PULL AND JUNCTION BOXES:

- A. General: Comply with UL 50, "Electrical Cabinets and Boxes", for boxes over 100 cubic inches volume. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.
- B. Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing.
- C. Hot-Dipped Galvanized Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.
- D. Stainless-Steel Boxes: Fabricate of stainless steel conforming to Type 302 of ASTM A 167, "Specification for Stainless and Heat Resisting Chromium-Nickel Steel Plate, Sheet, and Strip." Where necessary to provide a rigid assembly, construct with internal structural stainless steel bracing. Cover shall be gasketed.
- E. Cast-Aluminum Boxes: Molded of copper free aluminum, with gasketed cover and integral threaded conduit entrances and Neoprene gaskets.
- F. Malleable or Cast-Iron Boxes: Molded of iron alloy with gasketed cover and integral threaded conduit entrances.

2.7 CABINETS:

- A. Comply with UL 50, "Electrical Cabinets and Boxes."
- B. Construction: Sheet steel, NEMA 1 class except as otherwise indicated. Cabinet shall consist of a box and a front consisting of a one piece frame and a hinged door. Arrange door to close against a rabbet placed all around the inside edge of the frame, with a uniform close fit between door and frame. Provide concealed fasteners, not over 24 inches apart, to hold fronts to cabinet boxes and provide for adjustment. Provide flush or concealed door hinges not over 24 inches apart and not over 6 inches from top and bottom of door. For flush cabinets, make the front approximately $\frac{3}{4}$ " larger than the box all around. For surface mounted cabinets make front same height and width as box.

- C. Doors: Double doors for cabinets wider than 24 inches.
- D. Locks: Combination spring catch and key lock, with all locks for cabinets of the same system keyed alike. Locks may be omitted on signal, power, and lighting cabinets located within wire closets and mechanical-electrical rooms. Locks shall be of a type to permit doors to latch closed without locking.

2.8 STEEL ENCLOSURES WITH HINGED DOORS:

- A. Comply with UL 50, "Cabinets and Enclosures" and NEMA ICS 6, "Enclosures for Industrial Controls and Systems."
- B. Construction: Sheet steel, 16 gage, minimum, with continuous welded seams. NEMA class as indicated; arranged for surface mounting.
- C. Doors: Hinged directly to cabinet and removable, with approximately $\frac{3}{4}$ inch flange around all edges, shaped to cover edge of box. Provide handle operated, key locking latch. Individual door width shall be no greater than 24 inches. Provide multiple doors where required.
- D. Mounting Panel: Provide painted removable internal mounting panel for component installation.
- E. Enclosure: NEMA 1 except as indicated. Where door gasketing is required, provide neoprene gasket attached with oil-resistant adhesive, and held in place with steel retaining strips. For all enclosures of class higher than NEMA 1, use hubbed raceway entrances.

2.9 CAST METAL ENCLOSURES WITH HINGED DOORS:

- A. Copper free aluminum with bolted, hinged doors. Where used at hazardous (classified) locations, enclosures shall conform to UL and shall be listed and labeled for the classification of hazard involved.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL:

- A. Locations: Install items where indicated and where required to suit code requirements and installation conditions. Coordinate box locations with Architectural elements including casework, backsplash, door swings, etc.
- B. Cap with Knock out closures all unused knockout holes where blanks have been removed and plug unused conduit hubs.
- C. Support and fasten items securely in accordance with Division 26 Section on Supporting Devices.
- D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated. Size boxes to accommodate wire pulling, splices, taps, equipment connections and code compliance.
- E. Remove sharp edges where they may come in contact with wiring or personnel.

3.2 APPLICATIONS:

- A. Cabinets: Flush mounted, NEMA enclosure type 1 except as otherwise indicated.

- B. Hinged Door Enclosures Indoor: NEMA type 1 enclosure except as indicated.
- C. Hinged Door Enclosures Outdoors: NEMA Type 4. Install drip hood, factory tailored to individual units.
- D. Hinged Door Enclosures in Corrosive Locations: NEMA type 4X nonmetallic enclosure.
- E. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types suitable for each location and in conformance with the following requirements:
 - 1. Interior Dry Locations: Sheet steel, NEMA Type 1.
 - 2. Locations Exposed to Weather or Dampness: Cast metal, NEMA type 3R.
 - 3. Wet Locations: NEMA Type 4 enclosures.
- F. Pull and Junction Boxes: Install pull and junction boxes of materials and NEMA types suitable for each location except as otherwise indicated.

3.3 INSTALLATION OF OUTLET BOXES:

- A. Column and Pilaster Locations: Locate outlet boxes for switches and receptacles on columns or pilasters so the centers of the columns are clear for future installation of partitions.
- B. Locations in Special Finish Materials: For outlet boxes for receptacles and switches mounted in desks or furniture cabinets or in glazed tile, concrete block, marble, brick, stone or wood walls, use rectangular shaped boxes with square corners and straight sides. Install such boxes without plaster rings. Saw cut all recesses for outlet boxes in exposed masonry walls.
- C. Gasketed Boxes: At the following locations use malleable or cast metal, threaded hub type boxes with gasketed weatherproof covers:
 - 1. Exterior locations.
 - 2. Where surface mounted on unfinished walls, columns or pilasters. (Cover gaskets may be omitted in dry locations).
 - 3. Where exposed to moisture laden atmosphere.
 - 4. At food preparation equipment within four ft. of steam connections.
 - 5. High traffic areas (surface installations).
 - 6. Where indicated.
- D. Mounting: Mount outlet boxes for switches with the long axis vertical or as indicated. Mount boxes for receptacles vertically, except above counter receptacles to be mounted horizontally. Three or more gang boxes shall be mounted with the long axis horizontal. Locate box covers or device plates so they will not span different types of building finishes either vertically or horizontally. Locate boxes for switches near doors on the side opposite the hinges and close to door trim, even though electrical floor plans may show them on hinge side. Provide far side box supports, for electrical switch boxes installed on metal studs and provide stud to stud support for electrical receptacle boxes installed on metal studs.
- E. Ceiling Outlets: For fixtures, where wiring is concealed, use outlet boxes 4 inches square by 1-1/2 inches deep, minimum.
- F. Cover Plates for Surface Boxes: Use plates sized to box front without overlap.
- G. Protect outlet boxes to prevent entrance of plaster, and debris. Thoroughly clean foreign material from boxes before conductors are installed.

- H. Existing Outlet Boxes: Where extension rings are required to be installed, drill new mounting holes in the rings to align with the mounting holes on the existing boxes where existing holes are not aligned.
- I. Back to back outlet boxes are not permitted. Separate boxes a minimum of 6 inches in standard walls and 24 inches in acoustical walls.

3.4 INSTALLATION OF PULL AND JUNCTION BOXES:

- A. Box Selection: For boxes in main feeder conduit runs, use sizes not smaller than 8 inches square by 4 inches deep. Do not exceed 6 entering and 6 leaving raceways in a single box. Quantities of conductors (including equipment grounding conductors) in pull or junction box shall not exceed the following:

Size of Largest Conductors <u>in Box</u>	Maximum no. of Conductors in <u>Box</u>
No. 4/0 AWG	30
250 MCM	20
500 MCM	15
Over 500 MCM	10

- B. Cable Supports: Install clamps, grids, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30 inches inside boxes.
- C. Mount pull boxes in inaccessible ceilings with the covers flush with the finished ceiling. Where possible, locate pull and junction boxes above accessible ceilings in finished areas.
- D. Size: Provide pull and junction boxes for telephone, signal, and other systems at least 50 percent larger than would be required by Article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

3.5 INSTALLATION OF CABINETS AND HINGED DOOR ENCLOSURES:

- A. Mount with fronts straight and plumb.
- B. Install with tops 78 inches above floor.
- C. Set cabinets in finished spaces flush with walls.

3.6 GROUNDING:

- A. Electrically ground metallic cabinets, boxes, and enclosures. Where wiring to item includes a grounding conductor, provide a grounding terminal in the interior of the cabinet, box or enclosure.

3.7 CLEANING AND FINISH REPAIR:

- A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.
- B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the tray manufacturer.

- C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating.

END OF SECTION 260534

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:

1. Identification labeling for raceways, cables, and conductors.
2. Operational instruction signs.
3. Warning and caution signs.
4. Equipment labels and signs.

- B. Identification required in this section shall apply to equipment furnished in Division 26 and any other applicable Divisions including Division 23.

1.2 SUBMITTALS:

- A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.

- B. Product Data for each type of product specified.

- C. Submit schedule of identification nomenclature to be used for identification signs and labels for each piece of equipment including, but not be limited to, the following equipment types as specified in Division 26.

1. Cabinets and enclosures
2. Switchboards
3. Panelboards
4. Disconnect switches
5. Circuit breakers and switches
6. Starters
7. Variable frequency drives

- D. Submit samples of each color, lettering style and other graphic representation required for identification materials including samples of labels and signs.

1.3 QUALITY ASSURANCE:

- A. ANSI Compliance: Comply with requirements of ANSI Standard A13.1, "Scheme for the Identification of Piping Systems," with regard to type and size of lettering for raceway and cable labels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Ideal Industries, Inc.
2. LEM Products, Inc.
3. Markal Corp.

4. Panduit Corp.
5. W.H. Brady, Co.
6. 3M Company

2.2 ELECTRICAL IDENTIFICATION PRODUCTS:

- A. Provide colored Adhesive Marking Tape for banding Wires and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width. Make each color band completely encircling cables, at penetrations of walls and floors, at each junction box and at 20-foot maximum intervals in straight runs.
- B. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
- C. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Engraved legend in white letters on black face for normal and white letters on red face for emergency, black letters on yellow face for UPS and punched for mechanical fasteners. Where required for ground connections, provide engraved legend in white letters on green face.
- D. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws when screw ends do not protrude into working areas of equipment otherwise use number 10/32 stainless steel machine screws with nuts and flat and lock washers or rivets.
- E. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50 lb. minimum tensile strength, and suitable for a temperature range from minus 50 degrees F to 350 degrees F. Provide ties in specified colors when used for color coding.
- F. Adhesive Marking Tape for Device Cover Plates: 3/8 inch Kroy tape or Brother labels with 3/16 inch minimum height letters. Tape shall have black letters on clear background for normal and red letters on clear background for emergency. Embossed Dymo-Tape labels are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code. Clean surfaces to receive nameplates and labels and install nameplates and labels on front of equipment parallel with equipment/raceway/cable/wire/etc. lines.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- D. Identify Junction, Pull and Connection Boxes: Identification of systems and circuits shall indicate system voltage and identity of contained circuits on outside of box cover. Color code shall be same as raceway systems. Use self-adhesive marking tape labels at exposed locations and indelible black marker at concealed boxes.

- E. Circuit Identification: Tag or label conductors as follows:
1. Multiple Circuits: Where multiple branch circuits, control wiring or communications/signal conductors are terminated or spliced in a box or enclosure, label each conductor or cable with circuit number. For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
 2. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- F. Apply warning, caution and instruction signs and stencils as follows:
1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
 2. Emergency Operating Signs: Install, where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8 inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
 - a. Provide sign at main service entrance switch, indicating type and location of on-site stand-by generator as required by NEC. Sign shall read "Secondary Source Provided by Engine Generator Located in Room NAME and NUMBER".
- G. Install equipment/system circuit/device identification as follows:
1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own self-explanatory identification. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.
 - a. Panelboards, electrical cabinets and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchboards.
 - d. Motor starters.
- H. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere.
- I. For panelboards, provide framed, typed circuit schedules (label all spares and spaces in pencil) with explicit description and identification of items controlled by each individual breaker.
- J. Tag all grounding electrode conductors, associated bonding conductors, and grounding conductors at their point of attachment to any ground bus and grounding electrode (where possible) with a 2 inch diameter round green phenolic nameplate. Lettering shall be 1/4 inch

high with 1/5 inch between lines centered on the tag stating "DO NOT DISCONNECT," "MAIN GROUND." Nameplate shall attach to conductor with a short length of small chain.

- K. Install labels at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- L. Provide adhesive marking tape labels for identification of individual receptacles including receptacles in furniture systems and light switch wall-plates. Locate tape on front of plate and identify panel and branch circuit serving the receptacle. Provide tape labels for identification of individual switches or thermal overload switches which serve as equipment disconnects. Locate the tape on the front of the cover-plate and identify panel and branch circuit serving the equipment.

END OF SECTION 260553

SECTION 260583 – WIRING CONNECTIONS

PART 1 - GENERAL

1.1 SUMMARY:

- A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.
- B. Applications of electrical power connections specified in this section include the following:
 - 1. To resistive heaters.
 - 2. From electrical source to motor starters.
 - 3. From motor starters/motor controllers/VFD's/etc. to motors.
 - 4. To grounds including earthing connections.
 - 5. Other connections as shown.

1.2 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, soldering fluxes, and cable ties, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firms with at least 2 years of successful installation experience with projects utilizing electrical connections for equipment similar to that required for this project.

1.3 SUBMITTALS:

- A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.
- B. Product Data: Submit manufacturer's data on electrical connections for equipment products and materials. All mechanical and plumbing equipment shall be coordinated with unit nameplate information per the actual nameplate to be included on the equipment. As a minimum, information shall include: Operating Voltage; MCA (Min. circuit amperes); FLA (Full load amperes); MFS (Max. fuse size) or MOP (Max. overcurrent protection); and SCCR (Short Circuit Current Rating) and shall match electrical equipment and protection/distribution sizes and be rated for available short circuit currents as shown on the drawings. Bracing for equipment shall be provided at incoming terminals and as an option throughout the equipment for the available fault current or downstream equipment and devices shall be protected by current limiting fuses.

1.4 DEFINITIONS:

- A. Load voltage wiring shall be defined as:
 - 1. Conduit and wiring required to carry power to motors and other equipment or devices. Wiring from control devices to equipment that carry power to drive that equipment such as line voltage thermostats, etc., shall be included as load voltage wiring. Wiring that provides power to control panels, control transformers, control relays, time clocks, etc., shall also be included as load voltage wiring.

1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver electrical connection products wrapped in proper factory fabricated type containers.
- B. Store electrical connection products in original cartons and protect from weather, construction traffic and debris.
- C. Handle electrical connection products carefully to prevent breakage, denting, and scoring finish.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide circuit and motor disconnects by one of the following:
 - 1. Square D Company
 - 2. General Electric Co.
 - 3. Eaton
 - 4. Siemens Energy & Automation, Inc.
 - 5. Westinghouse Electric Corp.

2.2 GENERAL:

- A. Overcurrent Protective Devices (OCPDs): Provide type, rating, and features as indicated. Comply with Division 26 Section on Low Voltage Circuit Protective Devices, with OCPDs adapted to equipment connection installation. Tandem circuit breakers shall not be used. Multiple breakers shall have common trip.
- B. Provide motor controllers that are horsepower rated to suit the motor controlled.
- C. Contacts shall open each ungrounded connection to the motor. Contacts shall be NEMA rated, 75 degrees C.
- D. Overload relays shall be ambient-compensated type with inverse-time-current characteristic. Provide with heaters or sensors in each phase matched to nameplate full load current of the specific motor to which connected with appropriate adjustment for duty cycle and power factor correction supplied with the motor.

2.3 MATERIALS AND COMPONENTS:

- A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, disconnect, starter, contactor, relays, etc., and other items and accessories as needed to complete splices and terminations of types indicated.
- B. Metal Conduit, Tubing and Fittings:
 - 1. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Provide products complying with Division-26 section on Raceways.
- C. Wires, Cables, and Connectors:

1. General: Provide wires, cables, and connectors complying with Division-26 section on Wires and Cables.
2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes, ratings, and material of wires/cables which are supplying electrical power.
3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications.
4. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wire-nuts and cable ties as recommended for use by accessories manufacturers for type services indicated.
5. Cord and Plug Connected Equipment: Where indicated, contractors shall provide a length of SO cord complete with a straight blade or twist-lock receptacle for connection of equipment. Cord and plug rating shall be suitable for the connected equipment load and rating of the branch circuit overcurrent protective device. Plug shall match receptacle configuration included on the plans and cord length shall be as required. Contractor shall connect cord to equipment.

2.4 MANUAL MOTOR STARTERS:

- A. Manual starters shall be flush-mounting type except where conduits are run exposed or as otherwise noted. Manual starters shall be complete with properly sized overload protection and neon pilot light. Manual starters shall be Square D Class 2510 or Allen-Bradley Bulletin 600 with stainless steel plates. Handles shall be lockable in open and closed position without modification.
- B. Heater units in all manual motor starters shall be sized for approximately 115 percent of full load motor current. Check and coordinate all thermal protective devices with the equipment they protect.

2.5 CIRCUIT AND MOTOR DISCONNECT SWITCHES:

- A. General: Provide circuit and motor disconnect switches in types, sizes, duties, features, ratings, and enclosures as indicated. All equipment with maximum fuse size listed in nameplate shall have fusible disconnect switch provided. Provide NEMA 1 enclosure. For outdoor switches and switches indicated as weatherproof, provide NEMA 3R enclosures with rain-tight hubs. For motor and motor starter disconnects, provide units with horsepower ratings suitable to the loads.
- B. Fusible Switches: Provide UL type "HD" 100 percent duty rated switches, with fuses of classes and current ratings indicated. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses. All disconnect switches shall be fusible unless otherwise noted.
- C. Non-fusible Disconnects: Provide UL type "HD" 100 percent duty rated switches of classes and current ratings as indicated.
- D. Accessories:
 1. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated or required.
 2. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
 - a. Stainless Steel Type 304: For NEMA Type 4.

- b. Molded Fiberglass Reinforced Plastic: For NEMA Type 4x.
 - c. Heavy Cast Aluminum: For hazardous locations. NEMA Types 7 through 9.
- 3. Handles shall be lockable in open and closed position without modification.
 - 4. Disconnect switches provided in the motor feeders between a VFD and the motor shall be provided with auxiliary contacts at the disconnect that de-energizes power to the VFD.

2.6 MOTOR STARTERS:

- A. See Division 23 for Requirements

PART 3 - EXECUTION

3.1 INSPECTION:

- A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL CONNECTIONS:

- A. Furnish, set in place, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, plumbing and fire protection, elevator, etc., motors and controls in accordance with the following schedule and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements. Carefully coordinate with work performed under the Mechanical Division of these Specifications.
- B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. Maintain existing electrical service and feeders to equipment serving occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.
- E. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
- F. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.
- G. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

- H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torqueing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torqueing requirements are not available, tighten connectors and terminals to comply with torqueing values contained in UL's 486A.
- I. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
- J. Provide suitable strain relief clamps for cord connection to outlet boxes and equipment connection boxes.
- K. Make wiring connections in control panel or in wiring compartment of pre-wired equipment and interconnecting wiring in accordance with manufacturer's instructions.
- L. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated or per manufacturer's instructions.
- M. Provide each motor with a fused disconnect switch for 3 phase motors and horsepower rated and/or thermal rated disconnect switch for single phase motors as shown on schedules or required. Coordinate with manufacturers of standalone, packaged and other equipment for factory installed and field installed motors and controllers.
- N. Provide circuit and motor disconnect switches as indicated and where required by Code. Comply with switch manufacturers printed installation instructions. Install within sight of motors.
- O. All splices in control panels, terminal junction boxes, low voltage control circuits and fire alarm conductors shall be on numbered terminal strip.
- P. Each branch circuit serving dedicated, isolated or emergency receptacles, multi-outlet assemblies or equipment connections shall be furnished with a dedicated neutral conductor. Neutrals common to more than one circuit shall only be permitted where specifically noted.
- Q. Where conduit is not required, plenum rated cable shall be provided in ceiling, floor or other air plenum spaces.

3.3 FIELD QUALITY CONTROL:

- A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

3.4 EQUIPMENT CONNECTION SCHEDULES:

A. Mechanical Equipment:

1. Refer to Mechanical Equipment Schedule on the drawings.
2. It is suggested that all load voltage wiring shall be provided under Division 26.
3. Unless otherwise indicated, it is suggested that all equipment motors and control shall be furnished, set in place, and wired in accordance with the schedule contained herein. The exact furnishing and installation of the equipment is left to the Contractors involved. Contractor should note that the intent of this schedule is to have the Contractor responsible for coordinating all wiring as outlined, whether or not specifically called for by

the Division 23 or Division 26 drawings and specifications. Comply with the applicable requirements of Division 26 for all electrical work which is not otherwise specified. No extras will be allowed for contractor's failure to provide for these required items. Contractor shall refer to the Division 26 and Division 23 specifications and plans for all power and control wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

ITEM	FURNISHED BY	SET BY	CONTROL WIRING (non-load voltage)
1. Mechanical Equipment Motors	M	M	--
2. Special Equipment (i.e., elevators, etc.)			
a. Motors	G	G	--
b. Magnetic Motor Starters	G	E*	--
c. Disconnect Switches	E	E	--
d. Thermal OL Switches			
e. Manual Operating Switches			
3. Motor Starters, combination motor starter/disconnect and Variable Frequency Drives			
a. Automatically controlled, with or without HOA switches.	M	E*	M
b. Manually controlled.	M	E*	--
c. Starters integral with motor control center including control relays and transformers.	E	E	--
d. Combination Starter/Disconnects	M	E*	M
4. Pushbutton stations, pilot lights	M	E*	M
5. Disconnect switches, thermal overload switches, manual operating switches.	E	E*	M
6. Multi-speed switches	M	E*	M
7. Control relays, transformers.	M	M	M
8. Load voltage control items such as line voltage thermostats not connected to control panel systems.	M	M	E
9. Non-load voltage control items.	M	M	M
10. Electric thermostats, remote bulb thermostats, motor valves, float controls, etc., which are an integral part of mechanical equipment or directly attached to ducts, pipes, etc.	M	M	M
11. Motor valves, damper motor, solenoid valves, EP and PE switches, VAV box controls, actuators, etc.	M	M	M**
12. Control circuit outlets	E	E	--
a. Load voltage control items such as line voltage thermostats not connected to control panel systems.	M	M	E
b. Non-load voltage control items.	M	M	M

ITEM	FURNISHED BY	SET BY	CONTROL WIRING (non-load voltage)
c. Electric thermostats, remote bulb thermostats, motor valves, float controls, etc., which are an integral part of mechanical equipment or directly attached to ducts, pipes, etc.	M	M	M
d. Motor valves, damper motor, solenoid valves, EP and PE switches, VAV box controls, actuators, etc.	M	M	M**
e. Control circuit outlets	E	E	--
13. Load voltage control items such as line voltage thermostats not connected to control panel systems.	M	M	E
14. Non-load voltage control items.	M	M	M
15. Electric thermostats, remote bulb thermostats, motor valves, float controls, etc., which are an integral part of mechanical equipment or directly attached to ducts, pipes, etc.	M	M	M
16. Motor valves, damper motor, solenoid valves, EP and PE switches, VAV box controls, actuators, etc.	M	M	M**
17. Control circuit outlets	E	E	--
18. Load voltage control items such as line voltage thermostats not connected to control panel systems.	M	M	E
19. Non-load voltage control items.	M	M	M
20. Duct smoke detectors, including relays for fan shutdown.	E	M	M**
21. Temperature Control Panel	M	M	M
22. Interlocks	M	M	M

G = General, Division 13 or 14
M = Mechanical, Division 23
E = Electrical, Division 26

* For factory pre-wired equipment specified under other Divisions, all wiring within the equipment shall be by the manufacturer. All required field wiring between sections or other field connection details for power and/or control shall be clearly identified on shop drawings for contractor installation. Division 26 drawings show the provided electrical characteristics for equipment.

Manufacturer's equipment provided under other divisions which varies from what is shown on Division 26 drawings shall be the responsibility of the Contractor to complete and pay for any costs for those variations.

** Fire alarm system control modules and wiring from fire alarm contacts to fire alarm system shall be installed by Fire Alarm system installer and match other components of the system. Refer to Division 28. See details.

*** Integral control wiring under Electrical Division as manufacturer supplied equipment. Control wiring for automatic control portion under Mechanical Division.

END OF SECTION 260583

SECTION 262800 - LOW-VOLTAGE CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY:

- A. This section includes overcurrent protective devices (OCPD's) rated 600 V and below and switching devices commonly used with them.
- B. Panelboards and Switchboards: Application, installation, and other related requirements for overcurrent protective device installations in distribution equipment are specified in other Division 26 sections.

1.2 DEFINITIONS:

- A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.
- B. Ampere-Squared-Seconds: An expression of available thermal energy resulting from current flow. With regard to current-limiting fuses and circuit breakers, the ampere-squared-seconds during fault current interruption represents the energy allowed to flow before the fuse or breaker interrupts the fault current within its current limiting range.

1.3 SUBMITTALS:

- A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.
- B. Product data for fuses, fusible switches, circuit breakers, and OCPD accessories specified in this Section, including descriptive data and time-current curves for all protective devices and let-through current curves for those with current limiting characteristics. Include coordination charts and tables and related data.
- C. Submit documentation of compliance with Code and Specification requirements for circuit protective devices including but not limited to SCCR, Listings for use with downstream breakers/fuses and equipment where required, Ground Fault protection; Arc Flash reduction for breakers above 1200A; Surge Protection; Metering; Relaying; etc.

1.4 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of overcurrent protective devices of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Each type of OCPD shall be the product of a single manufacturer.

PART 2 - PRODUCTS:

2.1 MANUFACTURERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Cartridge Fuses:
 - a. Bussmann Div., Cooper Industries, Inc.

- b. Littelfuse Inc.
 - c. Mersen
2. Fusible Switches:
- a. General Electric Co.
 - b. Square D Co.
 - c. Allen-Bradley Co.
 - d. Siemens Energy & Automation, Inc.
 - e. Eaton
3. Molded-Case Circuit Breakers:
- a. Square D Co.
 - b. General Electric Co.
 - c. Siemens Energy & Automation, Inc.
 - d. Eaton
4. When mounting overcurrent protective devices in switchboards, panelboards, etc., provide equipment of same manufacturer as equipment into which they are being mounted.

2.2 OVERCURRENT PROTECTIVE DEVICES (OCPDS), GENERAL:

- A. General: Provide OCPDs in indicated types, as integral components of panelboards, switchboards, motor control centers, and other related equipment; and also as individually enclosed and mounted single units.
- B. Enclosures: NEMA 250 "Enclosures for Electrical Equipment (1,000 Volts Maximum)."
- C. Where OCPD's are to be installed in existing panelboards, switchboards, and motor control centers, they shall be of the same manufacture and type as those existing in the equipment. If this is not possible, provide devices which are compatible with the existing equipment and when installed will not void the U.L. label or reduce the short circuit rating of the equipment.
- D. All overcurrent devices shall be individually rated for the available fault current unless otherwise noted. Series ratings of equipment will only be allowed where specifically called out.

2.3 CARTRIDGE FUSES:

- A. General: NEMA Standard FU1, "Low-Voltage Cartridge Fuses." Unless indicated otherwise, provide nonrenewable cartridge fuses of indicated types, classes, and current ratings that have voltage ratings consistent with the circuits on which used.
- B. All fuses used for main, feeder, or branch-circuit protection shall be Underwriters Laboratories listed, current-limiting fuses with 200,000 ampere interrupting rating and shall be so labeled. Fuses used for supplementary protection (other than branch circuit protection) shall be as specified above or shall be U.L. approved or component recognized for such purposes. All fuses provided shall be furnished by the same manufacturer. Should equipment provided require a different U.L. Class or size of fuse, the engineer shall be furnished sufficient data to ascertain that system function will not be adversely affected.
- C. In order to simplify fuse replacement, reduce spare fuse inventory and insure adequate thermal protection, all fuses 600 amperes and below shall be true dual-element time-delay fuses with

separate spring-loaded thermal overload elements in all ampere ratings. All ampere ratings shall be designed to open at 400 degrees F or less when subjected to a non-load oven test.

- D. To eliminate induction heating, all fuse ferrules and end caps shall be non-ferrous and shall be bronze or other alloy not subject to stress cracking.
- E. Class L Fuses: UL 198C, "High-Interrupting Capacity Fuses, Current-Limiting Type."
- F. Class RK1 Dual Element Time-Delay Fuses: UL 198E, "Class R Fuses."
- G. Class J Low-Peak dual Element Fuse: UL 198C

2.4 FUSIBLE SWITCHES:

- A. General: UL 98 "Enclosed and Dead Front Switches" and NEMA KS 1 "Enclosed Switches," quick-make, quick-break heavy-duty units.
- B. Rating: Load-breaking capacity in excess of the normal horsepower rating for the switch.
- C. Withstand Capability: In excess of the let-through current permitted by its fuse when subject to faults up to 100,000 RMS symmetrical amperes.
- D. Operation: By means of external handle.
- E. Interlock: Prevents access to switch interior except when in "off" position.
- F. Fuse Clips: Rejection type.
- G. Enclosure for Switchboard or Panel board Mounting: Suitable for panel mounting where indicated.
- H. Enclosure for Independent Mounting: Provide NEMA Type 1 enclosure except as otherwise indicated or required to suit environment where located.
- I. Contacts shall be NEMA rated 75 degrees C.
- J. Provide fuses for safety switches and other equipment of classes, types, and rating needed to fulfill electrical requirements for services indicated.
- K. Provide auxiliary contacts for disconnects supplied from variable frequency drives.

2.5 MOLDED-CASE CIRCUIT BREAKERS:

- A. General: UL 489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures," and NEMA AB 1, "Molded Case Circuit Breakers."
- B. Construction: Provide bolt-in type, except breakers 225-ampere frame size and larger which may be plug-in type if held in place by positive locking device requiring mechanical release for removal.
- C. Characteristics: Indicated frame size, trip rating, number of poles, and a short-circuit interrupting capacity rating as indicated or required to match existing devices or equipment.

- D. Tripping Device: Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous overcurrent trip protection for each pole. Trip unit to be interchangeable within frame sizes for breakers 200 amperes or larger. Breakers 150 amperes and above shall have adjustable trip selection for trip units. All 120/208 volt rated breakers shall be rated and labeled "High Magnetic".
- E. Enclosure for Switchboard or Panelboard Mounting: Suitable for panel mounting in switchboard

PART 3 - EXECUTION:

3.1 INSTALLATION:

- A. Independently Mounted OCPDs: Locate as indicated and install in accordance with manufacturer's written installation instructions. Install OCPDs level and plumb.
- B. OCPDs in new distribution and branch circuit equipment shall be factory installed. OCPD's in existing distribution and branch circuit equipment shall match existing for type and be provided with features as listed herein.
- C. Install fuses in fusible devices as indicated. Arrange fuses so that fuse ratings are readable without removing fuse.
- D. All fuses for new disconnect switches feeding motors or motor starters shall be provided with Class J fuses.
- E. OCPDs and mounting accessories installed in existing equipment shall match the existing manufacturer and be rated for the available fault current.

3.2 IDENTIFICATION:

- A. Identify components in accordance with Division 26 Section on electrical identification.

3.3 CONTROL WIRING INSTALLATION:

- A. Install wiring between OCPDs and control/indication devices.

3.4 CONNECTIONS:

- A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

3.5 GROUNDING:

- A. Provide equipment grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.6 FIELD QUALITY CONTROL:

- A. Reports: Prepare written reports on tests and observations. Report defective materials and workmanship, and unsatisfactory test results. Include complete records of repairs and

adjustments made. Tests shall be made on all new and existing OCPD's provided and/or connected under this project in accordance with this section.

- B. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.
 - C. Schedule visual and mechanical inspections and electrical tests with at least one week's advance notification.
 - D. Upon completing installation of the system, perform the following tests on all new equipment and existing equipment as indicated on the drawings:
 - 1. Visual and mechanical inspection: Include the following inspections and related work.
 - a. Overcurrent-Protective-Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters.
 - b. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.
 - c. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 - d. Check tightness of electrical connections of OCPD's with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
 - e. Clean OCPD's using manufacturer's approved methods and materials.
 - f. Verify installation of proper fuse types and ratings in fusible OCPD's.
 - 2. Electrical Tests: Perform the following tests in accordance with manufacturer's instructions:
 - a. Make insulation resistance tests of OCPD buses, components, and connecting supply, feeder, and control circuits.
 - b. Make continuity tests of circuits.
 - E. Check stored-energy charging motors for proper operation of motor, mechanism, and limit switches.
 - F. Check operation of electrically operated OCPDs in accordance with manufacturer's instructions.
 - G. Check key and other interlock and safety devices for operation and sequence. Make closing attempts on locked-open and opening attempts on locked-closed devices including moveable barriers and shutters.
 - H. Retest: Correct deficiencies identified by tests and observations and provide retesting of OCPDs by testing organization. Verify by the system tests that specified requirements are met.
- 3.7 CLEANING:
- A. Upon completion of installation, inspect OCPD's. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.
- 3.8 DEMONSTRATION:
- A. Training: Arrange and pay for the services of factory-authorized service representatives to demonstrate OCPD's and train Owner's maintenance personnel.

- B. Conduct a minimum of one half day of training in operation and maintenance as specified under in the Project Closeout Section of these specifications. Include both classroom training and hands-on equipment operation and maintenance procedures.
- C. Schedule training with at least seven days' advance notification.

END OF SECTION 262800