

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

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS:**

- A. All drawings associated with the entire project, including the General Conditions of the Contract for Construction, General and Supplementary Conditions, and Division 01 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 01, 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. It expands and supplements the requirements specified in other sections of Division 01 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 and the installation shall be worked out during construction.
- C. Conflicting Requirements: Where compliance with two or more standards is specified, and the standards establish different or conflicting requirements for minimum quantities or quality levels, clarify uncertainties with the Engineer prior to quotation.
  - 1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum, as appropriate for the context of the requirements. Refer uncertainties to the Engineer for a decision before proceeding.
  - 2. Clarification methods: At the time of bidding, bidders shall familiarize themselves with the drawings and specifications. Any questions, misunderstandings, conflicts, deletions, discontinued products, catalog number discrepancies, discrepancies between the equipment supplied and the intent or function of the equipment, etc., shall be submitted to the Engineer in writing for clarification prior to issuance of the final addendum and bidding of the project. Where discrepancies or multiple interpretations occur, the most stringent (which is generally recognized as the most costly) that meets the intent of the documents shall be enforced.

- D. 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.
- E. 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.
- F. 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.
- G. 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.
- H. Verify all dimensions by field measurements.
- I. Arrange for chases, slots, and openings in other building components to accommodate electrical installations.
- J. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work.
- K. 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.
- L. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting and removal with minimum of interference with other installations.
- M. Make allowance for expansion and contraction for all building electrical components and conduit systems that are subject to such.
- N. In general, all conduit systems shall be routed as high as possible. Keep all equipment in accessible areas and coordinate with systems and equipment from other sections.
- O. 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/or 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, boxes, conduit, disconnects, etc., necessary to overcome congested conditions at no increase in contract sum. The Contractor's 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. Refer to individual sections for requirements.

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 required coordination drawings showing major elements, components, and systems of electrical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale, large enough to indicate required detail, and showing the necessary dimensions. 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.
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. 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.
7. For projects where any portion of the electrical is sub-contracted to Greiner Electric; Cator, Ruma, and Associates will not release any shop drawings until a coordination drawing, meeting all requirements within these specifications, has been submitted and approved for every area of construction indicated on the Electrical plans. Start of work constitutes a material requirement for the aforementioned Coordination Drawings. Contractor shall bear any and all costs associated with changes that are not specifically addressed on the Coordination Drawings that were reviewed by the Engineer of Record.

D. Existing Conditions:

1. Contractor shall carefully survey existing conditions prior to bidding work.
2. Provide proper coordination of electrical work with existing conditions.
3. Contractor shall report any issues or conflicts immediately to Engineer before commencing with work and prior to purchasing equipment and materials. Start of work indicates acceptance of conditions.

**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. Support Dimensions: Provide dimensions and drawings so that equipment supports to be provided under other sections of the specifications can be built at the proper time.

- C. Modifications required as result of failure to resolve interferences, provide correct coordination drawings or call attention to changes required in other work as result of modifications shall be paid for by Contractor.

**1.6 DESIGN WORK REQUIRED BY CONTRACTOR:**

- A. The construction of this project requires the Contractor to include the detailing and design of select 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. Equipment supports, hangers, anchors and seismic systems

**1.7 PROJECT CONDITIONS:**

- A. The contractor shall attend a pre-bid walk-thru with Owner and Engineer; and shall make themselves familiar with the existing conditions. No additional costs to the Owner shall be accepted for additional work associated with existing conditions that are readily available for investigation.
- B. Provide field verification of all electrical conditions and possible building interferences 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 Engineer, 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 when connecting to existing systems.
- G. Coordinate all services shut-down with the Owner; provide temporary services. Coordinate any required disruptions with Owner, at a minimum one week in advance.
- H. Minimize disruptions to operation of electrical systems in occupied areas.
- I. After entering into contract, Contractor will be held to complete all work necessary to meet the intent of the engineered system shown on the Construction Documents and defined within these specification requirements without additional expense to the Owner.

**1.8 SAFETY:**

- A. Refer to Division 01.

**1.9 EQUAL EMPLOYMENT OPPORTUNITY REQUIREMENTS:**

- A. Refer to Division 01 and conform with the Owners requirements.

**1.10 REQUIREMENTS OF REGULATORY AGENCIES:**

- A. Refer to Division 01.
- 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 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. 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 01.
- B. Contractor shall arrange for and pay for all permits, 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.

**1.13 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 01.
- 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 01.
- 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. Substituted equipment will only be allowed where specifically listed in a written addendum. 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 may be submitted for substituted prior to bidding. This may be done by submitting to the 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 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 or which does not have prior approval.

**1.15 SUBMITTALS:**

- A. General
  - 1. Refer to the Conditions of the Contract listed herein as well as in Division 01.
  - 2. Contractor shall provide a submittal schedule appropriate for the size and duration 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.
  - 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 shall adequate annotation to indicate the equipment/materials/etc. within the section. Submittals with incomplete 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. Specification Section
    - c. Manufacturer and Model Number
- B. Basis of Design: The manufacturer's material or equipment listed first in the specifications or on the drawing key notes are the basis of design and are provided for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the first names, the cost of any changes in construction required by their use shall be borne by this Contractor. Product names

used in construction details are not necessarily considered to be basis of design and specific operating parameters should be confirmed with manufacturer prior to submitting a bid.

- C. 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 Engineer. Any submittal not stamped or complete will be sent back. Data submitted from subcontractors and material suppliers directly to the Engineer will not be processed unless written prior approval is obtained by the Contractor.
- D. Submittal Review Process: Before starting work, prepare and submit to the Engineer shop drawings and descriptive product data required for the project. Continue to submit in the stated format after each 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 requirements listed in each Division 26 Section.
- E. 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
- F. 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.
- G. 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.
- H. The Design Professional shall not be required to review partial submissions or those for which submissions of correlated items have not been received.
- I. 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.
- J. The contractor shall cloud all changes made on submittals that are marked "Revise and Resubmit."

- K. 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 Engineer of Record.
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.

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. Mobilization/Demobilization
  - c. Demolition
  - d. Power Distribution
  - e. Basic Materials/Devices/Equipment Connections
  - f. Testing, Acceptance, and Commissioning
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 to indicate which of the variations is to be provided. Improperly marked sheets will be rejected and returned.
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.

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", unless otherwise noted.

E. Coordination Drawings: See applicable paragraph in 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 applicable paragraph in this specification section.

H. Record Drawings: See applicable paragraph in this specification section.

**1.17 DELIVERY, STORAGE AND HANDLING:**

- A. Refer to the Division 01, 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 01 Section on Summary of work for requirements on working in Owner-occupied areas of the existing building and Division 02 section on selective demolition. The following are additions and modifications.
- 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 Engineer. At the completion of the remodeling works or when directed by the Engineer, all stored items not reused or wanted by the Owner shall be removed from the premises.
- C. 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.
- D. Existing equipment that is removed and is to be reused shall be cleaned, serviced and operable before being reinstalled.
- E. Revise panelboard schedules to reflect removal or relocation of equipment. Circuit integrity of equipment in adjacent areas shall be left intact.
- F. 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.

- G. 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.
- H. 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.
- I. 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.
- J. 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.
- K. Electrical Outages: Electrical outages must be held to a minimum. The Contractor shall submit a Method of Procedure (MOP) to the Owner for each outage, detailing the reasons for the outage, areas affected and the sequence of procedures to accomplish work; long with 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.
- L. 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.

**1.19 CUTTING AND PATCHING:**

- A. This Article specifies the cutting and patching of electrical equipment, components, and materials to include 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. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
- C. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.
- D. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.
- E. 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.

- F. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- G. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- H. Locate, identify, and protect electrical services passing through remodel or demolition area and serving other areas required to be maintained operational.

**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. See applicable Article above.

**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. 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 01 for access door specification and requirements.
- D. 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.

**1.22 TESTING:**

- A. Submit test reports as outlined in Division 01 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 Engineer. Reschedule testing for Owner convenience if required.

- D. Test Report: Submit electronic copy copies of the completed report to the 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. Failure to Meet Test:
  - 1. Contractor shall replace the defective material or equipment as necessary, and have test repeated until test proves satisfactory without additional cost to the Owner.
- F. The Contractor or 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 manufacturer recommendations. Dated calibration labels shall be visible on all test equipment.

**1.23 CLEANING:**

- A. Refer to the Division 01 Section on project closeout or final cleaning for general requirements for final cleaning.

**1.24 RECORD DOCUMENTS:**

- A. Refer to the Division 01 Section on Project Closeout or Project Record Documents for requirements. The following paragraphs supplement the requirements of Division 01.
- 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; Change Orders; concealed control system devices, and any other relevant deviations from the Contract Documents.
- D. Mark shop drawings to indicate approved substitutions; 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 on drawings to indicate installed equipment and materials used, and any deviations and final 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 Engineer 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 proper channels. Using the above color scheme, transfer any undocumented revisions from the construction site record drawings to this complete set. Submit completed documents for review. This contract will not be considered completed until these record documents have been received and accepted.

- 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.

**1.25 OPERATION AND MAINTENANCE DATA:**

- A. Refer to the Division 01 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 01 (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 01. 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 routine and normal 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

change order costs included and identified is provided and the manual is reviewed by the Engineer.

**1.26 PROJECT CLOSEOUT LIST:**

- A. In addition to the requirements specified in Division 01, complete the requirements listed below.
- B. 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.

**1.27 WARRANTIES:**

- A. Refer to the Division 01 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.

**1.28 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. Submittals
  - 3. Site observation reports with current status of all action items.
  - 4. Test results; including recorded values, procedures, and other findings.
  - 5. Outage information.

**END OF SECTION 26 05 00**

**SECTION 26 05 19**  
**ELECTRICAL 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. Field Quality Control Test Reports: Submit record of testing. Refer to Section 26 05 00 – Common Work Results for additional requirements.
- C. Record Documents: Record actual installed circuiting arrangements for panel feeders and underground circuits.

**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 APPLICATIONS**

- A. General: Provide wire and cable suitable for the temperature, conditions, and location where installed. Wire shall be single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- B. Dry and Exposed Interior Locations

1. Provide single conductor building wire in suitable raceway system.
- C. Damp or Wet Interior Locations
1. Provide single conductor building wire in suitable raceway system.
- D. Cable types that will NOT be permitted are listed as follows:
1. Metal-clad Cable assemblies (MC)
  2. Armored Cable assemblies (AC)
  3. Flat Cable assemblies (FC / FCC)
  4. Integrated Gas Spacer cables assemblies (IGS)
  5. Medium Voltage cable assemblies (MV)
  6. Mineral-Insulated, metal sheathed cable assemblies (MI)
  7. Nonmetallic-Sheathed cable assemblies (NM / NMC / NMS)
  8. Service-Entrance cable assemblies (SE / USE)
  9. Underground Feeder and branch-circuit cable assemblies (UF)

## 2.2 CONDUCTOR AND CABLE REQUIREMENTS

- A. General Requirements
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
  2. Provide copper conductors only.
  3. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
  4. Tinned Copper Conductors: Comply with ASTM B33.
- B. Single Conductor Building Wire
1. Description: Single conductor insulated wire.
  2. Conductor Stranding:
    - a. Size 10 AWG and Smaller: Solid.
    - b. Size 8 AWG and Larger: Stranded.
  3. Insulation: Type THHN/THWN or THHN/THWN-2.
  4. Conductor: Copper.
  5. Insulation Voltage Rating: 600 volt.

## 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 INSTALLATION OF WIRES AND CABLES:

- A. Per Laramie County Community College (LCCC) Construction Quality Standards:
  - 1. Circuits shall be furnished with a dedicated neutral conductor. Neutrals common to more than one circuit will not be permitted for this project.
- B. 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.
- C. Coordinate wire/cable installation work, including electrical raceway and equipment connection work, with other work.
- D. 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.
- E. 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.
- F. Keep conductor splices to minimum. Splice only in accessible junction boxes. No splices are allowed in feeder or control wiring. Connect un-spliced wire to numbered terminal strips at each end.
- G. Install splices and taps which possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
- H. Use splice and tap connectors which are compatible with conductor material.
- I. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A for copper.
- 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. For wire splices and taps, 10 AWG and smaller, use insulated screw on type spring wire connectors with plastic caps, push on type are not acceptable.
- L. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- M. Thoroughly tape the ends of spare conductors in boxes and cabinets.
- N. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.
- O. 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.

- P. Branch circuits whose length from panel to first outlet exceeds 75 feet for 120 volt circuits shall be #10 or larger.
- Q. Provide wire training, lacing, labeling, and terminal blocks as required in panelboards and all control cabinets. All wiring shall be installed neat and be labeled to match wiring diagrams.
- R. 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.

**3.2 FIELD QUALITY CONTROL:**

- A. Provide all test results to Engineer in Substantial Completion Submittals prior to scheduling Substantial Completion observations. Test results shall be tabulated to show name of tested device, measured value, expected values, acceptable standard deviation, and test conditions, as well as any miscellaneous variables that may be applicable to test being performed.
- B. 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.
- C. Prior to energization, test wires and cables for electrical continuity and for short-circuits.

**3.3 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.

**END OF SECTION 26 05 19**

**SECTION 26 05 26**  
**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: Provide manufacturer's catalog information showing dimensions and materials, for ground rods, connectors and connection materials, and grounding fittings.
- C. Field Quality Control Test Reports: Submit record of testing as described below. Refer to Section 26 05 00 - Common Work Results for additional requirements.
- D. Record Documents: Record actual installed circuiting arrangements. Indicate 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.

**PART 2 - PRODUCTS**

**2.1 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.

**2.2 WIRE AND CABLE CONDUCTORS:**

- A. General: Comply with Division 26 Section on Conductors 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

### **2.3 MISCELLANEOUS CONDUCTORS:**

- A. Braided Bonding Jumpers: Copper tape, braided No. 30 gauge 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.

### **2.4 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.

### **2.5 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: 3/4 inch 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 all feeders and branch circuits, in addition to those locations where required by Code:
- B. 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. 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.

- C. Labeling: Provide a phenolic tag for all grounding electrode conductors as described in section on Electrical Identification.
- D. 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.

### 3.4 FIELD QUALITY CONTROL:

- A. Provide all test results to Engineer in Substantial Completion Submittals prior to scheduling Substantial Completion observations. Test results shall be tabulated to show name of tested device, measured value, expected values, acceptable standard deviation, and test conditions, as well as any miscellaneous variables that may be applicable to test being performed.
- B. 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.
- C. 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.

D. 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 26 05 26**

**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. Shop Drawings: Contractor shall indicate details of fabricated products and materials.
- C. Design Data: Indicate details and engineering analysis for any suspended transformers, cable trays, and trapeze hangers for multiple conduit runs.

**PART 2 - PRODUCTS**

**2.1 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.

**2.2 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. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- 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.

### 2.3 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.

## 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 inch 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 3/4 inch 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. Contractor shall use 1/4 inch-diameter or larger threaded steel for hanger rods with spring steel fasteners. 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.
  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.
- 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 channel supports anchored to structure (multiple clamps may be secured to a single channel support). Individual conductors or cables may be served utilizing a vinyl or fiberglass clamp which shall be anchored to the structure.
  2. Install simultaneously with installation of conductors.
- 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 inch 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. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cabinets, disconnect switches, and control components in accordance with the following:
1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. 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. 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.

### 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.

**END OF SECTION 26 05 29**

**SECTION 26 05 33  
RACEWAYS 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. Rigid Metal Conduit (RMC)
  - 2. Liquidtight Flexible Metal Conduit (LFMC)
  - 3. Electrical Metallic Tubing (EMT)
- C. The following raceway systems are either specified in other sections or not anticipated to be provided by this Contractor.
  - 1. High Density Polyethylene (HDPE)
  - 2. Rigid Polyvinyl Chloride (PVC)
  - 3. Intermediate Metallic Conduit (IMC)
  - 4. Flexible Metal Conduit (FMC)
  - 5. Nonmetallic Underground Conduit with Conductors (NUCC)
  - 6. Reinforced Thermosetting Resin Conduit (RTRC)
  - 7. Liquidtight Flexible Nonmetallic Conduit (LFNC)
  - 8. Flexible Metallic Tubing (FMT)
  - 9. Electrical Nonmetallic Tubing (ENT)
  - 10. Busways and/or Cablebus
  - 11. Cellular Concrete Floor Raceways
  - 12. Underfloor Raceways
  - 13. Cable Trays
  - 14. Auxiliary Gutters / Wireways
  - 15. Surface Raceway

**PART 2 - PRODUCTS**

**2.1 CONDUIT AND TUBING:**

- A. General: Aluminum, Brass, and Stainless Steel tubing are not allowed unless specifically noted otherwise and/or for specialty systems such as use in corrosive or special condition environments. Provide galvanizing as indicated below. All fittings shall comply with NEMA FB 1.
- B. Rigid Metal Conduit (RMC)
  - 1. Conduit: Galvanized, rigid steel, zinc-coated inside and outside, threaded ends.
  - 2. Fittings: Threaded galvanized steel, bushings shall have nylon insulated throat.
  - 3. Provide conduit and fittings with external coating of PVC when being installed underground or encased in concrete.
- C. Liquid-Tight Flexible Metal Conduit (LFMC)
  - 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.

D. Electrical Metallic Tubing (EMT)

1. Conduit: Thinwall steel tubing, unthreaded, with zinc electroplating.
2. Fittings: Steel compression fittings for all applications. Bushings shall be threaded and have nylon insulated throat or nylon bushing.
3. Weatherproof Fittings: Steel compression fittings for rain-tight and concrete-tight applications. Steel set-screw for all other connections. Set-screw quick fit type for 2-1/2 inches and larger may be used. Bushings shall be threaded and have nylon insulated throat or nylon bushing.

**2.2 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.

**2.3 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 parity sized equipment ground.

**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 the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer. Start of work constitutes acceptance of conditions.

**3.2 CONDUIT SCHEDULE:**

- A. General: Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit (RMC).
- B. Interior, Damp or Wet Locations: RMC or EMT w/ rain tight fittings.
- C. Exposed Interior in utility areas or areas with open ceilings: EMT
- D. Connections to Vibrating Equipment: LFMC (Max 6' length)
- E. Raceways in locations subject to mechanical injury: RMC.

- F. Emergency Circuits: All emergency system circuits shall be run totally in non-flexible metal conduit (RMC or EMT).
- G. 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. 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.
  - 7. 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.
  - 8. 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.
  - 9. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.
  - 10. 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.
  - 11. 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.
  - 12. 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.
  - 13. Tighten set screws of thread less fittings with suitable tool.
  - 14. 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. RMC 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.
  - 15. 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.
  - 16. 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.
17. Flexible Connections: Use short length (maximum of 6 feet) of flexible conduit 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. PVC externally coated rigid steel conduit: Patch all nicks and scrapes in PVC coating after installing conduit.
  18. Where conduits are to be installed through structural framing members, the Contractor shall provide sleeves. The Engineer's written approval must be obtained prior to cutting, notching or drilling of structural framing members.
  19. Ream the ends of all cut and/or threaded conduit. Ends shall be cut square.
  20. 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.
  21. Route conduit through roof openings for piping and ductwork where possible; otherwise, rout through jack with pitch pocket.
  22. 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 Engineer.
  23. Install an insulated ground conductor in all conduits.
  24. Provide separate raceway systems for each of the following:
    - a. Power Distribution
    - b. Emergency Systems
    - c. Building Automation/Management (BAS/BMS)
- B. Install labeling as required in Division 26 section - "Electrical Identification".
- 3.4 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 26 05 33**

**SECTION 26 05 34  
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 and Enclosures
- B. Conduit-body-type electrical enclosures and wiring fittings are specified in the Division 26 Section on Raceways.

**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: Provide manufacturer's catalog information showing dimensions, materials, colors, and configurations for any control enclosures.
- C. Shop Drawings: Provide computer generated drawings of all floor boxes as well as boxes, enclosures, and cabinets that are to be shop fabricated (non-stock items). For shop fabricated boxes, show accurately scaled views and spatial relationships to adjacent equipment as well as field wiring. Show box types, dimensions, and finishes. Control panels shall include, but not be limited to; lighting and specialized fan.

**PART 2 - PRODUCTS**

**2.1 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 and accessories required for the intended use. Provide gaskets for units in damp or wet locations.

**2.2 MATERIALS AND FINISHES:**

- A. Sheet Steel: Flat-rolled, code-gauge, 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.

### **2.3 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.
- B. Steel Boxes: Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports." Boxes shall be sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs.

### **2.4 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.

### **2.5 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 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 gaskets are 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 appropriate weatherproof raceway entrances.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, GENERAL:**

- A. Locations: Install items where indicated and where required to suit code requirements and installation conditions.



- B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
- C. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.
- D. Remove sharp edges where they may come in contact with wiring or personnel.

### **3.2 APPLICATIONS:**

- A. Hinged Door Enclosures Indoor: NEMA type 1 enclosure except as indicated.
- B. 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: NEMA Type 1, sheet steel or nonmetallic as permitted by local code.
  - 2. Locations Exposed to Weather or Dampness: Cast metal, NEMA type 3R.
- C. 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. Gasketed Boxes: At the following locations use malleable or cast metal, threaded hub type boxes with gasketed weatherproof covers:
  - 1. Where surface mounted on unfinished walls, columns or pilasters. (Cover gaskets may be omitted in dry locations).
  - 2. Where exposed to moisture laden atmosphere.
- B. Mounting: Mount outlet boxes for switches with the long axis vertical or as indicated. Mount boxes for receptacles vertically. 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.
- C. Cover Plates for Surface Boxes: Use plates sized to box front without overlap.
- D. Protect outlet boxes to prevent entrance of plaster, and debris. Thoroughly clean foreign material from boxes before conductors are installed.

### **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 allowable limits of the NEC.
- B. 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.

- C. 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.

**3.5 INSTALLATION OF CABINETS AND HINGED DOOR ENCLOSURES:**

- A. Mount with fronts straight and plumb.
- B. Install with tops 78 inches above floor.

**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 26 05 34**

**SECTION 26 05 53  
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
  - 2. Instruction / Warning signs
  - 3. Equipment labels and signs

**1.2 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 ELECTRICAL IDENTIFICATION PRODUCTS:**

- A. Identify System Raceways with Painted Couplings & Connectors: Install painted couplings at all conduit connecting couplings including end couplings. Apply the following colors:
  - 1. Normal Power: Unpainted
  - 2. Emergency Power: OSHA Orange
  - 3. BMS/Temperature Control: Blue
  - 4. Ground: Green
- B. Adhesive Marking Labels: Pre-printed, flexible, self-adhesive labels with legend indicating voltage and service.
  - 1. Label Size for Raceways: 1 inch high by 12 inches long (minimum) with 5/8 inch minimum height letters.
  - 2. Label Size for Boxes, Enclosures, and Utilization Equipment: See detail on electrical plans.
  - 3. 600 Volt and Below Normal: White letters on black background indicating source equipment designation, circuit number(s), and voltage.
  - 4. 600 Volt and Below Emergency: Black letters on OSHA Orange background indicating source equipment designation, circuit number(s), and voltage.
  - 5. Temperature Control: Black letters on white background indicating "BAS."
  - 6. Ground: White letters on green background indicating "GROUND".
- C. 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.
- D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
- E. 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 letters on colored face and punched for mechanical fasteners. Apply the following colors.

1. Normal Power: White letters on Black face
  2. Emergency / Standby Power: White letters on Red face
- F. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- G. 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.
- H. Adhesive Marking Tape for Device Cover Plates: 3/8 inch adhesive tape 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. Per Laramie County Community College (LCCC) Construction Quality Standards:
1. All electrical devices shall be labeled including junction boxes above ceilings.
  2. Label shall comply with information and requirements as dictated on electrical plan details.
- B. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated.
- C. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- E. Conduit Identification: Conduits shall have painted couplings and connectors to identify system cabling contained within. Labels shall also be provided on any exposed conduits. Install labels at 10 foot intervals. Labels for multiple conduits shall be aligned and read the same direction. Where conduits enter or exit a panelboard, pull or junction box, switchboard, or other distribution equipment, conduit labels shall include circuit number in addition to feeder identification and voltage. Use the colors as identified above.
- F. 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 conduits for pressure sensitive labels. Use self-adhesive marking tape labels at exposed locations and indelible black marker at concealed boxes. All control boxes (BAS/BMS) shall have covers painted blue.
- G. Circuit Identification: Tag or label enclosures and 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.
  3. Circuit Directory: Typed and reflective of final circuit changes required to balance panel loads. Every circuit and/or circuit modification shall be uniquely identified to be distinguishable from all other circuits. The identification description shall include an "APPROVED" degree of detail as determined by the State Fire Marshall's Office. Obtain approval before installing.
- H. 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.
- I. 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. Text shall match terminology and numbering of the Contract Documents. Apply labels for each unit of the following categories of electrical equipment. Manufacturer labels for Panelboards do meet meet the requirements of these specifications.
    - a. Panelboards, electrical cabinets and enclosures
    - b. Motor control centers buckets
    - c. Emergency Pushbutton stations
    - d. Contactors
- J. 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.
- K. 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.
- L. 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.
- M. Install labels at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
- N. Provide 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/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/branch circuit serving the equipment.

**END OF SECTION 26 05 53**

**SECTION 26 05 83  
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. From electrical source to safety/control equipment
  - 2. From safety/control equipment to motors
  - 3. From motors to secondary controllers (if applicable)
  - 4. To grounding system
  - 5. Other connections as shown within the electrical drawings

**1.2 SUBMITTALS:**

- A. See Section 26 05 00 Common Work Results 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. 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.
- C. Shop Drawings: Provide wiring diagrams where specialized control is detailed on the plans. Indicate all devices and final enclosure sizes.
- D. Coordination Drawings: All mechanical and plumbing equipment shall be coordinated with unit nameplate information per the actual nameplate to be included on the equipment.
- E. Field Quality Control Test Reports: Submit record of testing as described below. Refer to Section 26 05 00 - Common Work Results for additional requirements.

**1.3 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.

**PART 2 - PRODUCTS**

**2.1 GENERAL:**

- A. Per Laramie County Community College (LCCC) Construction Quality Standards:

1. All motor starters and motor rated switches shall be manufactured by General Electric (GE) Corporation. No equals will be considered.
  2. All Fuses shall be manufactured by Bussman subsidiary of Eaton Corporation. No equals will be considered.
  3. All safety disconnect switches shall be manufactured by General Electric (GE). Owner will also consider product by Cutler –Hammer and/or Square D.
- B. 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.
- C. Provide motor controllers that are horsepower rated to suit the motor controlled.
- D. Contacts shall open each ungrounded connection to the motor. Contacts shall be NEMA rated, 75 degrees C.
- E. 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.

## 2.2 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.

## 2.3 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.

- 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.

#### **2.4 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. Accessories:
  - 1. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated or required.
  - 2. Handles shall be lockable in open and closed position without modification.
  - 3. 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.

#### **2.5 MOTOR STARTERS:**

- A. See Division 23 for Requirements.
- B. Coil voltages for contactors are anticipated to be 24V, dc; to interface with existing BAS/BMS. Contractor shall field coordinate final requirements.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION:**

- A. Inspect area and conditions under which electrical connections for equipment are to be installed and provide notification 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. Start of work constitutes acceptance of conditions

#### **3.2 INSTALLATION OF ELECTRICAL CONNECTIONS:**

- A. Per Laramie County Community College (LCCC) Construction Quality Standards:
  - 1. Circuits shall be furnished with a dedicated neutral conductor. Neutrals common to more than one circuit will not be permitted for this project.
- B. 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.
- C. 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.



- D. 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.
- E. 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.
- F. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
- G. 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.
- H. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
- I. 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 NEC Appendix I.
- 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 strips.
- P. Each branch circuit 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 EQUIPMENT CONNECTION SCHEDULES:**

- A. The exact furnishing and installation of the equipment is left to the Contractors involved. Contractor should note that the intent 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 Engineer of any discrepancies prior to bidding.
- B. Mechanical Equipment:
  - 1. Refer to Mechanical Equipment Schedule on the drawings.
  - 2. The exact furnishing and installation of the equipment is left to the Contractors involved. Comply with the applicable requirements of Division 26 for all electrical work which is not otherwise specified.
  - 3. It is suggested that all line voltage wiring shall be provided under Division 26 and all 24V control wiring be provided under Division 23.
  - 4. The exact furnishing and installation of the equipment is left to the Contractors involved. Contractor should note that the intent is to have the Contractor responsible for coordinating wiring requirements whether or not specifically called for by the Division 23 or Division 26 drawings and specifications. Comply with the applicable requirements 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 advise the Engineer of any discrepancies prior to bidding.
- C. 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.
- D. 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.

**END OF SECTION 26 05 83**

**SECTION 26 24 19  
MOTOR CONTROL CENTERS**

**PART 1 - GENERAL**

**1.1 SUMMARY:**

- A. This Section includes motor-control centers (MCCs) and components for circuits rated 600 V or less.
- B. Coordinate controls and other connections with work provided in Division 23 and/or as otherwise indicated.

**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: Provide manufacturer's catalog information showing dimensions, materials, colors, and configurations for each product and component specified.
- C. Shop Drawings:
  - 1. Wiring Diagrams: Interconnecting wiring diagrams pertinent to the class and type specified for the MCC. Schematic diagram of each type of controller unit indicated. Clearly differentiate between factory and field installed wiring.
- D. Field Quality Control Test Reports: Submit record of testing. Refer to Section 26 05 00 – Common Work Results for additional requirements.
- E. Extra Materials:
  - 1. Spare Fuses: Furnish spares of each type and rating of fuse for fusible devices amounting to one set of 3 fuses for each 9 fuses installed but not less than 3 fuses of each type. Include spares for:
    - a. Control power fuses.
    - b. Overloads (heaters).
  - 2. Spare Indicating Lamps: Furnish 6 of each type and color installed.
- F. Operation and Maintenance Data: Include detailed information on system operation, device programming and setup, replacement parts and recommended maintenance procedures and intervals. Refer to Section 26 05 00 – Common Work Results for additional requirements.

**1.3 QUALITY ASSURANCE:**

- A. Listing and Labeling: Provide MCCs that are listed and labeled.
  - 1. The terms "listed" and "labeled": As defined in the National Electrical Code, Article 100.
- B. Motor control centers shall conform to the requirements of NEMA ICS 1, NEMA ICS 2, NEMA ICS 4 and NEMA ICS 6.
- C. Manufacturers: Components shall match existing Allen-Bradley Centerline 2100 MCC.

## PART 2 - PRODUCTS

### 2.1 FUNCTIONAL FEATURES:

- A. Per Laramie County Community College (LCCC) Construction Quality Standards:
1. All Fuses shall be manufactured by Bussman subsidiary of Eaton Corporation. No equals will be considered.
  2. All safety disconnect switches shall be manufactured by General Electric (GE). Owner will also consider product by Cutler –Hammer and/or Square D.
- B. General: Provide a modular arrangement of motor controllers, control devices, overcurrent protective devices, transformers, instruments, indicating panels, blank panels, and other items mounted in the compartments of the existing motor-control center as indicated or required. Provide all items listed herein unless otherwise indicated.
- C. Provide (FVNR) full-voltage magnetic motor starter with circuit-breaker/fusible disconnect type disconnects and auxiliary control devices unless otherwise indicated. Construct each starter unit with doors, unit support pans, saddles and disconnect operators. Enclose and isolate each unit from adjacent units. Design units so that faults will be contained within compartments. Design plug-in units of same NEMA size and branch feeder units of same trip rating, to be interchangeable with each other. Provide starters with the following ratings, features and accessories:
1. Provide equipment with Short Circuit Current Rating (SCCR).above available fault current.
  2. Starters, including contacts and coils, shall be NEMA rated, fully horsepower sized, and rated. IEC sized and rated equipment will not be allowed. Contacts shall open each ungrounded connection to the motor.
  3. Equip with ambient temperature compensated, thermal/ magnetic solid state overload protection devices for each motor. Electronic motor overload protection including thermal modeling type thermal protection, Ground fault protection, individual monitoring of motor current in each phase, and a wide FLA adjustment with selectable trip.
    - a. Provide trip-free overload relays, set for 115 percent of motor full load amps.
    - b. All 3-phase motors 3/4 hp and larger shall be protected against loss of phase and phase reversal wired into the starter or integral to the controller. Differential single phasing protection shall be provided in the overload relay with solid state 3-phase sensing circuit and isolated contracts. If the overload relay does not advance the trip point under phase loss conditions by 25 percent or more, a separate phase protection device such as a Time-Mark 257 series relay shall be factory mounted and wired in the starter enclosure.
    - c. Provide Class 10 overload for standard applications and Class 20 for high inertia loads.
    - d. Over and Under voltage: The ability for automatic re-start of equipment shall be provided. Settings shall be 110% for overvoltage and 80-95% for under voltage unless stated otherwise on the motor data sheets.
    - e. Voltage and current unbalance: Settings shall be 10-15% of FLA for current unbalance alarm with 5-10 second delay and 20-25% of FLA for current unbalance trip with 2-5 second delay unless otherwise stated on the motor data sheets, Phase imbalance shall be adjustable from 2 to 10% with disable setting.
  4. Provide externally operated manual reset.
  5. Provide maintained contact HAND-OFF-AUTO (H-O-A) selector switches properly arranged and wired for manual speed selection in the HAND position and for remote speed selection in the AUTO position.
  6. Provide built-in, 120 VAC control circuit transformer. Install with line side fuses.

7. Provide pilot lights as follows:

- a. OFF - red
- b. Running - green
- c. Fault - amber

8. Provide four (4) additional spare sets of auxiliary contacts with each starter, two (2) normally open and two (2) normally closed.
9. Provide control and timing relays, interlocks, pneumatic switches and similar devices as required for coordination with control requirements of Division 23. Provide additional auxiliary contacts as required to coordinate with Division 23.
10. Stop and Lockout Pushbutton Station for equipment connections where not provided in Division 23: Momentary-break pushbutton station with a factory-applied hasp arranged so a padlock can be used to lock the pushbutton in the depressed position with the control circuit open.

- D. Overcurrent Protective Devices: Provide types of devices with features, ratings, and circuit assignments indicated, as specified in Division 26 Section on Overcurrent Protective Devices.
- E. Spare Units: Provide type, sizes, and ratings as indicated, and installed in compartments indicated "spare."
- F. Provide padlocking provisions on each overcurrent protective device and motor controller lockable in the open or closed position. Provide three (3) sets of lockout/tagout devices for each type of breaker or switch provided. Include tags, locks, and all accessories necessary.
- G. Where reduced voltage starting is required, the starting method shall be part winding or closed transition auto-transformer / solid state electronic starting. Motors shall be constructed accordingly. Other methods of reduced voltage starting shall not be used unless reviewed by the Engineer prior to bid.

**2.2 OTHER CIRCUIT CONTROL AND PROTECTIVE DEVICES:**

- A. General: Factory-installed and tested devices of types listed below, with indicated ratings, settings, and features.
- B. Indicating Lights: For circuit breakers where indicated. Lights shall be oil tight type, push-to-test with lens color as indicated.
- C. Control Power: Where electrically operated/shunt tripped contactors are required, provide 120 volt control circuits supplied through secondary disconnect devices from a control power transformer. Include the following features:
- D. Control Wiring:
  1. Flexible Conductors: Use for size No. 8 and smaller and for conductors across hinges, and conductors for interconnections between shipping units.
  2. Conductors Sizes: In accordance with NEC for the duty required.
  3. All control wiring shall be terminated on labeled power type terminal blocks with ring terminals.
  4. Limit cable bundles to 12 cables maximum.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION:**

- A. General: Install MCCs in accordance with NEMA ICS 2.3 "Instructions for the Handling, Installation, Operation, and Maintenance of MCCs," and with the manufacturer's written installation instructions.
- B. Limit cable bundles to a maximum of 12 cables per bundle.
- C. Provide two-hole compression connections for all incoming and outgoing phase, neutral, and ground connections.

#### **3.2 IDENTIFICATION:**

- A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section on Electrical Identification.

#### **3.3 GROUNDING:**

- A. Provide equipment grounding connections for motor control centers as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

#### **3.4 FIELD QUALITY CONTROL:**

- A. Provide all test results to Engineer in Substantial Completion Submittals prior to scheduling Substantial Completion observations. Test results shall be tabulated to show name of tested device, measured value, expected values, acceptable standard deviation, and test conditions, as well as any miscellaneous variables that may be applicable to test being performed.
- B. Assure MCC installation meets specified requirements, is operational within specified tolerances, and provides appropriate protection for systems and equipment.
  - 1. Test and inspect MCCs in accordance with manufacturer's recommendations and these specifications.
  - 2. Schedule tests and provide notification at least 1 week in advance of test commencement.
  - 3. Reports: Prepare written reports of test results and observations. Report defective materials and workmanship. Include complete records of adjustments and corrective action taken.
  - 4. Labeling: On satisfactory completion of tests and related effort, apply a label to tested components indicating results, person responsible, and date.
- C. Visual and Mechanical Inspection:
  - 1. Inspect for defects and physical damage, testing laboratory labels, circuit connections, and nameplate compliance with up-to-date system drawings.
  - 2. Perform operational test and exercise of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
  - 3. Check MCC anchorage, external clearances, and alignment and fit of components including internal elements.
  - 4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
  - 5. Perform visual and mechanical inspection and related work for motor control and protective devices as specified in Division 26 Sections on Overcurrent Protective Devices and Motor Controllers.

D. Electrical Testing:

1. Make continuity tests of supply, feeder, and control circuits.
2. Verify appropriate capacity, overcurrent protection, and operating voltage of control power elements including control power transformers and control power wiring.
3. Check phasing of supply source to the bus.
4. Test overcurrent protective devices as specified in Division 26 Section "Overcurrent Protective Devices."
5. Retesting: Correct deficiencies and retest. Verify by the retests that specified requirements are met.

**END OF SECTION 26 24 19**

**SECTION 26 28 00  
ELECTRICAL CIRCUIT PROTECTIVE DEVICES**

**PART 1 - GENERAL**

**1.1 SUMMARY:**

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

**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: Provide manufacturer's catalog information showing dimensions, materials, colors, and configurations for fuses, fusible switches, circuit breakers, and OCPD accessories specified in this Section.
- C. Field Quality Control Test Reports: Submit record of testing as described below. Refer to Section 26 05 00 – Common Work Results for additional requirements.
- D. Extra Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Spare Fuses: Furnish spares of each type and rating of fuse for fusible devices amounting to one set of 3 fuses for each 9 fuses installed but not less than 3 fuses of each type.

**PART 2 - PRODUCTS:**

**2.1 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. Manufacturers: When mounting overcurrent protective devices in switchboards, switchgear, panelboards, MCC's, etc., provide equipment of same manufacturer as equipment into which they are being mounted.
- C. Per Laramie County Community College (LCCC) Construction Quality Standards:
  - 1. All Fuses shall be manufactured by Bussman subsidiary of Eaton Corporation. No equals will be considered.
  - 2. All safety disconnect switches shall be manufactured by General Electric (GE). Owner will also consider product by Cutler –Hammer and/or Square D.
- D. Enclosures: NEMA 250 "Enclosures for Electrical Equipment (1,000 Volts Maximum)."
- E. 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.



- F. 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.

## 2.2 CARTRIDGE FUSES:

- A. General: Comply with 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. Comply with UL Standards for Safety High-Interrupting-Capacity Fuses, Current-Limiting Types. UL 198C
  - 1. Class J Fuses: Dual Element, Time Delay, Type LPJ
  - 2. Class CC Fuses: Time Delay, Type LP
  - 3. Class G Fuses: Dual Element, Time Delay, Type SC
- F. Comply with UL Standards for Safety Class R Fuses. UL 198E
  - 1. Class RK1 Fuses: Dual Element, Time Delay, Type LPN/LPS
  - 2. Class RK5 Fuses: Dual Element, Time Delay, Type FRN/FRS

## 2.3 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.
- 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. All 120/208 volt rated breakers shall be rated and labeled "High Magnetic".
- E. Enclosure for Switchboard, Motor Control Center, or Panelboard Mounting: Suitable for mounting in equipment indicated.

**2.4 OCPD ACCESSORIES:**

- A. Lock-Out Devices: Provide padlocking provisions on each overcurrent protective device, lockable in the open or closed position. Provide 3 sets of lockout/tagout devices for each type of breaker or switch provided. Include tags, locks and all accessories necessary.

**PART 3 - EXECUTION:**

**3.1 INSTALLATION:**

- A. Per Laramie County Community College (LCCC) Construction Quality Standards:
  - 1. All circuits that require GFI protection shall have the protection integral to the circuit breaker at the Lighting & Appliance Panelboard.
  - 2. Receptacles with integral GFI protection are NOT acceptable for use on this project.
- B. 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 or MCC's 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.
- B. Provide computer-generated circuit directory for each lighting and appliance panelboard and each power distribution panelboard provided with a door, clearly and specifically indicating the loads served. Identify spares and spaces.
  - 1. Description included on electrical panel schedules are for design purposes only. Description printed on final panel schedules must have a sufficient degree of detail that allows each circuit to be distinguished from all others, as approved by the Authority Having Jurisdiction.

**3.3 CONTROL WIRING INSTALLATION:**

- A. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- B. 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.

**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. Provide all test results to Engineer in Substantial Completion Submittals prior to scheduling Substantial Completion observations. Test results shall be tabulated to show name of tested device, measured value, expected values, acceptable standard deviation, and test conditions, as well as any miscellaneous variables that may be applicable to test being performed.
- B. 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. Insulation resistance test of fused power circuit devices, insulated-case, and molded-case circuit breakers, 600-ampere frame size and over at 1000 degree V D.C. for one minute from pole to pole and from each pole to ground with breaker closed and across open contacts of each phase. Insulation resistance less than 100 megohms is not acceptable.
    - b. Make insulation resistance tests of OCPD buses, components, and connecting supply, feeder, and control circuits.
    - c. Make continuity tests of circuits.
- C. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating test results, date, and responsible organization and person.
- D. Make adjustments for final settings of adjustable-trip devices.
- E. Activate auxiliary protective devices such as ground fault or under-voltage relays, to verify operation of shunt-trip devices.
- F. Check operation of electrically operated OCPDs in accordance with manufacturer's instructions.

**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.

**END OF SECTION 26 28 00**