LCCC – ALBANY COUNTY CAMPUS

EMERGENCY GENERATOR ADDITION

FOR

Laramie County Community College (LCCC)
1400 East College Drive
Cheyenne, WY 82007

ENGINEERS

Cator, Ruma & Associates
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Cheyenne, WY 82001

JUNE 2018
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PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. All drawings associated with the entire project, including general provisions of the Contract, including The General Conditions of the Contract for Construction, General and Supplementary Conditions and Division-1 Conditions specification sections shall apply to the Division 21, 22, and 23 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. Related Sections: Refer to all sections in Division 21, 22, and 23. Refer to Division 26 specification sections and Division 26 drawings.

C. Where contradictions occur between this section and Division 1, the more stringent requirement shall apply.

D. 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 mechanical installations and includes requirements common to more than one section of Divisions 21, 22, and 23. It expands and supplements the requirements specified in Division 1.

1.3 MECHANICAL INSTALLATIONS:

A. The Contract Documents are diagrammatic, showing certain physical relationships which must be established within the mechanical work and its interface with all other work. Such establishment is the exclusive responsibility of the Contractor. Drawings shall not be scaled for the purpose of establishing material quantities.

B. Drawings and specifications are complementary. Whatever is called for in either is binding as though called for in both. Report any discrepancies to the Engineer and obtain written instructions before proceeding. Where any contradictions occur between the specifications and the drawings the more stringent requirement shall apply. The contractor shall include pricing for the more stringent and expensive requirements.

C. Drawings shall not be scaled for rough-in measurements or used as shop drawings. Where drawings are required for these purposes or have to be made from field measurement, Contractor shall take the necessary measurements and prepare the drawings.

D. The exact location for some items in this specification may not be shown on the drawings. The location of such items may be established by the Engineer during the progress of the work.

E. The contract documents indicate required size and points of terminations of pipes, and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. It is not intended that drawings indicate necessary offsets. The contractor shall make the installation in such a manner as to conform to the structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or costs to the Owner. All equipment shall be installed so access is maintained for serviceability.
F. Before any work is installed, determine that equipment will properly fit the space; that required piping grades can be maintained and that ductwork can be run as intended without interferences between systems, structural elements or work of other trades.

G. Verify all dimensions by field measurements.

H. Coordinate installation in chases, slots and openings with all other building components to allow for proper mechanical installations.

I. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

J. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

K. The Contractor shall provide all labor and material necessary but not limited to the starting/stopping of all mechanical equipment, and operating/verifying the operation of all mechanical systems controls as required to accomplish all work necessary to meet construction document requirements. Contractor shall submit records of such activities to engineer and include in the O & M manuals.

1.4 COORDINATION:

A. Work out all installation conditions in advance of installation. The Contractor shall be responsible for providing all labor and material, including but not limited to all fittings, isolation valves, offsets, hangers, control devices, etc., necessary to overcome congested conditions at no increase in contact sum.

B. Provide proper documentation of equipment, product data and shop drawings to all entities involved in the project.

C. Existing Conditions:
   1. Carefully survey existing conditions prior to bidding work.
   2. Provide proper coordination of mechanical work with existing conditions.
   3. Report any issues or conflicts immediately to Engineer before commencing with work and prior to purchasing equipment and materials.

D. 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.

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

F. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

G. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.

H. Modifications required as result of failure to resolve interferences, provide correct coordination drawings or call attentions to changes required in other work as result of modifications shall be paid for by responsible Contractor/Subcontractor.
1.5 PROJECT CONDITIONS:

A. The Contractor shall be required to attend a mandatory pre-bid walk-thru and shall make themselves familiar with the existing conditions. No additional costs to the Owner shall be accepted for additional work for existing conditions.

B. Field verify all conditions prior to submitting bids.

C. Report any damaged equipment or systems to the Owner prior to any work.

D. Protect all mechanical work against theft, injury or damage from all causes until it has been tested and accepted.

E. Be responsible for all damage to the property of the Owner or to the work of other contractors during the construction and guarantee period. Repair or replace any part of the work which may show defect during one year from the final acceptance of all work, provided such defect is, in the opinion of the Architect, due to imperfect material or workmanship and not due to the Owner's carelessness or improper use.

F. The Contractor shall coordinate and co-operate with Owner at all times for all new to existing connections, system shutdowns and start-ups, flushing and filling both new and existing systems.

G. Provide temporary piping services, where required, to maintain existing areas operable.

H. Coordinate all services shut-down with the Owner; provide temporary services. Coordinate any required disruptions with Owner, one week in advance.

I. Minimize disruptions to operation of mechanical systems in occupied areas.

1.6 SAFETY:

A. Refer to LCCC Bidding Documents.

1.7 EQUAL EMPLOYMENT OPPORTUNITY REQUIREMENTS:

A. Refer to LCCC Bidding Documents and conform with the Owners requirements.

1.8 REQUIREMENTS OF REGULATORY AGENCIES:

A. Refer to LCCC Bidding Documents.

B. Execute and inspect all work in accordance with all Underwriters, 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 greater requirement shall be followed. Follow recommendations of NFPA, SMACNA, EPA, OSHA and ASHRAE.

C. Comply with the local and state codes adopted by the Authorities Having Jurisdictions at the time of permit application, including referenced standards, amendments and policies. The following are the codes in effect:

1. 2015 International Building Code
2. 2015 International Fire Code
3. 2015 International Plumbing Code
4. 2015 International Mechanical Code
5. 2015 International Fuel Gas Code

D. Comply with standards in effect at the date of these Contract Documents, except where a standard or specific date or edition is indicated.

E. The handling, removal and disposal of regulated refrigerants and other materials shall be in accordance with U.S. EPA, state and local regulations.

F. The handling, removal and disposal of lead based paint and other lead containing materials shall comply with EPA, OSHA, and any other Federal, State, or local regulations.

G. After entering into contract, Contractor will be held to complete all work necessary to meet these requirements without additional expense to the Owner.

1.9 REQUIREMENTS OF LOCAL UTILITY COMPANIES:

A. Comply with rules and regulations of local utility companies. Include in bid the cost of all valves, valve boxes, meter boxes, meters and such accessory equipment which will be required but not provided by Local Utility Company for the project.

B. Utility Connections:
   1. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.
   2. The contract documents indicate the available information on existing utilities and services and on new services (if any) to be provided to the project by utility companies and agencies. Notify Engineer immediately if discrepancies are found.
   3. Coordinate mechanical utility interruptions one week in advance with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

1.10 PERMITS AND FEES:

A. Refer to LCCC Bidding Documents.

B. The Contractor shall pay all tap, development, meter, etc., fees required for connection to municipal and public utility facilities, unless directed otherwise by the General Contractor/Owner – IN WRITING.

C. Contractor shall arrange for and pay for all inspections, licenses and certificates required in connection with the work.

1.11 TEMPORARY FACILITIES:

A. Light, Heat, Power, Etc.: Responsibility for providing temporary electricity, heat and other facilities shall be as specified in LCCC Bidding Documents.

1.12 PRODUCT OPTIONS AND SUBSTITUTIONS:

A. Refer to the Instructions to Bidders and LCCC Bidding Documents.

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 Architect/Engineer at least ten (10) working days prior to the bid date requesting prior review. This submittal shall include all data necessary for complete evaluation of the product.

1. Substitutions shall be allowed only upon the written approval of the Architect/Engineer NO EXCEPTIONS.
2. The Contractor shall be responsible for removal, replacement and remedy of any system or equipment which has been installed which does not meet the specifications or which does not have prior approval.

1.13 MECHANICAL SUBMITTALS:

A. General

1. Refer to the Conditions of the Contract (General and Supplementary), LCCC Bidding Documents.
2. 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.
3. The front of each submittal package shall be identified with the specification section number, job name, Owner's project number, date, Prime Contractor and Sub-Contractor's names, addresses, and contact information, etc. Each Specification Section shall be submitted individually and submittal shall be tabbed for the equipment/materials/etc. within the section. Submittals that are not complete with the required information will not be reviewed and will be sent back to be corrected.
4. 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.
5. An index shall be provided which includes:
   a. Product
   b. Plan Code (if applicable)
   c. Specification Section
   d. Manufacturer and Model Number
6. Submittal schedule shall be provided for review within four (4) working weeks from award of contract to successful bidder.

B. Basis of Design: The manufacturer's material or equipment listed in the schedule or identified by name on the drawings are the basis of design and provide for the establishment of size, capacity, grade and quality. If alternates are used in lieu of the scheduled names, the cost of any changes in construction required by their use shall be borne by Contractor.

C. Contractor Review: Submittal of shop drawings, product data and samples will be accepted only when submitted by and stamped by the General 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 prior written approval is obtained by the Contractor.
D. Submittal Review Process: Before starting work, prepare and submit to the Engineer shop drawings and descriptive equipment 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 Operating 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 MECHANICAL SUBMITTAL CHECKLIST, of this section; supplemental requirements are listed in each Division 21, 22, and 23 Sections.

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.

1.14 SPECIFIC CATEGORY SUBMITTAL REQUIREMENTS:

A. Product Data:

1. Where pre-printed data covers more than one distinct product, size, type, material, trim, accessory group or other variation, mark submitted copy with black pen to indicate which of the variations is to be provided.
2. Delete or mark-out portions of pre-printed data which are not applicable.
3. Where operating ranges are shown, mark data to show portion of range required for project application.
4. For each product, include the following:
   a. Sizes.
   b. Weights.
   c. Capacities.
   d. Piping and electrical connection sizes and locations.
   e. Statements of compliance with the required standards and regulations.
   f. Performance data.
   g. Manufacturer's specifications.
B. 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.

C. Product Listing:
   1. 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.
   2. When two or more items of same material or equipment are required (plumbing fixtures, pumps, valves, air conditioning units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units and similar items used in work, except as otherwise indicated.
      a. Provide products which are compatible within systems and other connected items.

D. Schedule of Values
   1. Provide preliminary schedule of values with product data submittal, within three (3) weeks from award of contract to successful bidder. Provide according to the following descriptions:
      a. Site Utilities
      b. Plumbing
      c. Demolition
      d. Miscellaneous
   2. Provide a final Schedule of Values at close-out of project including updated values based on actual installation.

E. Coordination Drawings: See section 1.4 of this specification section.

F. Required Submittals: Provide submittals for each item of equipment specified or scheduled in the contract documents. See table at the end of this section.

G. If more than two submittals (either for product data, shop drawings, record drawings, or test and balance reports) 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.

H. The contractor shall cloud all changes made on submittals that are marked “Revise and Resubmit.”

1.15 DELIVERY, STORAGE, AND HANDLING:

A. Refer to LCCC Bidding Documents 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 or contamination 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, dirt, dust, freezing, heat and moisture.

E. Coordinate deliveries of mechanical 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.

F. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.

G. Protect stored ductwork, pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

H. Protect flanges, fittings and specialties from moisture and dirt by inside storage and enclosure, or be packaging with durable, waterproof wrapping.

1.16 DEMOLITION:

A. Refer to LCCC Bidding Documents. The following paragraphs supplement the requirements of LCCC Bidding Documents.

B. During the demolition phase of this contract it is the responsibility of this Contractor to carefully remove existing equipment, piping or ductwork 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 work or when directed by the Engineer, all stored items not reused or wanted by the Owner shall be removed from the premises.

C. The location of existing equipment, pipes, ductwork, etc., shown on the drawings has been taken from existing drawings and is, therefore, only as accurate as that information. All existing conditions shall be verified from field measurements with necessary adjustment being made to the drawing information.

D. 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 for the hazardous material removal, which is not a part of the work to be done under this Division.

1.17 CUTTING AND PATCHING:

A. This Article specifies the cutting and patching of mechanical 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 mechanical equipment and materials.

B. Refer to LCCC Bidding Documents.

C. Do not endanger or damage installed work through procedures and processes of cutting and patching.

D. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.
E. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective or non-conforming installations.

F. Perform cutting, fitting and patching of mechanical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed work;
2. Remove and replace defective work;
3. Remove and replace work not conforming to requirements of the Contract Documents;
4. Remove samples of installed work as specified for testing;
5. Install equipment and materials in existing structures;
6. Upon written instructions from the Architect/Engineer, uncover and restore work to provide for Architect /Engineer observation of concealed work.

G. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim and other mechanical items made obsolete by the new work.

H. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.

I. Locate identify, and protect mechanical and electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational. When services must be interrupted, provide temporary services for the affected areas and notify the Owner prior to changeover. Cover openings in ductwork to remain. Protect equipment and systems to remain.

1.18 ACCESSIBILITY:

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

B. Final installed conditions shall accommodate accessibility and replacement of system components that regularly require service and replacement. This includes control devices, sensors, motors, etc.. Such devices shall not be permanently obstructed by building systems such as piping, ductwork, insulation, drywall, etc.

1.19 NAMEPLATE DATA:

A. Provide permanent operational data nameplate, on each item of mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location. Coordinate with Owner for specific requirements.

1.20 CLEANING:

A. Refer to LCCC Bidding Documents.

1.21 RECORD DOCUMENTS:

A. Refer to LCCC Bidding Documents. The following paragraphs supplement the requirements of LCCC Bidding Documents.

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 Drawing Prints to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices. Changes to be noted on the drawings shall include final location of any piping or ductwork relocated more than 1 foot-0 inches from where shown on the drawings.

D. Mark shop drawings to indicate approved substitutions; Change Orders; actual equipment and materials used.

E. Mark equipment and fixture schedules on drawings to indicate manufacturer and model numbers of installed equipment and fixtures.

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 Mechanical Contract Documents in a read-only electronic format (.pdf unless otherwise noted). This set will include all revisions officially documented through the Engineer. Using the above color scheme, transfer any undocumented revisions from the construction site record drawings to this complete set. Submit completed documents to the Engineer. This contract will not be considered completed until these record documents have been received and reviewed by the Engineer.

H. Contractor may propose methods of maintaining record documents on electronic media. Obtain approval of Engineer and Owner prior to proceeding. Marked-up .pdf format readable by Bluebeam is preferred.

1.22 OPERATION AND MAINTENANCE DATA:

A. Refer to LCCC Bidding Documents.

B. No later than four (4) weeks prior to the completion of the project provide one complete set of Operating and Maintenance Manuals, or as specified in Sections of LCCC Bidding Documents (whichever is more stringent).

C. In addition to the information required LCCC Bidding Documents for Maintenance Data, include the following information:
   1. The job name and address and contractor's name and address shall be identified at the front of the electronic submittal.
   2. Description of mechanical equipment, function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
   3. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions. Provide any test reports and start-up documents.
4. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
5. Servicing instructions, lubrication charts and schedules, including Contractor lubrication reports.
6. Manufacturer's service manuals for all mechanical equipment provided under this contract.
7. Include the valve tag list.
8. Name, Address and Telephone numbers of the Sub-contractors and local company and party to be contacted for 24-hour service and maintenance for each item of equipment.
9. Starting, stopping, lubrication, equipment identification numbers and adjustment clearly indicated for each piece of equipment.
10. Complete recommended spare parts list.
11. Mechanical System and Equipment Warranties.
12. Copies of all test reports shall be included in the manuals.
13. Provide manuals with dividers for 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.
14. Final schedule of values with all mechanical change order costs included and identified.
15. 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.

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

1.23 PROJECT CLOSEOUT LIST:

A. In addition to the requirements specified in LCCC Bidding Documents, complete the requirements listed below.

B. The Contractor shall be responsible for the following Mechanical Submittal Checklist either by performing and/or coordinating such items prior to applying for certification of substantial completion. Refer to individual specification sections for additional requirements. (Checklist is located at the end of this section.)

1.24 WARRANTIES:

A. Refer to the LCCC Bidding Documents for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements. In any case the entire mechanical system shall be warranted no less than one year from the time of acceptance by the Owner.

B. Compile and assemble the warranties specified in Division 23, into the Operating and Maintenance Manuals.

C. Provide complete warranty information for each item to include product or equipment to include date or 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.

1.25 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.

### MECHANICAL SUBMITTAL CHECKLIST:

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<sup>3</sup> See Specific Specification Section for Test & Certification Requirements

END OF SECTION 23 05 00
SECTION 23 05 10
BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUBMITTALS:
A. Refer to LCCC Bidding Documents and Section 23 05 00 “Common Work Results for Mechanical” for administrative and procedural requirements for submittals.
B. Product Data: Submit industry standards and manufacturer's technical product data, installation instructions, and dimensioned drawings for each type of pipe and pipe fitting. Submit piping schedule showing pipe or tube weight, fitting type, and joint type for each piping system.
C. Welding Certifications: Submit reports as required for piping work.

1.2 QUALITY ASSURANCE:
A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
B. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
C. Welding procedures and testing shall comply with the latest revisions of the applicable sections for B31, of the ANSI/ASME standard codes for pressure piping, noted as follows: B31.1 - Pressure Piping Code / B31.2 - Fuel Gas Piping Code / B31.5 - Refrigeration Piping / B31.9 - Building Service Piping Code.
D. Before any welding is performed, the contractor shall submit to the Architect/Engineer, or his authorized, a copy of the Manufacturer's Record of Welder or Welding Operator Qualification Tests and his Welding Procedure Specification together with the Procedure Qualification Record as required by ASME Boiler and Pressure Vessel Code.
E. Each manufacturer or contractor shall be responsible for the quality of welding done by his organization and shall repair or replace any work not in accordance with these specifications.

PART 2 - PRODUCTS

2.1 GENERAL:
A. Piping Materials: Provide pipe and tube of type, pressure and temperature ratings, capacities, joint type, grade, size and weight (wall thickness or Class) indicated for each service. Where type, grade or class is not indicated, provide proper selection as determined by Installer for installation requirements, and comply with governing regulations and industry standards.
B. Pipe/Tube Fittings: Provide factory-fabricated fittings of type, materials, grade, class and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections, and with pipe manufacturer's recommendations where applicable.
2.2 STEEL PIPES AND PIPE FITTINGS:

A. Black Steel Pipe: ASTM A 53, Grade B, type E, electric resistance welded.

B. PE Pipe: ASTM D 2513, SDR 11.

C. Malleable-Iron Threaded Fittings: ANSI/ASME B16.3; plain or galvanized as indicated (Class 125 and 300).


E. Steel Flanges/Fittings: ANSI/ASME B16.5, including bolting and gasketing of the following material group, end connection and facing, except as otherwise indicated.
   - Material Group: Group 1.1.
   - End Connections: Buttwelding.
   - Facings: Raised-face.

F. Wrought-Steel Buttwelding Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.

G. Forged Branch-Connection Fittings: Except as otherwise indicated, provide type as determined by Installer to comply with installation requirements.

H. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2 inches, and where pipe size is less than 1-1/2 inches, and do not thread nipples full length (no close-nipples).

I. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.

J. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

   - Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
   - Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.[ Vent casing aboveground.]
   - Aboveground Portion: PE transition fitting.
   - Outlet shall be threaded or flanged or suitable for welded connection.
   - Tracer wire connection.
   - Ultraviolet shield.
   - Stake supports with factory finish to match steel pipe casing or carrier pipe.

   - Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
   - Outlet shall be threaded or flanged or suitable for welded connection.
   - Bridging sleeve over mechanical coupling.
   - Factory-connected anode.
   - Tracer wire connection.
   - Ultraviolet shield.
CONSTRUCTION DOCUMENTS
LARAMIE COUNTY COMMUNITY COLLEGE
June 25, 2018
Laramie Campus Generator Addition
Project No. 2017-125

2.3 MISCELLANEOUS PIPING MATERIALS/PRODUCTS:

A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements.


7. Stake supports with factory finish to match steel pipe casing or carrier pipe.

M. Plastic Mechanical Couplings, NPS 1-1/2 (DN 40) and Smaller: Capable of joining PE pipe to PE pipe.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   c. Perfection Corporation; a subsidiary of American Meter Company.

2. PE body with molded-in, stainless-steel support ring.
4. Acetal collets.
5. Electro-zinc-plated steel stiffener.

N. Plastic Mechanical Couplings, NPS 2 (DN 50) and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   c. Perfection Corporation; a subsidiary of American Meter Company.

2. Fiber-reinforced plastic body.
3. PE body tube.
5. Acetal collets.

O. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Dresser Piping Specialties; Division of Dresser, Inc.
   b. Smith-Blair, Inc.

2. Steel flanges and tube with epoxy finish.
4. Steel bolts, washers, and nuts.
5. Factory-installed anode for steel-body couplings installed underground.
B. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

C. Pipe Thread Sealant Material: Except as otherwise indicated, provide all pipe threads with the sealant material as recommended by the manufacturer for the service.

1. Manufacturer: Subject to compliance with requirements, provide piping thread sealant material of the following:
   a. The Rectorseal Corporation

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Verify all dimensions by field measurements. Verify that all water distribution piping may be installed in accordance with pertinent codes and regulations, and original design, and the referenced standards.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PIPING INSTALLATION:

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16 inch misalignment tolerance.

1. Comply with ANSI B31 Code for Pressure Piping.
2. Install underground, PE, natural-gas piping according to ASTM D 2774.
3. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures. Only piping serving this type of equipment space shall be allowed.
4. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
5. Use fittings for all changes in direction and all branch connections.
6. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
7. Install piping free of sags or bends.
8. Coordinate foundation and all other structural penetrations.

3.3 PIPING SYSTEM JOINTS:

A. General: Provide joints of type indicated in each piping system.

B. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.
C. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31. Provide weld-o-let fittings for two pipe sizes less than main pipe size.

D. Weld pipe joints in accordance with recognized industry practice and as follows:
   1. Weld pipe joints only when ambient temperature is above 0 degrees F (-18 degrees C) where possible.
   2. Bevel pipe ends at a 37.5 degrees angle where possible, smooth rough cuts, and clean to remove slag, metal particles and dirt.
   3. Use pipe clamps or tack-weld joints with 1 inch long welds; 4 welds for pipe sizes to 10 inches, 8 welds for pipe sizes 12 inch to 20 inch.
   4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusions.
   5. Do not weld-out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.

E. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

F. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.4 PIPING APPLICATION:

A. Accessible Gas Piping:
   1. Above Grade:
      a. Exposed Location:
         1) 2 Inches and Smaller: Schedule 40, black steel pipe, beveled ends, with 150 lb. malleable iron fittings and threaded joints.
         2) Over 2 Inches: Schedule 40 black steel with butt weld fittings and welded joints.
         3) Above Ground Outside: Schedule 40 black steel pipe sizes matching above. Piping shall be painted to protect against rust.
      b. Inaccessible Location:
         1) All sizes: Schedule 40 black steel pipe, beveled ends, with socket weld fittings same thickness as pipe; welded joints.

3.5 PIPING TESTS:

A. General: Provide temporary equipment for testing, including pump and gauges. Test piping system before insulation is installed wherever feasible, and remove control devices before testing. Test each section of each piping system independently but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.
B. Test all piping systems as specified. Correct leaks by remaking joints. Remove equipment not able to withstand test procedure during test.

C. Work to be installed shall remain uncovered until the required tests have been completed.

D. Piping which is to be concealed shall be tested before being permanently enclosed.

E. As soon as work has been completed, conduct preliminary tests to ascertain compliance with specified requirements. Make repairs or replacements as required.

F. Give a minimum of twenty-four hours notice to Engineer of dates when acceptance test will be conducted. Conduct tests as specified for each system in presence of representative of owner, agency having jurisdiction or his representative. Submit three (3) copies of successful tests to the Engineer for his review. Report shall state system tested and date of successful test.

G. Contractor shall obtain certificates of approval, acceptance and compliance with regulations of agencies having jurisdiction. Work shall not be considered complete until such certificates have been delivered by the Engineer to the Owner.

H. All costs involved in these tests shall be borne by Contractor.

I. System Tests

1. Compressed Air or Nitrogen Test: Compressed air tests may be substituted for hydrostatic tests only when ambient conditions or existing building conditions prohibit safe use of hydrostatic testing and must be reviewed by the Engineer prior to any testing. For tests of this type, the piping system shall be subjected to the gas pressure indicated for that specific system. The piping capped or plugged and water-pumped with oil free air, or a nitrogen bottle shall be introduced into the entire system to the pressure specified. The system shall maintain that pressure for the duration of a soapy water test of each joint.

2. Repair piping systems sections which fail required piping test, by disassembly and re-installation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.

3.6 ADJUSTING AND CLEANING:

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

1. Inspect pressure piping in accordance with procedures of ASME B31.

3.7 COMMISSIONING:

A. Fill system.

B. Before operating the system open valves to full open position.

END OF SECTION 23 05 10
SECTION 23 05 29
HANGERS AND SUPPORTS FOR MECHANICAL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.
   2. MSS Standard Compliance:
      a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-69.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location, and features for each required pipe hanger and support.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

C. Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.

D. Maintenance Data: Submit maintenance data and parts list for each type of support and anchor. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 23.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

   1. Pipe Hangers and Supports:
      a. B-Line Systems Inc.
      b. ANVIL International
      c. PHD Manufacturing, Inc.
      d. Unistrut Metal Framing Systems
      e. Hubbard Enterprises (Supports for domestic water piping)
      f. Specialty Products Co. (Supports for domestic water piping.
      g. Erico
      h. Grinnell
2.2 PIPE HANGERS & SUPPORTS:

A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-69.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.
2. Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

B. Pipe Clamps: MSS Type.

2. Copper Pipe, size 1/2" thru 4", Type 8 (PVC Coated).

C. U Bolts: MSS Type.

1. Steel Pipe, size 1/2" thru 30", Type 24.
2. Copper Pipe, size 1/2" thru 8", Type 24 (PVC Coated).

D. Straps: MSS Type 26.

E. Pipe Stanchion Saddle: MSS Type 37.

F. Hangers:

1. Cold Pipes:
   a. 1/2" through 1-1/2": Adjustable wrought steel ring.
   b. 2" and Over: Adjustable wrought steel clevis.

2. Multiple or Trapeze: Structural steel channel (with web vertical and engineered for the specific applications), with welded spacers and hanger rods. Provide cast iron roll and base plate for hot pipe sizes six inches and over. Provide hanger rods one size larger than for largest pipe in trapeze. If the deflection at center of trapeze exceeds 1/360 of the distance between the end hangers, install an additional hanger at mid-span or use a larger channel.

G. Wall Supports for Horizontal Steel Pipe:

1. ½ inch through 4 inches: Offset or straight j-hook.
2. 4 inches and Over: Welded steel bracket Type 31, 32 or 33 and wrought steel clamp. Provide adjustable steel yoke and cast iron roll Type 44 for hot pipe 200 degrees F and over and for sizes six inches and over.

H. Supports for Vertical Pipe: Steel riser clamp. Type 8.

2.3 MISCELLANEOUS MATERIALS:

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

C. Pipe Alignment Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted.
tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide
guides of length recommended by manufacturer to allow indicated travel.

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which supports and anchors are to be installed. Do not
proceed with work until unsatisfactory conditions have been corrected in manner acceptable to
Installer.

3.2 PREPARATION:

A. Proceed with installation of hangers, supports and anchors only after required building structural
work has been completed in areas where the work is to be installed. Correct inadequacies including
(but not limited to) proper placement of inserts, anchors and other building structural attachments.
Review Structural Drawings to obtain structural support limitations.

B. Prior to installation of hangers, supports, anchors and associated work, Installer shall meet at
project site with Contractor, installer of each component of associated work, inspection and testing
agency representatives (if any), installers of other work requiring coordination with work of this
section and Engineer for purpose of reviewing material selections and procedures to be followed in
performing the work in compliance with requirements specified. Provide Shop Drawing showing
method and support locations from structure.

3.3 INSTALLATION OF BUILDING ATTACHMENTS:

A. Install building attachments within concrete or on structural steel. Space attachments within
maximum piping span length indicated in MSS SP-69. Install additional attachments at
concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in
direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where
concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through
openings at top of inserts.

B. Existing Construction:

1. In existing concrete construction, drill into concrete slab and insert and tighten expansion
anchor bolt. Connect anchor bolt to hanger rod. Care must be taken in existing concrete
construction not to sever reinforcement rods or tension wires.

3.4 INSTALLATION OF HANGERS AND SUPPORTS:

A. Install hangers, supports, clamps and attachments to support piping properly from building
structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be
supported together on field fabricated, heavy-duty trapeze hangers where possible. Install supports
with maximum spacings complying with MSS SP-69. Where piping of various sizes is supported
together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports
for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support
piping from other piping.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other
accessories.
C. Prevent electrolysis and abrasion in support of copper tubing by use of hangers and supports which are plastic coated, or with EPDM isolation strips. Duct tape or copper coated hangers are not acceptable.

D. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, to facilitate action of expansion joints, expansion loops, expansion bends and similar units and within 1'-0" of each horizontal elbow.

E. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

F. Install steel natural gas piping with the following minimum rod size and maximum spacing:

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<th>MAX. SPAN IN FEET</th>
<th>MIN. ROD SIZE - INCHES</th>
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<td>30</td>
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Vertical, all sizes every floor level

G. Place a support within one foot of each horizontal elbow.

H. Support vertical steel piping at every story height but at not more than 15 foot intervals for steel and 10 feet for copper.

I. Where practical, support riser piping independently of connected horizontal piping.

J. Install anchors and fasteners in accordance with manufacturer's recommendations and the following:

1. In the event a self-drilling expansion shield or machine bolt expansion shield is considered to have been installed improperly, the Contractor shall make an acceptable replacement or demonstrate the stability of the anchor by performing an on-site test under which the anchor will be subjected to a load equal to twice the actual load.

2. Powder-driven fasteners may be used only where they will be concealed after the construction is complete. Where an occasional fastener appears to be improperly installed, additional fastener(s) shall be driven nearby (not closer than 6 inches) in undisturbed concrete. Where
it is considered that many fasteners are improperly installed, the Contractor shall test load any 50 successively driven fasteners. If 10 percent or more of these fasteners fail, the Contractor shall utilize other fastening means as approved and at no additional cost to the Owner.

3.5 METAL FABRICATION:

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours at welded surfaces match adjacent contours.

3.6 ADJUSTING:

A. Support Adjustment: Adjust supports to distribute loads equally on attachments and to achieve indicated slope of pipe. Cut off the bottom of threaded rods so they are no more than one rod diameter below the bottom nut.

B. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

END OF SECTION 23 05 29
SECTION 23 05 53
IDENTIFICATION FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer’s technical product data and installation instructions for each identification material and device required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

B. Mechanical Identification:

1. Allen Systems, Inc.
4. Industrial Safety Supply Co., Inc.
5. Seton Name Plate Corp.
6. PVC Specialties
7. Marking Systems, Inc. (MSI)

2.2 MECHANICAL IDENTIFICATION MATERIALS:

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division-23 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

END OF SECTION 23 05 53
PART 1 - GENERAL

1.1 DEFINITIONS:

A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

B. Gas Distribution Piping: A pipe within the building which conveys gas from the point of delivery to the points of usage.

C. Gas Service Piping: The pipe from the gas main or other source of supply including the meter, regulating valve, or service valve to the gas distribution system of the building served.

D. Point of Delivery is the outlet of the service meter assembly, or the outlet of the service regulator (service shutoff valve when no meter is provided).

1.2 SUBMITTALS:

A. Product data for each gas piping specialty and special duty valve. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.

B. Shop drawings detailing dimensions, required clearances, for connection to gas meter.

C. Record Drawings: At project closeout, submit record drawings of installed systems products; in accordance with requirements of Division 23.

D. Maintenance data for gas specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 23.

E. Welders' qualification certificates, certifying that welders comply with the quality requirements specified under "Quality Assurance" below.

F. Test reports specified in Part 3 below.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of natural gas systems products, of types, materials, sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer Qualifications: Installation and replacement of gas piping, gas utilization equipment or accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.

C. Qualifications for Welding Processes and Operators: Comply with the requirements of ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualification."
D. Regulatory Requirements: Comply with the requirements of the following codes:
   1. NFPA 54 - National Fuel Gas Code, for gas piping materials and components, gas piping installations, and inspection, testing, and purging of gas piping systems.
   2. Local Building Code.
   3. Utility Compliance: Fabricate and install natural gas systems in accordance with local gas utility company.

1.4 DELIVERY, STORAGE, AND HANDLING:
   A. Handling Flammable Liquids: Remove and legally dispose of liquid from a drip in existing gas piping and handle cautiously to avoid spillage or ignition. Notify the gas supplier. Handle flammable liquids used by the installer with proper precautions, and do not leave on the premises from the end of one working day to the beginning of the next.

1.5 SEQUENCING AND SCHEDULING:
   A. Notification of Interruption of Service: Except in the case of an emergency, notify all affected users when the gas supply is to be turned off.
   B. Work Interruptions: When interruptions in work occur while repairs or alterations are being made to an existing piping system, leave the system in safe condition.
   C. Coordinate the installation of pipe sleeves for foundation wall penetrations.

1.6 EXTRA MATERIALS:
   A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring same.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:
   A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
      1. Gas Cocks:
         a. Jenkins Bros.
         b. Lunkenheimer Co.
         c. Nibco, Inc.
         d. Powell Co.
         e. Stockham.

2.2 PIPE, TUBING AND JOINTING MATERIALS:
   A. Provide pipes and pipe fitting complying with Division 23, Section 23 05 10 “Basic Piping Materials and Methods”.

2.3 NATURAL GAS PIPING SPECIALTIES:
   A. Protective Coating: Provide factory applied polyethylene tape, having the following properties:
      1. Overall thickness; 20 mils.
      2. Synthetic adhesive.
3. Water vapor transmission rate.
4. Gallons per 100 square inch: 0.10 or less.
5. Water absorption, percent: 0.02 or less.
6. Prime pipe and fittings with a compatible primer prior to application of tape.
7. Pipe wrapping shall conform to the following schedule:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Tape Width</th>
<th>Scotchwrap No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td>1/4 - 3/4 inch</td>
<td>1 inch</td>
<td>50</td>
</tr>
<tr>
<td>1 - 1-1/2 inch</td>
<td>2 or 4 inch</td>
<td>50</td>
</tr>
<tr>
<td>2 inch and larger</td>
<td>4 inch</td>
<td>50</td>
</tr>
<tr>
<td>Color backing</td>
<td>Black</td>
<td>Green</td>
</tr>
</tbody>
</table>

8. During application of wrap, if the ambient temperature is 40 degrees F or less, use only Scotchwrap No. 40 tape. If ambient temperature is 40 degrees F or more, use only Scotchwrap No. 50.

2.4 VALVES:

A. Special duty valves are specified in this section by their generic name. Refer to Part 3, "VALVE APPLICATION," for specific uses and applications for valve specified.

B. Gas Cocks 2 Inch and Smaller: 150 psi WOG, bronze body, straightaway pattern, square head, threaded ends.

C. Gas Cocks 2-1/2 Inch and Larger: MSS SP-78; 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.

D. Gas Line Pressure Regulators: Single stage, steel jacketed, corrosion-resistant gas pressure regulators; with atmospheric vent, elevation compensator; with threaded ends for 2 inch and smaller, flanged ends for 2-1/2 inch and larger; for inlet and outlet gas pressures, specific gravity, and volume flow indicated.

PART 3 - EXECUTION

3.1 INSPECTION:

A. General: Examine areas and conditions under which natural gas systems materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2 PREPARATION:

A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.

B. Conform to the requirements in NFPA 54, for the prevention of accidental ignition.
3.3 INSTALLATION OF PIPE:

A. Install natural gas piping in accordance with Division 23, Section 23 05 10.

B. Conform to the requirements of NFPA 54 - National Fuel Gas Code.

C. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.

D. Install pipe sleeve and seals at foundation and basement wall penetrations, as specified in Division 23 Section 23 05 10 "Basic Piping Materials and Methods."

E. Drips and Sediment Traps: Install a drip leg at points where condensate may collect, at the outlet of the gas meter, and in a location readily accessible to permit cleaning and emptying. Do not install drips where condensate is likely to freeze.

1. Construct drips and sediment traps using a tee fitting with the bottom outlet plugged or capped. Use a minimum of 3 pipe diameters in length for the drip leg. Use same size pipe for drip leg as the connected pipe.

F. Use fittings for all changes in direction and all branch connections.

G. Install gas piping at a uniform grade upward to risers, and from the risers to the meter, or service regulator when meter is not provided, or the equipment.

H. Connect branch outlet pipes from the top of horizontal lines, not from the bottom or sides.

3.4 NATURAL GAS PIPING SPECIALTIES:

A. Protective Coating:

1. Provide protective coating on piping and fittings that will be in contact with material or atmosphere exerting a corrosive action, or piping buried in floors. Protective coating shall be applied at the factory.

3.5 VALVE APPLICATIONS:

A. General: The Drawings indicate valve types, locations, and arrangements.

B. Shut-off duty: Use gas cocks.

3.6 VALVE INSTALLATIONS:

A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.

B. Install a gas cock upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.

C. Install pressure relief or pressure limiting devices so they can be readily operated to determine if the valve is free; so they can be tested to determine the pressure at which they will operate; and examined for leakage when in the closed position. Pipe atmospheric vent to outdoors.
D. Valves shall be installed with unions or other means to facilitate removal or repair without disassembly of connecting piping.

3.7 ELECTRICAL BONDING AND GROUNDING:
A. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code."
B. Do not use gas piping as a grounding electrode.

3.8 FIELD QUALITY CONTROL:
A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.
B. Test system before covering underground lines.
C. Submit written results of tests to Engineer.

3.9 SPARE PARTS:
A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring same.

END OF SECTION 23 11 23
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. Give particular attention to large equipment requiring an access path for positioning prior to closing-in the building or space.

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 such as corridors 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 transformers.

1.4 COORDINATION:

A. Work out all installation conditions in advance of installation. The Contractor shall be responsible for preparing coordination drawings, showing all work, in all areas. The Contractor shall be responsible for providing all labor and material, including but not limited to all fittings, hangers, control devices, lighting, low voltage equipment, cable tray, conduit, transformers, disconnects, etc., necessary to overcome congested conditions at no increase in contact sum. The Contractors base bid shall include any and all time and manpower necessary to develop such coordination efforts and drawings. Increases to contract sum or schedule shall not be considered for such effort.
B. Provide proper documentation of equipment, product data and shop drawings to all entities involved in the project. 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. Due to a proven history of failing to comply with the coordination and project management requirements of Cator, Ruma, and Associates. Any proposal directly from Greiner Electric or using Greiner electric as a sub-contractor will be rejected and returned.

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 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 not fully detailed nor specified in these documents, or catalogued by the manufacturer
3. Seismic restraint systems

1.6 PROJECT CONDITIONS:

A. The contractor shall attend a pre-bid walk-thru, when required under Division 01, and shall make themselves familiar with the existing conditions. No additional costs to the Owner shall be accepted for additional work for existing conditions.

B. Provide field verification of all conditions prior to submitting bids.

C. Report any damaged equipment or systems to the Owner prior to any work.

D. Protect all work against theft, injury or damage from all causes until it has been tested and accepted.

E. Be responsible for all damage to the property of the Owner or to the work of other contractors during the construction and guarantee period. Repair or replace any part of the work which may show defect during one year from the final acceptance of all work, provided such defect is, in the opinion of the 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 for all new to existing connections.

G. Provide temporary electrical connections where required to maintain existing areas operable.

H. Coordinate all services shut-down with the Owner; provide temporary services. Coordinate any required disruptions with Owner, at a minimum one week in advance.

I. Minimize disruptions to operation of electrical systems in occupied areas.

J. 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.

1.7 SAFETY:

A. Refer to Division 01.

1.8 EQUAL EMPLOYMENT OPPORTUNITY REQUIREMENTS:

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

1.9 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. The handling, removal and disposal of regulated liquids or other materials shall be in accordance with U.S. EPA, state and local regulations.

E. The handling, removal and disposal of lead based paint and other lead containing materials shall comply with EPA, OSHA, and any other Federal, State, or local regulations.

F. 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.

1.10 PERMITS AND FEES:
A. Refer to Division 01.

B. Owner shall pay all fees required for connection to municipal and public utility facilities through their service contract with each respective service provider.

C. Contractor shall arrange for and pay for all permits, inspections, licenses and certificates required in connection with the work.

1.11 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 and fire alarm systems shall be installed to meet NFPA and IBC Seismic requirements.

1. Where any conflicts arise the more stringent requirements shall be applicable.

2. The design of the seismic requirements shall be the responsibility of the contractor.

1.12 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.

1.13 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.

1.14 SUBMITTALS:

A. General

1. Refer to the Conditions of the Contract (General and Supplementary), 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 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.
4. 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.
5. An index shall be provided which includes:
   a. Product
   b. Specification Section
   c. Manufacturer and Model Number
6. Submittal schedule shall be provided for review within four (4) working weeks from award of contract to successful bidder.

B. Basis of Design: The manufacturer's material or equipment listed first in the specifications or on the 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. Submit proposed changes to electrical room or other equipment room layouts when revised from contract documents prior to installation.

L. 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, panelboards, overcurrent protection devices and utilization equipment.
1.15 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. Emergency Generator
   g. Power Transfer Equipment
   h. 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. Equipment Settings Report: Where specifically identified or within individual Division 26
Sections or necessary for confirmation of products, submit Equipment Settings Report
indicating final configurations and settings.

1. Provide report of settings, parameters, programing inputs and parameters, etc., installed at
each piece of electrical equipment that allows adjustments to be made in the field and those
set at the factory. The report shall be arranged by specification section and each piece of
equipment broken out individually or by listing of equipment if the same settings are installed in
multiple pieces of equipment.

2. In addition to the requirements above, include within this report any transfer switch settings
including time delays and upstream protection device settings with copies of listed OCPD’s for
each ATS; as well as, Generator settings and parameters.

3. Report shall be submitted and received by the Engineer at least fifteen calendar days prior to
the contractor's request for final observation. Include in the O & M Manual after review and "No
Exceptions Taken" has been accomplished.

I. Software Licenses: Provide documentation of ownership under the Owner’s corporate name
(coordinate with owner’s representative for exact ownership wording) for Software Licenses
provided as part of the work included under Divisions 26, 27, and 28. Include information for
updates, subscription requirements if applicable, backup, support, login, passwords, date when
purchased, expiration date if applicable, version, etc. Include in the O & M Manual after review
and "No Exceptions Taken" has been accomplished.

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

1.16 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.

1.17 DEMOLITION/REMODEL WORK:

A. 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.
B. 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.

C. Existing equipment that is removed and is to be reused shall be cleaned, serviced and operable before being reinstalled.

D. Revise panelboard schedules to reflect removal or relocation of equipment. Circuit integrity of equipment in adjacent areas shall be left intact.

E. 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.

F. 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.

G. Where remodeling interferes with circuits serving areas outside of the project or phase limits or which are remodeled in later phases of the project, circuits shall be reworked or temporary circuits provided as required. Take care to avoid overloading any one of the three phases in existing three phase panels.

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, luminaries, 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; along 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.

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.
1.18 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. Refer to the Division 01 Section covering cutting and patching for general requirements.

C. Do not endanger or damage installed Work through procedures and processes of cutting and patching.

D. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.

E. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.

F. 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.

G. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

H. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

I. Locate, identify, and protect electrical services passing through remodel or demolition area and serving other areas required to be maintained operational.

1.19 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.

1.20 ACCESSIBILITY:

A. Install equipment and materials to provide required code clearances and access for servicing and maintenance. Coordinate the final location with piping, ducts, and equipment of other trades to insure proper access for all trades. Coordinate locations of concealed equipment, disconnects, and boxes with access panels and doors. Allow ample space for removal of parts, fuses, lamps, etc. that require replacement or servicing.

B. Extend all conduits so that junction and pull boxes are in accessible locations.

C. Provide access panel or doors where equipment or boxes are concealed behind finished surfaces.
D. Furnish hinged steel access doors with concealed latch, whether shown on drawings or not, in all walls and ceilings for access to all concealed valves, shock absorbers, air vents, motors, fans, balancing cocks, and other operating devices requiring adjustment or servicing. Refer to Division 01 for access door specification and requirements.

1.21 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.

1.22 EXCAVATING AND BACKFILLING:

A. General:

1. In general, follow all regulations of OSHA as specified in Part 1926, Subpart P, "Excavations, Trenching and Shoring." Follow specifications of Division 26 as they refer specifically to the electrical work.

B. Contact Owners of all underground utilities to have them located and marked, at least 2 business days before excavation is to begin. Prior to starting excavation, brief employees on marking and color codes and train employees on excavation and safety procedures for Utilities including electrical lines and natural gas lines. When excavation approaches electrical or gas lines, expose lines by carefully probing and hand digging.

C. Trenching:
1. Provide all necessary pumping, cribbing and shoring.

2. Walls of all trenches shall be a minimum of 6 inches clearance from the side of the nearest electrical work. Install conduits with a minimum of 6 inches (or as identified on the drawings) clearance between them when located in same trench.

3. Dig trenches to depth, width, configuration, and grade appropriate to the materials being installed. Dig trenches to 6 inches below the level of the bottom of the material to be installed. Install 6 inches bed of sand, pea gravel, or squeegee, mechanically tamp to provide a firm bed, true to line and grade without irregularity. Provide depressions only at hubs, couplings, flanges, or other normal protrusions.

D. Backfilling shall not be started until all work has been inspected, tested and accepted. All backfill material shall be accepted by LCCC. In no case shall lumber, metal or other debris be buried in with backfill.

1. Provide warning tape for marking and locating underground utilities. Tape shall be specifically manufactured for this purpose and shall be polyethylene film, 6 inches wide, 0.004 inches thick and have a minimum strength of 1750 psi. Tape shall carry continuous inscription naming the specific utility.
   a. Tape shall have magnetic strip and be used for exterior underground system only.

E. Trench Backfill

1. Backfill to 4 inches above top of conduits with sand, the same as used for conduit bed, compact properly.

2. Continue backfill to finish grade, using friable material free of rock and other debris. Install in 12 inch layers, each properly moistened and mechanically compacted prior to installation of ensuing layer. Compaction by hydraulic jetting is not permissible.

F. After backfilling and compacting, any settling shall be refilled, tamped, and refinished at contractor's expense.

G. This contractor shall repair and pay for any damage to finished surfaces.

H. Backfill near manholes or hand holes using sand, installing it in 12 inch layers to 4 inches above the shallowest conduit. Use suitable excavated material to complete the backfill, installed in 6 inch layers and mechanically compacted to seal against water infiltration. Compact to 95% below paving and slabs and 90% elsewhere.

I. Use suitable excavated material to complete the backfill, installed in 12 inch lifts and mechanically compacted to seal against water infiltration. Compact to 95 percent for the upper, 30 inches below paving and slabs and 90 percent elsewhere.

1.23 NAMEPLATE DATA:

A. Provide equipment with permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Install equipment so that nameplate is readily visible.

1.24 CLEANING:

A. Refer to the Division 01 Section on project closeout or final cleaning for general requirements for final cleaning.
1.25 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 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.

1.26 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 start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
5. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
6. Servicing instructions and lubrication charts and schedules.
7. Manufacturer's service manuals for all electrical equipment provided under this contract.
8. Complete equipment and protection wiring diagrams. All wiring diagrams shall show color coding of all connections and mounting dimensions of equipment.
9. Equipment identification numbers and adjustment clearly indicated for each piece of equipment.
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.

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.

1.27 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.

1.28 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.

1.29 CONSTRUCTION REQUIREMENTS:

A. The contractor shall maintain and have available at the jobsite current information on the following at all times:

1. Up to date record drawings.
2. 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.

1.30 EQUIPMENT HOUSEKEEPING PADS:

A. Provide 6" high concrete housekeeping pad for new generator. Fabricate pad as follows:

1. Coordinate size of equipment bases with actual unit sizes provided. Fabricate base 3" larger in both directions than the overall dimensions of the supported unit.
2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
3. Place concrete and allow proper curing before installation of units. Use Portland cement that conforms to ASTM C 150; 54,000-psi compressive strength, and normal weight aggregate.
4. Anchor housekeeping pads to slab using #3 rebar bent in “L” or “Z” shape 12 inch on center on each side of slab.

END OF SECTION 26 05 00
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. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.

C. Field Quality Control Test Reports: Submit record of testing. Refer to Section 26 05 00 – Common Work Results for additional requirements.

D. 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 Concealed or 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. Exposed Exterior Locations
   1. Provide single conductor building wire in suitable raceway system.

E. Underground Installation
   1. Provide single conductor building wire in suitable raceway system.

F. 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:
      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. General: Install electrical cables, wires and connectors in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation", and in accordance with recognized industry practices.

B. 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.

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, control or fire alarm 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. Support cables above accessible ceilings. Independent from the ceiling suspension system to support cables from structure, do not rest on ceiling tiles.
K. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger. For 10 AWG and smaller, use insulated screw on type spring wire connectors with plastic caps, push on type are not acceptable.

L. Use copper compression connectors for copper wire splices and taps, 1/0 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the conductor.

M. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

N. Thoroughly tape the ends of spare conductors in boxes and cabinets.

O. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.

P. Make all ground, neutral and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to individual ground terminal of devices.

Q. Parallel conductors shall be cut to the same length.

R. Provide wire training, lacing, labeling, and terminal blocks as required in panelboards and all control cabinets including, but not limited to, lighting, transfer switch, fire alarm, and security cabinets. All wiring shall be installed neat and be labeled to match wiring diagrams, control devices, etc.

1. Make temporary connections to panelboard devices with sufficient slack conductor to facilitate reconnections required for balancing loads between phases.

3.2 FIELD QUALITY CONTROL:

A. Provide all test results to Engineer in Substantial Completion Submittals, via Architect, 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.

3.3 COLOR CODING SCHEDULE:

A. Color code secondary service, feeder, and branch circuit conductors shall match existing color scheme currently installed for 208/120V Wye system.

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

END OF SECTION 26 05 19
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. Ground Bus: Bare annealed copper bars of rectangular cross section.

B. Braided Bonding Jumpers: Copper tape, braided No. 30 gage bare copper wire, terminated with copper ferrules.

C. 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.

D. Exothermic Welded Connections: Provided in kit form and selected for the specific types, sizes, and combinations of conductors and other items to be connected.

2.5 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:
   2. Nonmetallic Raceways: Install an insulated equipment ground conductor in nonmetallic raceways unless they are designated for telephone or data cables.

B. Underground Conductors: Bare, tinned, stranded copper except as otherwise indicated.

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

C. 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. Exothermic Welded Connections: Use for connections to structural steel and for underground connections. Install at connections to ground rods. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. 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.

D. 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.

E. 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.

F. Moisture Protection: Where insulated ground conductors are connected to ground rods or ground buses, insulate the entire area of the connection and seal against moisture penetration of the insulation and cable.
3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING:

A. Pad Mounted Gear: Install a 3/4 inch by 10 feet, driven ground rod inside the cable access block-out of the pad and set the rod depth such that 4 inches will extend above the finished pad. Where necessary, install ground rod before the equipment is placed. Protect ground rods passing through concrete with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below the concrete.

B. Grounding System: Ground non-current-carrying metallic items associated with pad-mounted equipment by connecting them to grounding electrodes arranged as indicated.

3.5 FIELD QUALITY CONTROL:

A. Provide all test results to Engineer in Substantial Completion Submittals, via Architect, 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.

3.6 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
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.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. 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.

E. 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.
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.

C. Pipe Sleeves: Provide pipe sleeves of one of either; Steel Pipe (fabricated from Schedule 40 galvanized steel pipe), or metallic conduit (EMT, IMC, or RMC).

### 2.4 FIRE SEALS:

A. Material: Fire stopping material shall be asbestos free, 100 percent intumescent, have code approval under BOCA, ICBO, SSBC, NFPA 101, NFPA 70, and be capable of maintaining an effective barrier against flame and gases in compliance with the following requirements.

B. Flame Spread: 25 or less, ASTM E84

C. Fire Resistance and Hose Stream Tests: Fire stopping materials shall be rated "F" and "T" in accordance with ASTM E 814 or UL 1479. Rating periods shall conform to the following:

### 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. When (4) or more 2 inch conduits are installed together in a trapeze, supports shall be spaced 5 feet O.C.

8. In all runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

9. Threaded rod supports to have bottoms cut off at a maximum length equal to rod diameter below bottom nut.

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. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for cable installations as required. Where sleeves through floors are installed, extend above finish floor. For sleeves through fire rated-wall or floor construction, apply UL-listed fire stopping sealant in gaps between sleeves and cables.

I. Conduit Seals: Install seals for conduit penetrations of exterior walls below grade. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

J. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws 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. Rigid Polyvinyl Chloride (PVC)
4. 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. Nonmetallic Underground Conduit with Conductors (NUCC)
3. Reinforced Thermosetting Resin Conduit (RTRC)
4. Liquidtight Flexible Nonmetallic Conduit (LFNC)
5. Flexible Metallic Tubing (FMT)
6. Electrical Nonmetallic Tubing (ENT)
7. Intermediate Metallic Conduit (IMC)
8. Flexible Metal Conduit (FMC)
9. Auxiliary Gutters / Wireways
10. Surface Raceway
11. Busways and/or Cablebus
12. Cellular Concrete Floor Raceways
13. Underfloor Raceways
14. Cable Trays

1.2 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of raceway systems of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with electrical raceway work similar to that required for this project.

1.3 SUBMITTALS:

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

B. Record Documents: Record actual installed circuiting arrangements and routing for panel feeders and underground circuits.
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)

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. Rigid Polyvinyl Chloride (PVC)

1. Conduit: rigid, nonmetallic conduit listed and labeled as complying with UL 651. Provide Schedule 40 wall thickness unless subject to physical damage, where Schedule 80 is required. Rated for use with 90deg C conductors.
2. Fittings: Mate and match conduit type and material. Cement as recommended by manufacturer.
4. 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.
5. Do not use die-cast or indenter type connectors and couplings.

E. 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.

2.4 RACEWAY SEALING COMPOUND:

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

PART 3 - EXECUTION

3.1 INSPECTION:

A. Examine areas and conditions under which raceways are to be installed, and substrate which will support raceways. Provide notification in writing of conditions detrimental to proper completion of the work. Do not proceed with 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.

B. Buried Raceways (direct contact with Earth): Schedule 40 PVC. Where PVC conduit is provided, Transition to RMC with PVC coating where emerging from underground. Where PVC conduit larger than 2 inch trade size is provided, use RMC elbows for bends.

C. Raceways Through Foundation Walls Below Grade: One 10 foot section of PVC coated rigid steel galvanized, extending from 1 foot inside the foundation wall.

D. Concealed Within Hollow Stud Walls: EMT.

E. Concealed Above Accessible Ceilings: EMT.

F. Interior, Damp or Wet Locations: RMC or EMT w/ weatherproof fittings.

G. Exposed Interior in utility areas or areas with open ceilings: EMT

H. Exposed Exterior: RMC or PVC.

I. Connections to Vibrating Equipment: (Such as Transformers and Motors)

1. All Locations: LFMC.
2. Maximum Length: 6 feet unless otherwise indicated.

J. Raceways in locations subject to mechanical injury: PVC or RMC.

1. Locations subject to mechanical injury include, but are not limited to, the following:
a. Exposed conduits outdoors up to 8’ A.F.G.
b. Exposed service entrance feeders.

K. Raceways in all other areas shall be EMT unless otherwise noted.

L. Emergency/Essential Electrical System Circuits: All emergency and Essential Electrical system circuits shall be run totally in non-flexible metal conduit (IMC, RMC, PVC, or EMT).

M. Rework or extensions of existing conduit shall include the use of similar materials to the existing conduit type unless otherwise noted.

3.3 INSTALLATION OF CONDUITS:

A. General: Install electrical raceways in accordance with manufacturer's written installation instruction, applicable requirements of NEC, and as follows:

1. Conceal all conduits unless indicated otherwise, within finished walls, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.

2. Elevation of Raceway:

a. Where horizontal raceway is installed near water and steam piping, route raceway above piping and as close to structure as possible and practical.
b. Route raceway as close to structure as possible.

3. Complete installation of electrical raceways before starting installation of conductors within raceways.

4. Provide supports for raceways as specified elsewhere in Division 26.

5. Prevent foreign matter from entering raceways by using temporary closure protection.

6. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bend is not visible above the finished slab.

7. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

8. Use raceway fittings that are types compatible with the associated raceway and suitable for the use and location. Install expansion fittings across all structural construction joints and expansion/deflection couplings across all structural expansion joints.

9. Run raceways parallel and perpendicular to building elements and other equipment with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.

10. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.

11. Install vertical feeder conduits in exterior walls, core walls, or chase spaces. Do not install in interior wall partition areas.

12. 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.

13. 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.

14. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Joints in non-metallic conduits shall be made with solvent cement in strict accordance with manufacturer's recommendations.

15. Tighten set screws of thread less fittings with suitable tool.

16. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. 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.

17. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

18. Provide nylon pull string with printed footage indicators having not less than 200 pounds tensile strength. Leave not less than 12 inches of slack at each end of the pull string. Identify with tags at each end the origin and destination of each empty conduit and indicate same on all empty or spare conduits on the as-built drawings.

19. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
   a. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
   b. Where conduits enter through a foundation wall or stub-up through a slab on grade floor.
   c. Where required by the NEC.

20. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded plugs flush with floor.

21. Flexible Connections: Use short length (maximum of 6 feet) of flexible conduit for recessed and semi-recessed luminaires, for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid-tight flexible conduit in wet locations. Install separate ground conductor across flexible connections. PVC externally coated rigid steel conduit: Patch all nicks and scrapes in PVC coating after installing conduit.

22. 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.

23. Ream the ends of all cut and/or threaded conduit. Ends shall be cut square.

24. 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.

25. Route conduit through roof openings for piping and ductwork where possible; otherwise, rout through jack with pitch pocket.

26. Conduit stub-ups from below grade or thru the slab shall be PVC coated or PVC taped rigid steel galvanized conduit and shall extend 6 inches above grade.

27. Wherever conduits enter a structure through a foundation or basement wall below grade, grout around the conduit with water-proof grout or install entrance seals. Seals shall be OZ type CSM Series or equivalent for existing structures.

28. 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.

29. Install an insulated ground conductor in all conduits.

30. Use PVC-coated rigid steel or Fiberglass factory elbows for bends in plastic conduit runs longer than 100 feet, or in plastic conduit runs which have more than two bends regardless of length. Use long sweep bends for wiring larger than 350 mcm.

31. Wipe plastic conduit clean and dry before joining. Apply full even coat of cement to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum.
32. No PVC conduit shall be run exposed or inside stud or masonry walls unless specifically called for on the drawings. Transition from PVC to metal conduit shall be made below grade.

33. Provide separate raceway systems for each of the following:
   a. Emergency Systems
      a) Lighting
      b) Power Distribution

34. Paint new exposed conduits to match existing exposed conduits where installed in areas with existing painted conduits or where otherwise indicated.

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

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

3.4 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
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

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

1.2 DEFINITIONS:

A. Cabinets: An enclosure designed either for surface or for flush mounting and having a frame, or trim in which a door or doors may be mounted.

B. Device Box: An outlet box designed to house a receptacle device or a wiring box designed to house a switch.

C. Enclosure: A box, case, cabinet, or housing for electrical wiring or components.

D. Hinged Door Enclosure: An enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with the walls of the box.

E. Outlet Box: A wiring enclosure where current is taken from a wiring system to supply utilization equipment.

F. Wiring Box: An enclosure designed to provide access to wiring systems or for the mounting of indicating devices or switches for controlling electrical circuits.

1.3 SUBMITTALS:

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

B. 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-gage, galvanized steel.

B. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.

C. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.

D. Cast Metal for Boxes, Enclosures, and Covers; Copper-free aluminum except as otherwise specified.

E. Exterior Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.

F. Painted Interior Finish: Where indicated, white baked enamel. Emergency system cabinets and boxes shall be red.

G. Fittings for Boxes, Cabinets, and Enclosures: Conform to UL 514B. Malleable iron or zinc plated steel for conduit hubs, bushings and box connectors.

2.3 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.

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

2.4 NONMETALLIC OUTLET, DEVICE, AND SMALL WIRING BOXES:

A. General: Conform to NEMA OS 2, "Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports" and UL 514C, "Nonmetallic Outlet Boxes, Flush Device Boxes and Covers." Boxes shall be molded PVC units of type, shape, size, and depth to suit location and application.

B. Boxes for Concealed Work: Mounting provisions and wiring entrances to suit installation conditions and wiring method used.
2.5  **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.

2.6  **CABINETS:**

A. Comply with UL 50, "Electrical Cabinets and Boxes."

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

C. **Doors:** Double doors for cabinets wider than 24 inches. Telephone cabinets wider than 48 inches may have sliding or removable doors.

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

2.7  **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. 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.
3. Wet Locations: NEMA Type 3R enclosures.

B. 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. Locations in Special Finish Materials: For outlet boxes for receptacles and switches mounted in desks or furniture cabinets or in glazed tile, concrete block, marble, brick, stone or wood walls, use rectangular shaped boxes with square corners and straight sides. Install such boxes without plaster rings. Saw cut all recesses for outlet boxes in exposed masonry walls.

B. Gasketed Boxes: At the following locations use malleable or cast metal, threaded hub type boxes with gasketed weatherproof covers:

1. Exterior locations
2. Where exposed to moisture laden atmosphere.
3. Where indicated.

C. Mounting: Mount outlet boxes for switches with the long axis vertical or as indicated. Mount boxes for receptacles vertically, except above counter receptacles to be mounted horizontally. Three or more gang boxes shall be mounted with the long axis horizontal. Locate box covers or device plates so they will not span different types of building finishes either vertically or horizontally. Locate boxes for switches near doors on the side opposite the hinges and close to door trim, even though electrical floor plans may show them on hinge side. Provide far side box supports, for electrical switch boxes installed on metal studs and provide stud to stud support for electrical receptacle boxes installed on metal studs.

D. Ceiling Outlets: For fixtures, where wiring is concealed, use outlet boxes 4 inches square by 1-1/2 inches deep, minimum.

E. Cover Plates for Surface Boxes: Use plates sized to box front without overlap.
F. Protect outlet boxes to prevent entrance of plaster, and debris. Thoroughly clean foreign material from boxes before conductors are installed.

G. Back to back outlet boxes are not permitted. Separate boxes a minimum of 6 inches in standard walls and 24 inches in acoustical walls.

3.4 INSTALLATION OF PULL AND JUNCTION BOXES:

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

C. Set cabinets in finished spaces flush with walls.

3.6 GROUNDING:

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

3.7 CLEANING AND FINISH REPAIR:

A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.

B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the tray manufacturer.

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

END OF SECTION 26 05 34
SECTION 26 05 43
UNDERGROUND RACEWAYS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY:
A. This Section includes underground conduits and ducts, duct banks, pull boxes and hand-holes, manholes and other underground utility structures.

1.2 SUBMITTALS:
A. See Section 26 05 00 – Common Work Results for submittal procedures.
B. Product Data: Provide manufacturer's catalog information showing dimensions, materials, colors, and configurations data for metal accessories for hand-holes, conduit, duct bank materials, and miscellaneous components.
C. Record Documents: Record actual routing for underground utility raceways and electrical ducts.

1.3 QUALITY ASSURANCE:
A. Manufacturer Qualifications: Firm experienced in manufacturing underground precast concrete utility structures of types and sizes required and similar to those indicated for this Project. Firm must have a record of successful in-service performance.

1.4 DELIVERY, STORAGE, AND HANDLING:
A. Store precast concrete units at site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
B. Lift and support precast concrete units only at designated lifting or supporting points.

PART 2 - PRODUCTS

2.1 CONDUIT AND DUCT:
A. Rigid Plastic Underground Conduit: High-density polyethylene, Schedule 40
B. Manufactured Bends: Fiberglass, long-sweep elbows; not less than 36-inch radius for four (4) inch trade size

PART 3 - EXECUTION

3.1 EARTHWORK:
A. Excavation and Backfill: Conform to Owner’s Earthwork requirements. Do NOT use heavy-duty, hydraulic-operated compaction equipment.
B. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed.
Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Perform according to Owner landscape requirements.

C. Warning Tape: Tape specifically manufactured for marking and locating underground utilities. Tape shall be polyethylene film, 6 inches wide, 0.004 inches thick and a minimum strength of 1,750 psi. Tape shall carry continuous inscription naming the specific utility. Color shall be:

1. Electric - Red
2. Tape for nonmetallic utility lines shall have foil backing or wires sufficient for detection by metal detector to a depth of 3 feet. Tape to be run continuously from manhole to manhole and have 3 feet slack rolled up at each end.

3.2 CONDUIT AND DUCT INSTALLATION:

A. Install nonmetallic conduit and duct as indicated according to manufacturer's written instructions.

B. Slope: Pitch ducts minimum of 4 inches per 100 feet (1:300) to drain toward hand-holes and away from buildings and equipment.

C. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends. Use only factory fittings for elbows, bends or offsets. Field bending is not permitted. Risers to grade to be PVC coated steel elbows.

D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

E. Building Entrances: Transition from underground duct to conduit 10 feet (3 m) minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below.

1. Direct-Buried, Non-encased Duct Entering Non-waterproofed Walls: Install a Schedule 40 galvanized-steel pipe sleeve for each duct. Caulk space between conduit and sleeve with duct-sealing compound on both sides for moisture-tight seal.
2. Waterproofed Wall and Floor Entrances: Install a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with 1 or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

F. Separation Between Direct-Buried, Non-encased Ducts: 3 Inches (75 mm) minimum for like services, and 6 inches (150 mm) minimum between power and signal ducts.

G. Stub-Ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 5 feet (1.5 m) from edge of pad. Install insulated grounding bushings at the terminations. Couple steel conduits to the ducts with adapters designed for the purpose and then encase coupling with 3 inches (75 mm) of concrete.

H. Sealing: Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi (1.03 MPa) hydrostatic pressure.

I. Pulling Cord: 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.
J. Install raceway sealing fittings in accordance with the manufacturer’s written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:

1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces
2. Where conduits enter through a foundation wall or stub-up through a slab on grade floor.
3. Where required by the NEC.

3.3 FIELD QUALITY CONTROL:

A. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

3.4 CLEANING:

A. Pull brush through full lengths of ducts. Use round bristle brush with a diameter 1/2 inch greater than internal diameter of duct.

B. Clean internal surfaces of manholes including sump. Remove foreign material.

END OF SECTION 26 05 43
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. Buried electrical line warnings
2. Identification labeling for raceways, cables, and conductors
3. Operational instruction signs
4. Warning and caution signs
5. Equipment labels and signs

1.2 SUBMITTALS:

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

1.3 QUALITY ASSURANCE:

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

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION PRODUCTS:

A. Identify System Raceways with Painted Couplings & Connectors: Provide painted couplings & connectors for all concealed raceways. Install painted couplings at all conduit connecting couplings including end couplings at stub outs. Apply the following colors:

1. Normal Power: Unpainted
2. Emergency / Standby Power: OSHA Orange

B. Adhesive Marking Labels: Pre-printed, flexible, self-adhesive labels with legend indicating voltage and service (Emergency, Lighting, Power, Power D.C., HVAC, Communications, Control, Fire).

1. Label Size for Raceways and Busway: 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. [ADD ALTERNATE #1]
4. 600 Volt and Below Emergency: Indicate source equipment designation, circuit number(s), and voltage for each applicable system/branch as follows.
   a. Emergency / Standby Power: White letters on Red background
5. Ground: White or black letters on green background indicating "GROUND" and equipment and designation.

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. Underground Line Marking Tape: Metal-detector detectable, permanent, bright-colored, continuous-printed, plastic tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Printed legend indicative of general type of underground line below.

E. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

F. 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

G. 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.

H. 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.

I. Adhesive Marking Tape for Device Cover Plates: 3/8 inch Kroy tape or Brother labels with 3/16 inch minimum height letters. Tape shall have black letters on clear background for normal and red letters on clear background for emergency. Embossed Dymo-Tape labels are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. 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. Install numbers, lettering, and colors as approved in submittals and as required by code.

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. Install labels at 10 foot intervals. Where conduits route above non-accessible ceiling or in floors and walls, labels shall be provided within 3 feet of becoming accessible. 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 fire alarm boxes shall have covers painted red. All temperature control boxes shall have covers painted blue.

G. Underground Electrical Line Identification: During trench backfilling, for exterior underground power, signal and communications lines, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade. Where multiple lines installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker. Tape shall be 6 inches wide, 0.004 inches thick and 1750 psi minimum strength, trace wire run continuous length manhole to manhole and to equipment. Provide 3 feet slack rolled at each end.

1. Install line marker for underground wiring, both direct-buried and in raceway. Red for electrical,

H. Circuit Identification: Tag or label enclosures and conductors as follows:

1. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicating source and circuit numbers.
2. 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.
3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
4. 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.

I. Apply warning, caution and instruction signs and stencils as follows:

1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. Emergency Operating Signs: Install, where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8 inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
   a. Provide sign at main service entrance switch, indicating type and location of on-site stand-by generator as required by NEC. Sign shall read “Secondary Source Provided by Engine Generator Located outside Electrical Room (ELEC RM 103)”.

J. Install equipment/system circuit/device identification as follows:

1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless unit is specified with its own
self-explanatory identification. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.

a. Panelboards, electrical cabinets and enclosures  
b. Power transfer equipment  
c. Contactors  
d. Remote-controlled switches  
e. Power generating units

K. 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.

L. 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.

M. 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.

N. Install labels at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

O. Adhesive Marking Tape for Exposed Cables in Cable Tray: 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.

P. 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
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 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, soldering fluxes, and cable ties, whose products have been in satisfactory use in similar service for not less than 5 years.

1.3 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 details 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.

1.4 DEFINITIONS:

A. Load voltage wiring shall be defined as:

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

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.

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 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.

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 Architect/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 torquing 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. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated or per manufacturer's instructions.

K. Each branch circuit serving dedicated, isolated or emergency receptacles, multi-outlet assemblies or equipment connections shall be furnished with a dedicated neutral conductor. Neutrals common to more than one circuit shall only be permitted where specifically noted.

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

3.3 FIELD QUALITY CONTROL:

A. Provide all test results to Engineer in Substantial Completion Submittals, via Architect, 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 connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

3.4 EQUIPMENT CONNECTION SCHEDULES:

A. 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 Architect/Engineer of any discrepancies prior to bidding.

B. Mechanical Equipment:
   1. All equipment is existing. Contractor shall match type and quantity of existing circuits unless otherwise noted.

END OF SECTION 26 05 83
SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Purpose:

1. Verify operation and functional performance of on-site electrical generation systems and controls for compliance with "Design Intent", as defined by the Contract Documents.
2. Document Electrical system test and inspections
3. Verify application of operation and maintenance manuals, as-build (record) documents, spare parts lighting, special tools, controls and other items as may be specified herein for support of Electrical systems and equipment.

B. General:

1. Furnish labor and material to accomplish complete mechanical and electrical system commissioning as specified herein. Complete interim commissioning of electrical systems during initial season operation.
2. Job Conditions: The commissioning contractor shall become familiar with the contract documents all Addenda and change orders issued for this project prior to commencing the commissioning work.

1.2 QUALITY ASSURANCE:

A. Qualifications: The "Commissioning Authority" shall be defined as a company or agency of experienced personnel, qualified to plan & carry out the overall commissioning progress. The Commissioning Authority shall submit for owner review, an outline of the organization's personnel qualification resources, commissioning, documentation process and commissioning plan specifically prepared for this project.

1.3 DOCUMENTATION:

A. The Commissioning Authority shall obtain the following:

1. Project plans and specification (contract documents), authorized revisions, shop drawings and submittals (approved, Test and Balance report, equipment start-up and certification reports, operation and maintenance manuals, etc.
2. Records of required code authority inspections, contractor test inspections, documentation sign-offs, etc.

1.4 SUBMITTALS:

A. Commissioning Authority will submit the name of the commissioning project manager approval prior to starting the commissioning process.

1. Commissioning Plan (describe commissioning effort extent and delivery schedule).
2. Commissioning Outline Plan (describe extent of plan, expected duration of observations, personnel involved, schedule, etc.).
3. Tool List: provide a detailed list of the tools required for the commissioning process.
1.5 RESPONSIBILITIES OF OTHERS:

A. Prime Contractor (Prime Signatory on Construction Contract)
   1. General Contractor shall verify completeness of the building envelope, perimeter and interior items which effect proper operation and control of equipment and systems.
   2. The General Contractor will assure participation and cooperation of specialty contractors (electrical, TAB, building automation system, etc.) under his jurisdiction as required for the commissioning process.

B. Contractors Specialty
   1. Individual sub-contractors for the appropriate mechanical and electrical divisions - will be responsible for providing labor, material, equipment, etc., required within the scope of commissioning to facilitate the commissioning process. The listed Sub-Contractor will perform tests and verification procedures required by the commissioning process when requested by the Commissioning Authority and directed by the General Contractor.

C. Owner/Operator
   1. Owner/Operator may schedule personnel to participate in commissioning process.
   2. Owner/Operator will advise the Commissioning Authority regarding changes in building occupancy, usage, or functional requirements.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION:

A. Instrumentation will be provided by agency performing prior tests. Instruments will be operated by individual agency requested by the Commissioning Authority, as specified elsewhere herein.

PART 3 - EXECUTION

3.1 GENERAL:

A. Commissioning Authority will participate in the final construction phase of the project to assure compliance with specific Commissioning requirements.

3.2 PROCEDURE:

A. Attend construction meeting and establish requirements for the Commissioning process throughout construction phase.

B. Prepare and submit to the owner’s representative after contract award, a Commissioning plan which shall outline:
   1. Responsibility of each trade affected by Commissioning as required by appropriate section of this specification.
   2. Requirement for documentation as listed elsewhere herein.
   3. Requirements for documentation of tests and inspections required by code authorities.
   4. Requirements for the Commissioning program during specified operational seasons, part and full loads as further delineated in 3.03.

C. Periodically attend construction and coordination meetings.
3.3 ELECTRICAL SYSTEMS COMMISSIONING:

A. General Scope:

1. Perform studies, field tests, and operational checks to assure that all electrical equipment is operational within industry and manufacturer’s tolerances and is installed in accordance with design specifications.
2. The tests and operational check shall determine the suitability for energization.
3. Witness tests performed by the contractor to verify proper procedures are followed.

B. Required studies to be performed by the Contractor include:

1. Short-Circuit Study
2. Coordination Study
3. Arc-Flash Hazard Study

C. Required inspections and tests to be performed by the Contractor include:

1. Low Voltage Cables (24V Max) NETA ATS Section 7.3.1
2. Low Voltage Cables (600V Max) NETA ATS Section 7.3.2
3. Low Voltage Switches (Air) NETA ATS Section 7.5.1.1
4. Low Voltage Circuit Breakers NETA ATS Section 7.6.1.2
5. Protective Relays NETA ATS Section 7.9.1
6. Grounding Systems NETA ATS Section 7.13
7. DC System Batteries NETA ATS Section 7.18.1.1/2/3
8. DC System Chargers NETA ATS Section 7.18.2
9. Low Voltage Surge Arrestors NETA ATS Section 7.19.1
10. Emergency Systems Generator NETA ATS Section 7.22.1
11. Emergency System Transfer Switch NETA ATS Section 7.22.3

D. Test Report: Submit three copies of the completed report no later than fifteen (15) days after completion of test unless directed otherwise. The test report shall be bound and its contents certified.

The test report shall include the following:

1. Summary of project.
2. Description of equipment tested.
3. Description of test.
4. List of test equipment used in calibration and calibration date.
5. Test results.
6. Conclusions and recommendations.
7. Appendix, including appropriate test forms.

E. Failure to Meet Test:

1. Any system material or workmanship which is found defective on the basis of performance tests shall be reported directly to the Architect.
2. Contractor shall replace the defective material or equipment and have test repeated until test proves satisfactory without additional cost to the Owner.

END OF SECTION 26 08 00
PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V or less.

1.2 DEFINITIONS:

A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

1.3 SUBMITTALS:

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories. Include information for all overcurrent devices of dedicated feeders to panelboards and motors 1/4 HP or larger, as well as any panelboard main breakers.

1. Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

D. Coordination Drawings: Wiring diagrams detailing schematic diagram including control wiring, and differentiating between manufacturer-installed and field-installed wiring.

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.

F. Record Documents: Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

G. Extra Materials: Furnish the following for Owner's use in maintenance of project.

1. Panelboard Keys: Two of each different key.

2. Touch-up Paint: Furnish one (1) half-pint container.

1.4 QUALITY ASSURANCE:

A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. 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 panelboards and enclosures, of types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

C. Per Laramie County Community College (LCCC) Construction Quality Standards:
1. All Distribution and Lighting & Appliance (L&A) type panelboards shall be manufactured by General Electric (GE). No equals will be considered.
2. All Service Entrance and Campus Distribution type switchgear/switchboards and panelboards shall be manufactured by Square D. No equals will be considered.

PART 2 - PRODUCTS

1.5 PANELBOARDS, GENERAL REQUIREMENTS:

A. Overcurrent Protective Devices (OCPDs): Provide type, rating, and features as indicated. Comply with Division 26 Section on Overcurrent Protective Devices, with OCPDs adapted to panelboard installation. Tandem circuit breakers shall not be used. Multiple breakers shall have common trip.

B. Enclosures: Flush or surface mounted cabinets as indicated. NEMA Type 1 enclosure, except where the following enclosure requirements are indicated. Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gauge, minimum 16-gauge thickness. Construct with multiple knockouts and wiring gutters. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for recessed mounting. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.

C. Front: Hinged trim type, secured to box with 1/4-20-large head slotted captive screws except as indicated. Front for surface-mounted panels shall be same dimensions as box. Fronts for flush panels shall overlap box except as otherwise specified. Provide fronts with hinged trim construction and door with flush locks and keys, all panelboard enclosures keyed alike, with concealed door hinges on inner door, piano hinge on outer trim door, and door swings as indicated.

D. Directory Frame: Metal, mounted inside each panel door with card and clear plastic cover. Directory shall match panelboard configuration, i.e. top to bottom, left to right. Provide permanent panelboard labels for each circuit number.

E. Bus Material: Provide tin plated hard-drawn copper of 98 percent conductivity.

F. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductor’s bonded to box.

G. Provide lugs for incoming feeders and grounds compatible with bus and feeder material.

H. Provide minimum short circuit current ratings as indicated.

I. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the OCPD ampere ratings indicated for future installation of devices.

J. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 13, list and label panelboards as a complete assembly including surge protective device.

1.6 LOAD CENTERS:

A. Load Centers are NOT acceptable for use on this project.
1.7 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS:
   A. Branch OCPDs: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

1.8 DISTRIBUTION PANELBOARDS:
   A. Branch-Circuit Breakers: Where OCPDs are indicated to be circuit breakers, use bolt-on breakers except circuit breakers 225-ampere frame size and greater may be plug-in type where individual positive locking device requires mechanical release for removal.

1.9 IDENTIFICATION:
   A. General: Refer to Division 26 Section on electrical identification for labeling materials.
   B. UL nameplates shall be provided for all panelboards. Information shall include, but not be limited to, manufacturer, model number, serial number, plant or manufacturing location, ampere rating, voltage rating, wire and phase identification and bus short circuit bracing rating.
   C. Provide arc flash warning labels in accordance with NFPA 70.
   D. Provide floor markings to clearly indicate required working clearances where indicated or where required by the authority having jurisdiction.

PART 3 - EXECUTION

1.10 INSTALLATION:
   A. General: Install panelboards and accessory items in accordance with NEMA PB 1.1, "General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less" and manufacturers' written installation instructions.
   B. Mounting: Plumb and rigid without distortion of box. Mount flush panels uniformly flush with wall finish.
   C. 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.
   D. Install filler plates in unused spaces.
   E. Feeders to multiple section panelboards, from Sub-Feed Lugs or Feed-Through lugs shall match the feeders to the panelboard.

1.11 GROUNDING:
   A. Connections: Make equipment grounding connections for panelboards as indicated.
   B. Provide ground continuity to main electrical ground bus indicated.

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

1.13 LOAD BALANCING:

A. For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

1.14 FIELD QUALITY CONTROL:

A. Provide all test results to Engineer in Substantial Completion Submittals, via Architect, 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. Procedures: Make field tests and inspections and prepare panelboard for satisfactory operation in accordance with manufacturer's recommendations and these specifications.

C. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating results of tests and inspections, responsible organization and person, and date.

D. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
2. Exercise and perform of operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.
3. Check panelboard mounting, area clearances, and alignment and fit of components.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
5. Verify that proper grounding bushings/bonding/ and panel enclosure bonding is complete.
6. Verify isolated neutral bar and neutral connections.

E. Electrical tests: Include the following items performed in accordance with manufacturer's instruction:

1. Insulation resistance test of buses. Insulation resistance less than 100 megohms is not acceptable.
2. Ground resistance test on system and equipment ground connections.
3. Test main and sub-feed overcurrent protective devices in accordance with Section "Overcurrent Protective Devices."

1.15 CLEANING:

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

END OF SECTION 26 24 16
PART 1 - GENERAL

1.1 SUMMARY:
   A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry but not utilize electric energy.

   B. Types of electrical wiring devices in this section include the following:
      1. Receptacles
      2. Switches
      3. Electronic Sensors

1.2 QUALITY ASSURANCE:
   A. Manufacturers: Firms regularly engaged in manufacture of electrical wiring devices, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.

   B. Installer's Qualifications: Firm with at least 2 years of successful installation experience on projects utilizing wiring devices similar to those required for this project.

   C. Listing and Labeling: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed.
      1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code", Article 100.
      2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

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

   B. Product Data: Provide manufacturer's catalog information showing dimensions, materials, colors, and configurations. Samples of device plates for color selection and evaluation of technical features shall be submitted with product data.

   C. Field Quality Control Test Reports: Refer to Section 26 05 00 – Common Work Results for additional requirements.

   D. 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.

1.4 COORDINATION:
   A. Wiring Devices for Owner Furnished Equipment: Match devices to plug connectors for Owner-furnished equipment.
B. Cord and Plug sets: Match cord and plug sets to equipment requirements.

**PART 2 - PRODUCTS**

**2.1 WIRING DEVICES:**

A. Color selection shall be verified with Engineer prior to ordering. Devices shall be Ivory. All receptacles and switches connected to circuits served from a generator system shall have a red face.

B. Receptacles:

1. All receptacles shall be minimum, specification grade commercial series, listed by Underwriter's Laboratories, UL 498 and Federal Specification FS W-C-596, 20 amp, nylon face and have a metal mounting strap with self-grounding and have a hex-head green grounding screw and be side and back wired. Each device shall bear the UL/FS Label. Meet NEMA standards for wiring devices including NEMA WD 1 for general requirements and NEMA WD 6 for dimensional standards. Each device shall have terminal screws and clamps listed for use with stranded wire. Plug-tail device connections are acceptable.

2. Convenience Receptacle Configuration: Duplex or Single as indicated on the drawings, Type 5-20R.

3. Weather Resistant Receptacles: In addition to the above requirements all receptacles in damp and wet locations shall be WR (Weather Resistant) labeled.

4. Ground-Fault Interrupter Receptacles: Where indicated or required provide "local reset" auto monitoring "self test" ground-fault circuit interrupters. Provide unit capable of being installed in a 2-3/4" deep outlet box without adapter, grounding type, Class A, Group 1 per UL Standard 943. Provide visual indication of lost protection.

**2.2 WIRING DEVICE ACCESSORIES:**

A. Verify color and type with Architect/Engineer prior to ordering. Device color to match Wiring Device Color identified above.

B. Wall Plates: Provide wall plates for single and combination wiring devices, of types, sizes, and with ganging and cutouts as indicated. Select plates which mate and match wiring devices to which attached. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates. Identify all wall plates used for receptacles with branch circuit number per requirements of section on Electrical Identification. Provide blank wall plates for all cable, data, telephone and junction and outlet boxes. Where cables are routed through the plate, provide grommets in opening to protect cables.

C. Weather proof covers: Where called out on the drawings as “WP” provide weatherproof junction box with gaskets and cover. Cover shall be rated while in use. Use low profile type covers with UV resistant polycarbonate.

**PART 3 - EXECUTION**

**3.1 INSTALLATION OF WIRING DEVICES:**

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.

3. Circuits shall be furnished with a dedicated neutral conductor. Neutrals common to more than one circuit will not be permitted for this project.
B. Install wiring devices as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.

C. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.

D. Install wiring devices only in electrical boxes which are clean; free from excess building materials, dirt, and debris.

E. Install wiring devices after wiring work is completed.

F. Install wall plates after painting work is completed.

G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds. 486A.

H. Provide GFCI type outlets as required in NEC 210, including but not limited to: each above counter duplex receptacle shown within 6'-0" of sinks/lavatories; Bathrooms; Kitchens; Roof Tops; Outdoors; Indoor Wet locations; Locker Rooms; Shower Facilities; Garages; Service Bays; vending machines; etc.

I. Provide Tamper Resistant (TR) devices for all 120V, 15A and 20A, non-locking receptacles in areas accessible to the general public.

3.2 PROTECTION OF WALLPLATES AND RECEPTACLES:

A. Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Substantial Completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

3.3 GROUNDING:

A. Provide equipment grounding connections for wiring devices, unless otherwise indicated. Tighten connections to comply with tightening torques specified in UL Std. 486A to assure permanent and effective grounds.

3.4 CLEANING:

A. Internally clean devices, device outlet boxes and enclosures. Replace stained, cracked, damaged or improperly painted wall plates or devices. Remove temporary markings of labels.

3.5 TESTING:

A. Prior to energizing circuitry, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained and prepare test reports. Subsequent to energization, test wiring devices to demonstrate compliance with requirements.

1. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices or similar problems.

2. Tests for Convenience Receptacles:
a. Line Voltage: Acceptable range is 114 to 126 V.
b. Ground Impedance: Values of up to 2 ohms are acceptable.
c. Polarity: Test for correct neutral conduct to neutral terminal connection.
d. Using the test plug, verify that the device and its outlet box are securely mounted.
e. GFCI Receptacles: Test for tripping values specified in UL 1436 and UL 943. Test with both local and remote fault simulations in accordance with manufacturing recommendations.
f. SPD receptacle indicating lights for normal indication check.

3. Tests for patient-care areas in Healthcare Facilities: In addition to the test listed above, perform additional field tests and inspections for equipment and receptacles in patient care areas per NFPA 99. Tests shall include but not be limited to:

a. The physical integrity of each receptacle shall be confirmed by visual inspection.
b. Continuity of the Grounding Circuit for each receptacle.
c. Test straight blade convenience outlets in patient-care areas for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).
d. Test and record the impedance between the ground point of each receptacle and the reference point according to NFPA 99. Impedance level shall be less than 0.1 Ohm.

1) The impedance measurement shall be made with an accuracy of ±20 percent.
2) For New Construction: The impedance measurement shall be made between the reference point according to NFPA 99 and the grounding contact of 10 percent of all receptacles in each patient care vicinity. The impedance measurement shall be the ratio of voltage developed (either 60Hz or DC between the point under test and the reference point to the current applied between these two points).

e. Voltage: Measurement shall be made under no-fault conditions between a reference point and all exposed fixed electrical equipment with conductive surfaces in the patient care vicinity, including but not limited to; over-bed wall-mounted fixtures, ceiling mounted exam lights, sensor faucets, etc. The maximum limit allowed is 20mV. Prepare certified test reports in compliance with NFPA 99 and submit reports in conjunction with field quality control reports required in Division 26 “Grounding and Bonding”.

4. Test Instruments:

a. Use instruments that comply with UL 1436.
b. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Correct Deficiencies and Report:

1. Correct unsatisfactory conditions and retest to demonstrate compliance; replace devices as required to bring system into compliance.
2. Correct malfunctioning units on-site, where possible and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Prepare a report that identifies enclosure, units, conductors and devices checked and describe results. Include notation of deficiencies detected, remedial action taken, and observations and test results after remedial action.

END OF SECTION 26 27 26
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 DEFINITIONS:

A. Overcurrent Protective Device (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

B. Ampere-Squared-Seconds: An expression of available thermal energy resulting from current flow. With regard to current-limiting fuses and circuit breakers, the ampere-squared-seconds during fault current interruption represents the energy allowed to flow before the fuse or breaker interrupts the fault current within its current limiting range.

1.3 SUBMITTALS:

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

B. Product Data: Provide manufacturer's catalog information showing dimensions, materials, colors, and configurations for fuses, fusible switches, circuit breakers, and OCPD accessories specified in this Section, including descriptive data and time-current curves for all protective devices and let-through current curves for those with current limiting characteristics. Include coordination charts and tables and related data.

C. 3rd Party Study/Report: Provide coordination study in accordance with ANSI/IEEE Standards to show proper coordination to the AHJ. Study shall include all Utility systems, overcurrent devices, transformers, buses, generator systems, grounding systems, etc., which comprises the AC power system, Bill of materials for devices and settings proposed shall be coordinated per the applicable sections of the current edition of the NEC, as required by the Authority Having Jurisdiction. Study shall be commissioned and paid for by the Contractor.

D. Field Quality Control Test Reports: Submit record of testing as described below. Refer to Section 26 05 00 – Common Work Results for additional requirements.

E. 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.

1.4 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of overcurrent protective devices of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
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.

G. Ground Fault Circuit Interrupters: Where indicated, provide bolt-on panelboard circuit breakers, with integral ground-fault circuit interrupters, UL-rated Class A, Group 1 with interrupt rating adequate for panel. Provide units with solid-state ground-fault sensing and signaling, with 30 mA ground-fault sensitivity trip level. Equip with PUSH-TO-TEST capability. Provide modules which mate and match panelboards in which they are located.

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 L Fuses: Time Delay
   2. Class J Fuses: Duel Element, Time Delay

2.3 NONFUSIBLE SWITCHES:
   A. General: UL 98 "Enclosed and Dead Front Switches" and NEMA KS 1 "Enclosed Switches," quick-make, quick-break heavy-duty units.
   B. Rating: Load-breaking capacity in excess of the normal horsepower rating for the switch.
   C. Withstand Capability: In excess of the available.
   D. Operation: By means of external handle.
   E. Interlock: Prevents access to switch interior except when in "off" position.
   F. Enclosure for Independent Mounting: NEMA Type 1 enclosure except as otherwise indicated or required to suit environment where located.
   G. Contacts shall be NEMA rated 75 degrees C.

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

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

D. Tripping Device: Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous overcurrent trip protection for each pole. Trip unit to be interchangeable within frame sizes for breakers 200 amperes or larger. Breakers 250 amperes and above shall have adjustable trip selection for trip units. All 120/208 volt rated breakers shall be rated and labeled "High Magnetic".

E. Adjustable Instantaneous Trip Devices: Factory adjusted to low-trip-setting current values. Provide adjustable instantaneous trip devices for each circuit breaker supplying individual motor loads and where indicated.

F. Enclosure for Switchboard or Panelboard Mounting: Suitable for mounting in equipment indicated.

2.6 CIRCUIT BREAKERS WITH SOLID-STATE TRIP DEVICES:

A. General: In addition to other requirements as listed, all breakers indicated on the drawings as GFP, GFI, Zone interlock (Z), all adjustable trip breakers, if required for coordination, and all breakers 250 amp frame size and larger with solid-state trip devices having the following features:

1. Ambient Compensation: Trip device insensitive to temperature changes between minus 20 degrees C and plus 55 degrees C.
2. Adjustability: Breaker ratings and trip settings shall be changeable by operation of controls on front panel of breaker and by change of plug-in element without removing the breaker.
   a. The trip device sensor shall have the same rating as the frame amperage of the circuit breaker unless noted otherwise.
3. Ground-Fault Circuit Interrupter: Where GFCI is indicated, provide system listed and labeled as complying with UL 943. Arranged for sensing and tripping for ground fault current in addition to overcurrent and short-circuit current. Match features and module size of panelboard breakers and provide clear identification of ground fault trip function.
4. Provide zone-selective interlocking capability with both short-time and ground-fault interlock on circuit breakers indicated with Z.

2.7 OCPD ACCESSORIES:

A. Provide adjustable-time-delay under-voltage trip devices where indicated.

B. 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.
3. All Fuses shall be manufactured by Bussman subsidiary of Eaton Corporation. No equals will be considered.
B. Independently Mounted OCPDs: Locate as indicated and install in accordance with manufacturer's written installation instructions. Install OCPDs level and plumb.

C. OCPDs in new distribution and branch circuit equipment shall be factory installed. OCPD's in existing distribution and branch circuit equipment shall match existing for type and be provided with features as listed herein.

D. Install fuses in fusible devices as indicated. Arrange fuses so that fuse ratings are readable without removing fuse.

E. All fuses for new disconnect switches feeding motors or motor starters shall be provided with Class J fuses.

F. OCPDs and mounting accessories installed in existing equipment shall match the existing manufacturer and be rated for the available fault current.

G. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:

1. Fire detection and alarm circuits.
2. Communications equipment circuits.
3. Intrusion detection and access control system circuits.
4. Video surveillance system circuits.

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 and UL 486B.
3.5 GROUNDING:

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

3.6 FIELD QUALITY CONTROL:

A. Provide all test results to Engineer in Substantial Completion Submittals, via Architect, 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 appropriate tests on all new equipment and existing equipment as indicated on the drawings:

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 stored-energy charging motors for proper operation of motor, mechanism, and limit switches.

G. Check operation of electrically operated OCPDs in accordance with manufacturer's instructions.

H. Check key and other interlock and safety devices for operation and sequence. Make closing attempts on locked-open and opening attempts on locked-closed devices including moveable barriers and shutters.

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
SECTION 26 32 14
NATURAL GAS GENERATORS

PART 1 - GENERAL

1.1 SUMMARY:

A. Extent of diesel generator set work is indicated by drawings and schedules, and is hereby defined to include, but not by way of limitation, engine, alternator, engine starting system including batteries and instrument control panel, weather-protective housing, remote starting provisions, gas regulators, annunciator panel, exhaust silencer and wall thimble, and any necessary accessories and appurtenances.

B. System Description:

1. Engine-driven generator to provide source of stand-by, critical system and/or emergency power.

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: Submit manufacturer's data on all engine-driven generator sets and components and include a copy of the manufacturer's standard product warranty. Include a detailed checklist which acknowledges compliance or a reason for non-compliance to each of the specification requirements. Arrange the checklist according to the headings of each item identified in this specification (i.e. Shop Drawings, Wiring Diagrams individual line items, etc.) Mark items as "N/A" where the item is not applicable.

C. Shop Drawings: Submit 1/2 inch scale, dimensioned plan and elevation layout drawings of engine-driven generator units and accessories being supplied, including, but not limited to, generator, engine control panel, fuel line piping, gas regulators and related equipment, batteries, battery racks, battery chargers, remote start-stop stations, instrumentation, main power circuit breakers, and transfer equipment (see Section 26 36 00 for Transfer Switch requirements). In addition, show generator set unit and its spatial relationship to associated equipment. Allow adequate clearance space for removal of engine generator elements for maintenance purposes. The drawings shall be for the particular unit to be supplied, with all other information removed.

D. Coordination Drawings: Submit wiring diagrams for generator set showing connections to output breaker, control panels, transfer switches or breakers, alarms, remote alarms and ancillary equipment. Show and differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed. The unit diagrams shall be for the particular unit to be supplied with all other information removed.

1. All interconnection and wiring diagrams shall include the following information as a minimum:

   a. Complete diagrams of the internal wiring for each of the items of equipment. The diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
   b. Diagrams shall include all field wiring and labeled terminals for connections including all controls, alarms, and customer connections.
   c. Submit BAS interface layouts for Alarms that communicate through the local BAS system using BACNET.
2. Submit generator sub transient reactance to meet specified voltage distortion and to allow proper short circuit and overload system coordination. Submit generator protection on time/current curves that show proper coordination including generator FLA, generator damage curve, generator decrement curve, protective relays, and circuit breaker settings.

E. Factory Test Reports: Provide diesel engine-driven generator set's manufacturer certified test record of the final production testing prior to shipping the unit from the factory to the project site. Include the following tests: Single-step load pickup, Transient and steady-state governing, Safety shutdown device testing, Voltage regulation, Rated power, and Maximum power. Also include the following information and test results:

1. Provide information on the content and capacity of exhaust gases emitted by the engine at 1/4, 1/2, 3/4, and full load. The exhaust gas omission shall comply with all Federal, State and Local Codes in force at the site location.
2. Submit de-rating data, calculations, and final unit rating for the specified operating conditions at the site, where they differ from the vendor's stated standard operating conditions.
3. Submit the generator harmonic analysis report for the 3rd, 5th and 7th harmonics that shows compliance with this specification.
4. Sound Test Data.

F. Field Quality Control Test Reports: Submit record of testing as described below. Refer to Section 26 05 00 – Common Work Results for additional requirements.

G. Certificate of Owner Training: Submit Owner Training Schedule with appropriate electrical sections initialed by Owner and/or Owner’s Representative indicating training has been completed.

H. Extra Materials: Furnish the following for Owner's use in maintenance of project. Provide spare parts for one year's maintenance of the engine generator system. Parts shall be labeled with the equipment identification which they are associated with and packed for storage. Spare parts shall include but not be limited to:

1. Belts: Provide 2 of each type.
2. Hoses: Provide 2 of each type.
3. Fuses: for voltage regulator and controls: Provide 3 of each type.
4. Filters: Provide 2 of each type, (fuel, air, water, oil, etc.)
5. Lamps/LED's: Provide 2 of each type

I. 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. Provide the following additional operating documents:

1. A safety shutdown list provided on the generator set and in the generator maintenance manual. Verify that the appropriate safety controls have been provided based on the shutdown list.
2. Satisfactory engine/alternator test records, lubrication, fuel and start battery maintenance records with space for continued entries.
3. "Engine operating instructions" posted near the unit that provides clearly defined, step-by-step procedures for starting, running and stopping the engine.
4. Lockout-tagout procedures in place for the AC switchgear and distribution during normal operation, manual operation and testing.
J. Warranty: Submit manufacturer warranty and ensure that forms have been completed in owner’s name and registered with manufacturer. The statement of warrantee shall be provided on manufacturer’s letterhead.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of diesel engine-driven generator units and ancillary equipment, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

1. The engine-generator shall be assembled, thoroughly tested and warranted, as the product of a single manufacturer. Sets which are assembled components by a service type facility are not acceptable.

2. The engine-generator set supplier shall be fully capable of providing all site service work on the engine-generator set and all accessories including:
   a. Repair or replacement of any component including large assemblies such as generator rotors, drive shafts, etc.
   b. Testing and trouble shooting
   c. General maintenance

3. The engine generator set supplier shall have in local stock, all customary parts required for service of the unit including engine parts and electrical assemblies at a local central location 24 hours per day, 365 days per year.

B. Per Laramie County Community College (LCCC) Construction Quality Standards:
   1. All on-site power generation equipment shall be manufactured by Cummins-Onan. No equals will be considered.

C. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with diesel engine-driven generator units similar to that required for this project.
   1. Agreement to Maintain: The Installer must be willing to execute with the Owner, an agreement for continued maintenance of diesel engine-driven generator units.

1.4 DELIVERY, STORAGE AND HANDLING:

A. Deliver engine-driven generators properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for engine-generator and components which protect equipment from damage.

B. Store engine-driven generator equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle engine-driven generator equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

PART 2 - PRODUCTS

1.5 MANUFACTURERS:

A. Per Laramie County Community College (LCCC) Construction Quality Standards:
1. All on-site power generation equipment shall be manufactured by Cummins-Onan. No equals will be considered.

1.6 RATINGS:

A. The engine-generator set shall have the following minimum measured ratings when installed at the specified site and all derating factors including those for temperature, altitude, fan, charging generator, water pump, etc. are considered.

1. Duty: Emergency
2. Kilowatts: 45 KW
3. Power Factor: 0.8 Lagging
4. Frequency: 60 Hz Nominal
5. Voltage: 208/120V
6. Phase: 3
7. Wire: 4
8. Synchronous Speed: 1800 RPM; Submit speeds for small Natural Gas sets.

1.7 ENVIRONMENTAL CONDITIONS:

A. The equipment specified is intended for application in an environment as described below:

1. Altitude: Sea Level to 7200 feet.
2. Maximum Temperature: Indoor: 104 degrees F, Outdoor: 104 degrees F
3. Minimum Temperature: Indoor: 32 degrees F, Outdoor: -20 degrees F
4. Location: Outdoor
5. Relative Humidity: 0-95%.

1.8 ENGINE:

A. Type: Liquid cooled with unit mounted radiator and engine driven water pump. Comply with the requirements of SAE 1349, ISO 8528 (Part 2), EGSA 101P and IEEE Standard 446 as they apply to standby application.

B. Fuel System: Natural Gas, in strict compliance with engine manufacturer’s instructions.

C. Governor: Adjustable Isochronous type to maintain governed speed at rated frequency regardless of the kW load and shall meet the following requirements:

1. Stability: 0.25 percent maximum frequency variation at any constant load from no load to full load.
2. Regulation: 0.25 percent maximum frequency deviation at steady state.
3. System shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.

D. Engine Accessories: Provide the following engine accessories.

1. Fuel filter
2. Lube Oil Pump-Positive displacement, mechanical, full pressure pump
3. Lube oil filter and strainer provided by engine manufacturer with adequate filtration
4. Crankcase Drain- arranged for complete gravity drainage to easily removable container with no disassembly and no use of pumps, siphons, special tools, or appliances.
5. Provide engine with an initial fill (including oil makeup tank) of manufacturer’s recommended multi-viscosity lubricating oil.
6. Provide a valved oil drain extended past the engine frame with braided stainless steel hose and reusable fittings
7. Intake air filter
8. Lube oil cooler
9. Fuel priming pump as required by manufacturer for site conditions
10. Gear-driven water pump
11. Lube Oil Pressure gauge

E. The engine shall be designed to develop rated speed and torque capable of developing full load within 8 seconds from the time the engine starts. Engine cranking period shall not exceed 30 seconds. In addition, comply with NFPA 110 requirements for a Level 1, Type 10, Class XX system.

F. The engine shall be equipped with protective devices to meet control requirements specified elsewhere in this specification. The control devices shall be tied into the engine generator control. All protective devices shall be wired into a master engine terminal box with terminal strips for remote connections and connections to annunciators or controls as required.

G. All equipment shall operate with minimum vibration throughout the operating range as assembled units. The equipment supplier shall assume all additional shop, shipping and transportation expense, and/or cost at the job site necessary to reduce excessive vibration attributable to unbalance of the equipment.

1.9 GENERATOR CHARACTERISTICS:

A. The generator shall be provided in accordance with the following:

1. The generator shall be of the single-bearing type, drip proof construction, externally regulated, directly connected to the engine flywheel through a semi-flexible coupling. The generator shall be complete with inboard brushless exciter. The generator rotor shall be dynamically balanced to withstand over-speeds up to 125 percent rated speed, and heat during operation at 110 percent of rated capacity without damage from mechanical, electrical, thermal, or vibration.

2. The generator shall comply with NEMA Standard MG-1, latest revision. Insulation shall be Class H. Rotor and stator temperature rise shall not exceed 105 degrees C. over a 40 degree C. ambient temperature at specified site altitude. Generator must be derated in accordance with NEMA MG-1.

3. Submit generator sub transient reactance to meet specified voltage distortion and to allow proper short circuit and overload system coordination. Submit generator protection on time/current curves that show proper coordination including generator FLA, generator damage curve, generator decrement curve, protective relays, and circuit breaker settings.

4. The generator shall be capable of continuously delivering its rated output at any power factor from 1.0 to 0.8 lagging at ±5 percent of rated voltage and at 60Hz, in the environmental conditions as specified.

5. Insulation shall be 100 percent epoxy material, pressure impregnated.

6. Total harmonic distortion of output waveform shall not exceed 5 percent total RMS voltage measured line to line at rated load.

7. The generator voltage regulator shall be SCR type, separate from exciter, solid state, microprocessor-controlled, full wave rectified, with pulse-width modulated signal to the exciter. Provide external voltage adjust rheostat. Provide a setscrew stability adjustment. Voltage regulation shall be +/-1.0 percent. Steady state voltage stability shall remain within a 0.5 percent band of rated voltage from no load to full load.

8. Provide PMG-Permanent Magnet Generator and controls to limit a sustained short circuit by excitation control to approximately 3 times FLA for both symmetrical and asymmetrical cases. If PMG is not available for specific engine/generator size, relay or circuit breaker and
ground fault protection shall be provided to limit current below the alternator thermal damage curve.

9. The engine alternator shall be capable of accepting a one-step application of 100% of nameplate kW load at 0.8 power factor and recover to steady state conditions without disruption of power to the load and within 10 seconds. When the alternator is sequentially loaded with rated full load in two equal steps, the transient voltage drop at any step shall be limited such that the alternator voltage is not less than 80% of nominal voltage, and frequency is not less than 91% of nominal. In addition, the voltage at the alternator shall recover to within 90% of nominal voltage and the frequency to within 97% of nominal within 4 seconds after each sequential load application, or 60% of each step time interval (whichever is less).

10. During recovery from transients caused by step-load increases, step-load decreases, or resulting from 100% load rejection, the speed of the alternator set shall not reach the over speed shutdown setpoint.

11. The generator shall be capable of providing 300 percent of rated full load current for ten seconds during a 3 phase bolted short circuit condition at system output terminals. For a 1 phase, bolted short circuit at the system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.

12. The generator shall be of twelve lead design for generators connected in three phase, 4 wire, Wye configuration. Neutral capacity shall be 100 percent of each phase.

13. Telephone influence factor (TIF) shall not exceed 50.

14. Generator bearing shall be designed for a minimum B-10 bearing life of 40,000 hours. The bearing shall be of the shielded type with provisions for lubricating without opening terminal compartment.

15. All generator leads (including neutral) shall be extended un-spliced from windings to generator connection junction box external to generator.

16. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

17. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

18. Transient Frequency Performance: Not more than 15 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 5 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.

19. Output Waveform: at full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic.

20. Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

1.10 STARTING EQUIPMENT:

A. General: The engine shall be equipped with an electric starting system of sufficient capacity to crank the engine at a speed which will allow starting of the engine. System shall be 12 volt for generators less than 200 kW.

1. Starting system shall be capable of starting the engine either manually or automatically.

B. Batteries:

1. The batteries shall be dedicated to the engine.
2. Provide maintenance free lead acid batteries having sufficient capacity for cranking the engine continuously for at least 45 seconds and Cycle crank (3 cycles) for at least 75
seconds at firing speed in the minimum ambient temperature specified. Batteries shall be sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum. Cranking Cycle shall be as required by NFPA for a level 1 system.

3. The cell container shall be made of high impact translucent polypropylene with clearly marked maximum and minimum electrolyte levels. All cell data such as battery type, manufacturer’s name, electrolyte level marks shall be displayed clearly. Each cell shall have terminal voltage of 1.2 volts DC nominal voltage. The lid shall be thermally welded onto the cell container to eliminate any risk of electrolyte leakage. Gluing or chemical bonding is not acceptable.

4. The battery shall be suitable for continuous operation, within the temperature range of -20 degrees C and +40 degrees C and able to operate adequately with occasional temperature excursions of up to +60 degrees C.

5. The battery electrolyte shall be an aqueous solution of potassium hydroxide with a specific gravity of approximately 1.20. Lithium hydroxide may be used as an additive. There shall be no need to change the electrolyte over the life of the battery.

6. The battery positive and negative terminals shall be of threaded type. The positive terminal shall be identified by a red plastic disc at the base.

7. Rigid connections shall be manufactured of nickel plated high quality copper bar. Flexible inter-cell connections shall be made out of copper cable with appropriate insulation. Nickel plated lead, or nickel plated steel are not acceptable for flexible or rigid connections. The battery cables shall be welding type cable using compression connectors and shall have physical protection. Provide corrosion inhibiting compound on all cable terminations.

C. Accessories:

1. Provide a battery rack and necessary cables and clamps. Size battery cables per engine manufacturer data for cable length as required. Include required interconnecting conductors and connection accessories.

2. Each battery shall be mounted on a free standing steel rack protected with alkaline resistant epoxy paint. Each cell row shall be elevated in steps so that the minimum electrolyte level mark is clearly visible on all cells from the front of the battery. Battery rack shall be grounded and anchored to the floor. Verify rack dimensions with field conditions indicated on plans to ensure rack will fit in location specified. Battery rack shall be designed and secured to match the specified seismic zone.

3. A suitable battery charging alternator shall be provided with sufficient capacity to recharge the batteries back to normal starting requirements within 90 minutes.

4. Provide battery blanket for 120 volt a.c. supply with controlling thermostat.

5. Provide continuous clear non-conductive covers for each row of terminals in rack.

D. Battery Charger:

1. Provide fully regulated, constant voltage, current limited battery charger for each bank specifically designed for engine starting batteries which shall maintain the starting batteries at full charge. The charger shall be capable of restoring the batteries to a fully-charged state within eight hours after a complete duty cycle discharge and 4 hours after a normal engine starting sequence. Starter shall be factory mounted on the engine.

2. The charging system shall permit charging from either a normal or emergency 120 volt AC power source.

3. The charger shall be so designed that it will not be damaged during the engine cranking.

4. The charger shall be a three stage with solid state voltage regulation, temperature stabilized type with automatic and manual charge control. The three stages consist of boost mode 28.8V for charging to 90% of battery capacity, normal mode 27.3V to safely complete the charge and storage mode 26.40V to minimize battery outgassing. The actual output of the charger to be provided shall be the sum of start battery C/10 capacity plus the continuous DC control power requirements (10 ampere capacity minimum). Additionally, the battery
charger shall have an equalization mode: every 21 hours when the system is operating in
the storage mode, the charger will automatically switch to the equalizing mode, which
increases the charging voltage up to 28.8V for 15 minutes to minimize battery sulfation.

5. Charger shall be Automatic Temperature Compensating to prevent overcharging at high
temperatures and undercharging at low temperatures.

6. Charger shall be Automatic Voltage Regulating to maintain constant output voltage
regardless of input voltage variations up to plus or minus 10 percent.

7. The charger shall be properly treated for NEMA 1 with chemical resistant epoxy coating.

8. The charger shall be equipped with the following accessories, as a minimum:

   a. Ammeter
   b. Voltmeter
   c. Fused AC input and fused DC output
   d. AC input failure contacts for alarms
   e. DC output failure contacts for alarms
   f. High Volts (red)
   g. Low Volts (red)
   h. Rectifier fail (red)
   i. AC fail (red)
   j. Float mode status (green)
   k. High rate status (amber)
   l. Relay contacts for fault conditions as required by NFPA.
   m. Safety Functions; Sense abnormally low battery voltage and close contacts providing
      low battery voltage indication on control and monitoring panel. Sense high battery
      voltage and loss of ac input or dc output of battery charger. Either condition shall
      close contacts that provide a battery charger malfunction indication at system control
      and monitoring panel.

1.11 COOLING SYSTEM:

A. Provide the engine with a liquid cooled unit mounted radiator. Radiator fan shall be of the pusher
type. Radiator shall be rated for the specified ambient temperature and shall be of the de-aeration
type. Provide cooling system components and meet requirements as follows:

B. The engine cooling system shall be filled with anti-freeze with a mixture of ethylene glycol
antifreeze in water appropriate to protect the engine at 20 degrees below the minimum ambient
temperature specified. Provide anticorrosion additives as recommended by engine manufacturer.
Provide glycol for complete piping and radiator system.

C. Provide radiator overflow tank adequate to contain expansion of total system coolant from cold
start to 110 percent load condition.

D. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop
coolant system pressure for engine. Equip with gauge glass and petcock.

E. Temperature Control: provide self-contained, thermostatic-control valve that modulates coolant
flow automatically to maintain optimum constant coolant temperature.

F. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter
flange as coordinated with other trades.

G. Provide Engine Coolant temperature gauge.

H. Provide a valved radiator drain with pipe extension and threaded connection at a location easily
accessible to maintenance personnel.
I. Provide OSHA guards on all belts, pulleys and fans.

J. Provide necessary pipe fittings. Provide necessary valves for ease of access and maintenance.

K. Provide minimum of two belts to radiator fan drive

1.12 AIR INTAKE SYSTEM AND EXHAUST SYSTEM:

A. Provide a dry type air intake filter and silencer. Mount on the engine in an accessible location.

B. Provide a stainless steel, corrugated, flexible exhaust pipe in between the engine exhaust flange and silencer to prevent the transmission of vibration. Minimum length shall be 18 inches.

C. Provide exhaust silencer.

   1. Provide exhaust silencer mounting bands and brackets.
   2. Pressure drop in the complete exhaust system shall be small enough for satisfactory operation of the engine-generator while it is delivering 110% of its specified rating.
   3. Exhaust pipe size from the engine to the muffler shall be as recommended by the engine manufacturer. Pipe size from muffler to air discharge shall be two pipe sizes larger than engine exhaust pipe.
   4. Connections at the engine exhaust outlet shall be made with a flexible exhaust pipe. Provide bolted type pipe flanges welded to each end of the flexible section.
   5. Condensate drain at muffler shall be made with schedule 40 black steel pipe through a petcock.
   7. Insulation for Exhaust Pipe and Muffler:

      a. Calcium silicate minimum 3" (in.) thick or as recommended by the silencer manufacturer.
      b. Insulation shall be as specified in Section 23 for HVAC, Plumbing, and Boiler Plant Insulation.
      c. The installed insulation shall be covered with aluminum jacket 0.016" (in.) thick. The jacket is to be held in place by band of 0.015" (in.) thick by 0.5" (in.) wide aluminum.
      d. Insulation and jacket are not required on flexible exhaust sections.
      e. Roof Sleeves: Pipe sleeves (thimble) shall be Schedule 40 standard weight steel pipe. Flash exhaust pipe thimble through roof with 16 oz. soft sheet copper, flanged, and made watertight under built-up roofing and extended up around pipe thimble. The exhaust pipe shall be positioned within the thimble by four-6" (in.) wide spiders welded to the exhaust pipe.

D. Provide flanges, non-slip type connectors and gaskets. Exhaust lines shall be gas tight. Connections are to be welded and/or flange type.

1.13 FUEL SYSTEM:
A. Provide fuel system designed for Natural Gas. System shall provide for 900 cubic feet per hour at full load output.

1.14 STARTING AIDS:

A. Provide AC single phase engine jacket water heaters installed on the engine. The heaters shall be sized to provide an engine jacket temperature of 90 degrees F. in the minimum ambient temperature specified. Provide isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss. Provide 12VDC thermostat, installed at the engine thermostat housing.

1.15 MOUNTING:

A. Provide a suitable full length sub-base for mounting the engine generator unit on a concrete foundation. Provide Lifting attachments, total package weight, and indicate center of gravity for rigging on unit mounted label. Maintain alignment of mounted components without depending on foundation.

B. Provide assembly with spring type vibration isolators for use between the sub-base and the concrete foundation. A pin shall be installed through the spring isolators, sub-base and bolted into concrete inserts for lateral movement limitation.

C. Mounting shall be designed, constructed, and installed to meet applicable seismic zone requirements.

1.16 ENGINE GENERATOR CONTROL PANEL:

A. Provide a NEMA 4 automatic starting control panel, powered via engine start batteries. Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.

1. Engine Generators 250 kW and below: The control panel shall be installed on the generator facing the rear of the unit.

B. The engine generator control panel shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit and be equipped with the following items:

1. Provide the following digital meters with 2% accuracy, minimum size 2-1/2" meters for engine mounted control panel:
   a. Generator ammeter: 3-Phase with simultaneous display of each phase.
   b. Generator voltmeter: 3-Phase, line to line and line to neutral with simultaneous display of each phase.
   c. Generator frequency meter
   d. Generator kilowatt meter: Total and for each phase and indicate power flow direction.
   e. Power factor meter, 0.5 lag to 0.5 lead.

3. Voltage level adjustment rheostat.
4. Accessory output contact which closes when the generator starts, for interlocking with remote items.
5. CT test block with shorting CT contacts and insertion tool, mounted on the front of the control panel.
6. Lube oil pressure gauge.
7. Alarm silence switch.
8. Parallel relays from each pre-alarm and alarm condition with dry contacts wired to alarm terminal strip.
9. Elapsed time meter.
10. Alarm lamp test pushbutton.
11. Adjustable Start/Stop time delay.
12. Fuel pressure gauge.
13. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
14. Fault Reset Switch: supply a dedicated control switch to reset/clear fault conditions.
15. Generator Voltage and Frequency digital raise/lower switches: Rheostats for these functions are not acceptable. The control shall adjust these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values).
16. AC Protective equipment: The control system shall include over/under voltage, over current, short circuit, loss of voltage reference, and over excitation shut down protection. There shall be an overload warning, and overcurrent warning alarm.
17. Status LED indicating lamps to indicate remote start signal present at the control, existing alarm condition, not in auto, and generator set running.
18. Graphic display panel with appropriate navigation devices shall be provided to view all information noted above as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
19. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.
20. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).

C. Control Start Sequence:

1. Automatic operation: Upon a remote contact closure from one or more automatic transfer switches, the auto-start panel shall automatically provide up to four cranking periods of ten seconds each with up to three rest periods of ten seconds in between. Should the engine fail to start, an over-crank timer shall lock out the engine from further attempts, sound an alarm, and provide an output contact closer for a remote alarm.
2. When mode is set to “ON” generator-set starts.
3. When mode is set to “OFF” the control panel initiates generator-set shutdown.
4. Operation of the local generator-set mounted and/or remote emergency-stop switch also shuts down generator-set.
5. When generator set is running, specified and required system or equipment failures or derangements automatically shut down generator set and initiate alarms.

D. Provide a local and remote LED alarm annunciator with audible and visual indications as listed below and to comply with NFPA 110 Level 1.

1. Provide with test/cancel pushbuttons, audible alarm silencing switch, contacts for local and remote alarms.
2. Locate the alarm panel in the engine generator control panel.
3. The annunciator shall alarm the following conditions:
<table>
<thead>
<tr>
<th>Required by:</th>
<th>Alarm</th>
<th>Type</th>
<th>Control Panel Annunciator</th>
<th>Remote Annunciator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>Generator running</td>
<td>Indicator</td>
<td>White</td>
<td>White</td>
</tr>
<tr>
<td>NFPA</td>
<td>Low lube oil pressure</td>
<td>Pre-alarm</td>
<td>Amber</td>
<td>Amber</td>
</tr>
<tr>
<td>NFPA</td>
<td>Low lube oil pressure</td>
<td>Alarm/shutdown</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Owner</td>
<td>High lube oil pressure</td>
<td>Alarm/shutdown</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>NFPA</td>
<td>High coolant temperature</td>
<td>Pre-alarm</td>
<td>Amber</td>
<td>Amber</td>
</tr>
<tr>
<td>NFPA</td>
<td>High coolant temperature</td>
<td>Alarm/shutdown</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Owner</td>
<td>Low coolant level</td>
<td>Pre-alarm</td>
<td>Amber</td>
<td>Amber</td>
</tr>
<tr>
<td>Owner</td>
<td>Low coolant level</td>
<td>Alarm/shutdown</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>NFPA</td>
<td>Low coolant temperature (&lt;70 degree F/20 degree C)</td>
<td>Alarm</td>
<td>Amber</td>
<td>Amber</td>
</tr>
<tr>
<td>NFPA</td>
<td>Over-crank</td>
<td>Alarm/shutdown</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>NFPA</td>
<td>Over-speed</td>
<td>Alarm/shutdown</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Owner</td>
<td>Overvoltage</td>
<td>Alarm/shutdown</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Owner</td>
<td>Under-frequency</td>
<td>Alarm/shutdown</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>NFPA</td>
<td>Control switch off normal</td>
<td>Alarm</td>
<td>Flashing red</td>
<td>Flashing red</td>
</tr>
<tr>
<td>Owner</td>
<td>Engine breaker open</td>
<td>Alarm</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>NFPA</td>
<td>Battery charger low DC voltage/output failure</td>
<td>Alarm</td>
<td>Amber</td>
<td>Amber</td>
</tr>
<tr>
<td>Owner</td>
<td>Battery charger AC failure</td>
<td>Alarm</td>
<td>Amber</td>
<td>Amber</td>
</tr>
<tr>
<td>Owner</td>
<td>High battery voltage</td>
<td>Alarm</td>
<td>Amber</td>
<td>Amber</td>
</tr>
<tr>
<td>NFPA</td>
<td>N/A -Low fuel level-day tank</td>
<td>Alarm</td>
<td>Amber</td>
<td>Amber</td>
</tr>
<tr>
<td>Owner</td>
<td>N/A-High fuel level-day tank</td>
<td>Alarm</td>
<td>Amber</td>
<td>Amber</td>
</tr>
<tr>
<td>NFPA</td>
<td>Emergency stop</td>
<td>Alarm/shutdown</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Owner</td>
<td>Low Fuel Pressure</td>
<td>Alarm</td>
<td>Amber</td>
<td>Amber</td>
</tr>
<tr>
<td>Required by</td>
<td>Alarm</td>
<td>Type</td>
<td>Control Panel Annunciator</td>
<td>Remote Annunciator</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------------------</td>
<td>------------</td>
<td>---------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Owner</td>
<td>High Fuel Pressure</td>
<td>Alarm</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td></td>
<td>Ground fault</td>
<td>Alarm</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>NFPA</td>
<td>Low fuel- main tank</td>
<td>Alarm</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>NFPA</td>
<td>Emergency power system (EPS) supplying load</td>
<td>Alarm</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Owner</td>
<td>High starting air pressure (when used)</td>
<td>Alarm</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>NFPA</td>
<td>Low starting air pressure (when used)</td>
<td>Alarm</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>NFPA</td>
<td>Low starting hydraulic pressure</td>
<td>Alarm</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>NFPA</td>
<td>Air shutdown damper (when used)</td>
<td>Alarm/shutdown</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>NFPA</td>
<td>Low cranking voltage</td>
<td>Alarm</td>
<td>Red</td>
<td>Red</td>
</tr>
</tbody>
</table>

4. Provide the following additional alarm outputs with Form C contacts (normally closed, open on alarm). The contacts shall be connected to a terminal strip in an enclosure set adjacent to the generator. Coordinate these and other alarms with controls contractor for annunciation to required building systems. Provide 10 spare pairs of terminal blocks:

   a. Standby engine run
   b. Standby engine failure (To originate from the alarm annunciator)
   c. Standby engine start system failure (To originate from the alarm annunciator)

E. Provide auxiliary engine run contacts for control of auxiliary systems required for operation of engine, such as ventilation, fuel system, electric start, regulator, governor, remote mounted fan, etc. Provide normally closed contacts for operation of intake and exhaust air dampers. In addition, provide a minimum of four (4) spare SPDT contacts.

1.17 GENERATOR CIRCUIT BREAKER:

A. Provide output main line circuit breaker which shall operate both manually as an isolation switch and automatically during overload and short circuit conditions.

B. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breaker shall meet standards established by UL, NEMA and the NEC.

C. Generator breakers shall be molded-case, solid-state trip, rated for the appropriate voltage and symmetrical interrupting capacity. Provide adjustable solid-state trip /digital long-time-delay (LTD), short-time-delay (STD), ground fault (GRD), and instantaneous (INST) trip elements with each
breaker. Pickup/delay adjustments and ranges associated with these trips will be as follows: LTD pickup - (0.5-1.0) x sensor, four time delay bands; STD pickup - (2-9) x LTD pickup, three time bands (0.1-0.35) second with I2t ramp; (GRD) pickup - (0.2-0.6) x sensor, three time bands (0.1-0.35) second with I2t ramp; INST pickup - (2-10) x sensor. Ground fault trip may be omitted when ground fault alarm is provided by a time overcurrent relay across the generator neutral current transformer. Provide trip indicators to show “overload”, “short-circuit”, and “ground-fault” trip.

D. Provide generator circuit breaker in a rated enclosure adjacent to the generator terminal compartment. Provide sufficient space for conduit and cable termination in and around the circuit breaker enclosure. Generator output shall be cabled at the factory or on site by the generator manufacturer.

E. Provide circuit breaker with auxiliary contacts which provide contact closure upon breaker automatic trip or manual opening. The alarm contact is to be used for remote annunciation of circuit breaker tripped or open.

1.18 STATE OF ASSEMBLY:

A. The engine generator system shall be factory assembled. Clean and paint all components per manufacturer's standards or as noted otherwise. Indoor and Outdoor Enclosures and Components shall be powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Paint manufacturer's standard color or as directed by Engineer.

B. Accessory items shall be mounted directly on engine generator skid except where freestanding or remotely mounted. Provide all wiring and conduit including: power wiring, lighting, receptacles, alarms, etc., for a fully installed system and include termination points/blocks for all remote or freestanding items.

1. Provide for and coordinate all field installed conduit and wiring between generator and remote or freestanding items. Provide all breakers, enclosures, lugs, labeled terminal strips, etc, for a complete installation.

C. Nameplates: Provide nameplate for each major system component to identify manufacturer’s name and address, model, serial number of component. Include information of the power output rating of the equipment.

1.19 EXTRA MATERIALS:

A. Provide spare parts for one year's maintenance of the engine generator system. Parts shall be labeled with the equipment identification which they are associated with and packed for storage. Spare parts shall include but not be limited to:

1. Belts: Provide 2 of each type.
2. Hoses: Provide 2 of each type.
3. Fuses: for voltage regulator and controls: Provide 3 of each type.
4. Filters: Provide 2 of each type, (fuel, air, water, oil, etc.)
5. Lamps/LED’s: Provide 2 of each type.

1.20 WEATHERPROOF HOUSING:

A. General: Provide a complete and operational generator enclosure, including all devices and equipment specified herein, as shown on the drawings and as required for service. Enclosure shall be factory installed and allow lifting of complete assembly as a single unit.
B. The enclosure shall conform with local building codes for the specified location and to withstand the highest level of winds as listed by the ANSI Basic Wind Speed Map for the contiguous United States.

C. Reach-In type: Engine Generators 500 kW and below: Enclosure shall be reach-in type and factory standard weatherproof option. Submit proposed factory detail drawings that fully identify enclosure construction, clearances, and access. Enclosure shall be constructed of all welded, formed sheet steel or bolted with sealed seams.

1. Construction shall allow for ability of panel replacement as well as engine/generator repairs to be performed without complete enclosure removal.
2. Provide 2 internal engine voltage DC lights and 2 control panel DC lights. Provide separate switches for internal lights and control panel lights.

PART 3 - EXECUTION:

1.21 EXAMINATION:

A. Examine areas and conditions under which engine-driven generator units are to be installed and notify the Engineer 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 the Installer.

1.22 INSTALLATION OF ENGINE-DRIVEN GENERATOR SETS:

A. Install engine-driven generator units in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine-generator units fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of engine-generator sets and accessories.

B. Coordinate with other work, including raceways, electrical boxes and fittings, fuel tanks, piping and accessories, wiring (including all interconnecting wiring between all major equipment, sections, etc., as necessary to interface installation of engine-generator equipment work with other work.

C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486 and the National Electrical Code.

D. Connect fuel piping to generator equipment as indicated, and comply with manufacturer's installation instructions.

E. In addition to a section of flexible conduit, provide pull box or connection box large enough to partially coil output conductors from the generator or the generator mounted circuit breaker or at a minimum one bend in conduit to allow for three dimensional movement and vibration during startup, shutdown, changes in load, fault conditions, etc.

F. Provide strain relief to all: control, accessory, and annunciator wiring. Use stranded wiring and a section of flexible conduit.

G. Control wiring to generator shall be monitored per NFPA 110 requirements.

1.23 GROUNDING:
A. Provide equipment grounding connections for engine-driven generator units as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounding.

1.24 FIELD QUALITY CONTROL:

A. Start-up Testing: Engage local equipment manufacturer's representative to perform start-up and load tests upon completion of installation, with the Engineer in attendance; provide certified test record.

B. The Contractor shall provide qualified personnel, load bank, cables, test equipment and all other necessary materials required and perform the following tests:

1. Check fuel, lubricating oil, and antifreeze in liquid cooled models for conformity to the manufacturer's recommendations under environmental conditions present.

2. Test accessories that normally function while the set is in a standby mode for proper operation, prior to cranking engine. Accessories include but are not limited to: engine heaters, battery charger, generator strip heater, remote annunciator, alarms, simulated safety shutdowns, etc.

3. Check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation during start-up test mode.

4. Test automatic start-up by remote-automatic starting, transfer of load, and automatic shutdown, by simulating a power outage. Prior to auto-start test, adjust transfer switch timers for proper system coordination. Test all modes of controlled start up/shut down. Monitor engine temperature, oil pressure, battery charge level, generator voltage, amperes, and frequency throughout the test, in accordance with NFPA 110 requirements and AT&T Standard Practice Checklist where applicable.

5. Test the complete system using a resistive load bank to 1.0 P.F. If for any reason, the load test is terminated, the entire test shall be restarted until satisfactory results are obtained. Use the following test parameters:

   a. 2 hours at 50 percent rated load
   b. 2 hours at 100 percent rated load (NFPA)

6. During load bank tests, record the following data on 15 minute intervals:

   a. Generator kW
   b. Generator amps on each phase
   c. Generator volts on each phase and phase to neutral
   d. Generator frequency
   e. Jacket input water temperature
   f. Jacket output water temperature
   g. Lube oil pressure
   h. Lube oil temperature
   i. Fuel pressure
   j. Exhaust back-pressure
   k. Ambient temperature
   l. Radiator inlet air temperature
   m. Oil, coolant or fuel leakage
   n. Generator stator temperature
   o. Battery charge rate (at 5 minute intervals for first 15 minutes then 15 minute intervals thereafter.)
7. Provide additional data for the following:
   a. Time to recover stable rated frequency and voltage after step addition of 50 percent, 75 percent AND 100 percent rated load.
   b. Voltage dip when applying the above step loads.
   C. Upon completion of installation, demonstrate capability and compliance of system with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting. Initial testing and retesting to be at no cost to Owner.

1.25 ADJUSTING:
   A. Adjust battery charger output.
   B. Adjust generator output voltage and engine speed.

1.26 CLEANING:
   A. Clean engine and generator surfaces. Replace oil and fuel filters.

1.27 DEMONSTRATIONS:
   A. Generator supplier shall provide Owner with a minimum of (4) hours field training and instruction.
   B. Describe system operation under emergency conditions and restrictions for future load additions.
   C. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency power.
   D. Field training and instruction shall be videotaped and electronic copy shall be turned over to maintenance personnel on an approved Digital Storage Device.

1.28 OPERATION AND MAINTENANCE:
   A. See Section 26 05 00 Common Work Results for Electrical for Submittal requirements. Supplemental information is listed within this section.
      1. Emergency instructions including addresses and telephone numbers for service sources.
      2. Troubleshooting guidelines.
      3. Complete operating instructions. All operating instructions shall include the following information as a minimum:
         a. Manufacturer's operating instructions for each piece of equipment furnished.
         b. Specific operating instructions for each portion of the system which involves multiple items of equipment.
         c. Instructions for charging, start-up, control or sequencing of operation, phase or seasonal variations, shut-down, safety and similar operations.
      4. Recommended maintenance procedures and intervals for all equipment.
      5. Complete shop drawings related to the entire system.
      6. Technical data sheets for all equipment.
      7. Complete interconnection diagrams which indicate all components of the system, including control systems and alarm interface.
8. Manufacturer’s maintenance data including complete parts lists, partial detailed parts drawings, etc. for each operational item in each system.
9. Ordering information for spare parts.
10. Manufacturer’s product warranties and guarantee relating to the system and equipment items in the system.

B. Provide the following additional operating documents:

1. A safety shutdown list provided on the generator set and in the generator maintenance manual. Verify that the appropriate safety controls have been provided based on the shutdown list.
2. Satisfactory engine/alternator test records, lubrication, fuel and start battery maintenance records with space for continued entries.
3. “Engine operating instructions” posted near the unit that provides clearly defined, step-by-step procedures for starting, running and stopping the engine.
4. Lockout-tagout procedures in place for the AC switchgear and distribution during normal operation, manual operation and testing.

1.29 WARRANTY:

A. Provide manufacturer’s warranty for duration of not less than two (2) years from the date of substantial completion of the project. The warranty shall include, but not be limited to, the replacement of materials and equipment used in generator systems.

B. Extended Warranty Agreement: Offer terms and conditions for furnishing parts and providing continued testing and servicing, beyond the warranty period, including replacement of materials and equipment, for a one-year period with an option for renewal of the Agreement by the Owner.

C. Maintenance Agreement: Prior to time of final acceptance, the supplier shall submit 4 copies of an agreement for continued service and maintenance of the engine-driven generator sets, for the Owner’s review and possible acceptance.

END OF SECTION 26 32 14
SECTION 26 36 00
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes transfer switches rated 600 V and less. It includes the following items:

1. Automatic transfer switch (ATS).
2. Remote annunciation and control system.

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: Provide manufacturer's catalog information showing dimensions, materials, colors, and configurations for all equipment associated with power transfer system. Include dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and materials lists. Also include the following information:

1. Checklist: Submit a detailed checklist which acknowledges compliance or a reason for non-compliance to each of the specification requirements. Arrange the checklist according to the headings of each item identified in this specification (i.e. shop drawings, wiring diagrams, individual line items, etc.). Mark items as “N/A” where the item is not applicable.

C. Factory Test Reports: Provide Manufacturer's certificate of compliance to the referenced standards and tested short-circuit closing and withstand ratings applicable to the protective devices and current ratings used. Submit ATS and associated circuit breaker coordination curves that show UL 1008 compliance.

D. Shop Drawings: Provide single-line diagrams of transfer switch units showing connections between automatic transfer switch, bypass/isolation switch, power source, and load, plus interlocking provisions.

E. Coordination Drawings: Wiring diagrams, elementary or schematic, differentiating between manufacturer-installed and field-installed wiring.

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. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay setting and calibration instructions.

1.3 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electrical power transfer switches, of types, ratings, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Per Laramie County Community College (LCCC) Construction Quality Standards:
1. All emergency power transfer equipment shall be manufactured by Onan Corporation. No equals will be considered.

C. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects utilizing electrical power transfer switches similar to that required for this project.


E. UL Listing and Labeling: Items furnished under this Section shall be listed and labeled by UL for Emergency Service under UL Standard 1008.

F. National Recognized Testing Laboratory Listing (NRTL) and Labeling: Items furnished under this Section shall be listed and labeled by a NRTL for emergency service under UL Standard 1008.

1. Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

G. Single-Source Responsibility: Obtain ATSs, BP/ISs, remote annunciator, and control panels from a single manufacturer that assumes responsibility for all system components furnished.

H. Source Quality Control: Factory test components, assembled switches, and associated equipment to ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for conformance with specified requirements. Perform dielectric strength test conforming to NEMA ICS 1.

1.4 DELIVERY, STORAGE AND HANDLING:

A. Deliver transfer switches and associated devices in factory-fabricated type containers or wrappings, which properly protect equipment from damage.

B. Store transfer switches and associated devices in original packaging, and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle transfer switches and associated devices carefully to prevent physical damage to equipment. Do not install damaged equipment; remove from site and replace damaged equipment with new equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

1. All emergency power transfer equipment shall be manufactured by Onan Corporation. No equals will be considered.

2.2 TRANSFER SWITCH PRODUCTS, GENERAL:

A. Number of Poles and Current and Voltage Ratings: As indicated

1. Units 400 amperes and larger shall have current ratings that apply to mixtures of loads including 30-percent-maximum tungsten filament lamp load.
2. The current rating shall be a continuous rating when the switch is installed in an unventilated enclosure and shall comply with NEMA temperature rise standards.

B. Tested Fault-Current Ratings: Closing and withstand ratings shall exceed the indicated available rms. symmetrical fault current at the equipment terminals based on testing according to UL Standard 1008, conducted at full-rated system voltage. For closed transition transfer switch, the fault current rating shall exceed that of the combined utility and generator in parallel. Rate each product for withstand duration time when tested for rated short-circuit current correlated with the actual type of circuit protective device indicated for transfer switches for this Project.

C. Annunciation and Control Interface Components: Provide devices at transfer switches for communicating with remote annunciators or annunciator/control panels which have communications capability matched with the remote device.

D. Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 degrees C. to 70 degrees C.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage surge withstand capability requirements when tested according to ANSI C37.90.1, IEEE Guide for Surge Withstand Capability (SWC) Tests. Components meet or exceed voltage impulse withstand test of NEMA ICS 1.

F. Four-Pole Switches: Where 4-pole switches are indicated, provide full-capacity and neutral switching.

G. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated shall be double the nominal rating of switch.

H. Enclosures: Provide a general-purpose NEMA 1 enclosure, conforming to UL Standard 508, "Electrical Industrial Control Equipment," except as otherwise indicated.

I. Factory Wiring: Train and bundle factory wiring and identify consistently with shop drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.

1. Designated terminals accommodate field wiring.
2. Power Terminal Arrangement and Field Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Terminals: Pressure-type, suitable for copper or aluminum conductors of sizes indicated.
4. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

J. Electrical Operation: Where indicated, accomplish by a non-fused, momentarily energized solenoid or electric motor-operated mechanism, mechanically and electrically interlocked in both directions. Switches using components of molded-case circuit breakers or contactors not designed for continuous-duty, repetitive switching between active power sources is not acceptable.

K. Switch Contacts: Use silver composition for switching load current. Units rated 225 amperes and more shall have separate arcing contacts.

L. Overcurrent devices are not part of switch products.

M. Transfer switch shall use copper bus throughout.

N. Control power for transfer switches shall operate from either source as available and shall include a connection terminal for a third separate source of power. Control, indication alarms, etc. shall operate from any of these sources automatically.
O. Provide two-hole compression lugs on all incoming and load side phase, neutral, and ground connectors.

2.3 AUTOMATIC TRANSFER SWITCHES (ATS):

A. Comply with Level 1 equipment according to NFPA 110, "Standard for Emergency and Standby Power Systems."

B. Manual Switch Operation: The switch shall have provision for manual operation under load with the door closed with either or both sources energized. Transfer time shall be the same as for electrical operation. Control circuit shall automatically disconnect from electrical operator during manual operation.

C. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts shall operate in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

D. Digital Communications Interface: Provide full-duplex serial communication (via RS - 485/422/232), matched to capability of remote annunciator and control panel.

2.4 AUTOMATIC TRANSFER SWITCH FEATURES:

A. Provide for normal source voltage sensing of each phase of normal source. Pick-up voltage shall be adjustable from 85 percent to 100 percent nominal, and drop-out voltage is adjustable from 75 percent to 98 percent pick-up value. Factory set for pick-up at 95 percent and drop-out at 85 percent.

B. Provide for emergency source voltage sensing of each phase to prevent premature transfer. Voltage pick-up shall be adjustable from 85 percent to 100 percent of nominal. Factory set to pick-up at 90 percent. Pick-up frequency shall be adjustable from 90 percent to 100 percent of nominal and factory set to pick-up at 95 percent.

C. Provide a transfer switch signal time delay to override normal source voltage-sensing, delay transfer signal and engine start signal. Delay shall be adjustable from 0 to 6 seconds, and factory set at 1 sec.

D. Provide a transfer to emergency time delay to delay transfer switch changeover after transfer signal. Delay shall be adjustable from 0 to 5 minutes and factory set at 0 minutes.

E. Provide a retransfer time delay to provide for automatic defeat of the delay upon loss of voltage or sustained under voltage of the emergency source, provided the normal supply has been restored. Delay shall be adjustable from 0 to 30 minutes and factory set at 15 minutes.

F. Provide an engine shut-down time delay adjustable from 0 to 15 minutes and factory set at 5 minutes.

G. Provide a momentary type test switch to simulate normal source failure.

H. Provide switch position pilot lights to indicate source to which the load is connected.

I. Provide source available indicating lights to supervise sources via the transfer switch normal and emergency source-sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
J. Provide a transfer override switch to override automatic retransfer control so the ATS will remain connected to the emergency power source regardless of the condition of the normal source. Provide a pilot light to indicate the override status.

K. Provide engine starting contacts, one isolated normally closed and one isolated normally open. Contacts shall be gold flashed or gold plated and rated 10 amperes at 32 VDC minimum.

L. Provide auxiliary emergency position and normal position relays. Each relay shall have two normally open and two normally closed SPDT contacts for each switch position, rated 10 amps at 240 VAC.

M. Provide a solid-state programmable engine-generator exerciser time switch to start engine-generator set and transfer load to it from normal source for a preset time, then retransfer loads to normal source and shut down engine after a preset cool-down period. The exercise cycle shall be initiated at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes and factory-set for 30 days and 30 minutes respectively.

N. Exerciser transfer selector switch which permits selection between exercise with and without load transfer.

1. Push button programming controls with digital display of settings.
2. Integral battery operation of time switch when normal control power is not available.

2.5 REMOTE ANNUNCIATOR WITH CONTROLS:

A. Provide a remote annunciation and control panel which shall provide the functions listed below for each transfer switch unless otherwise indicated.

1. Indication:
   a. Sources-available indication (as defined by actual pick-up and drop-out settings of transfer switch controls).
   b. Switch position indication.
   c. Switch in test mode indication.
   d. Failure of digital communications link indication.

2. Control:
   a. Key switch or user code access to control functions of panel.
   b. Control of switch test initiation.
   c. Control of switch operation in either direction.
   d. Control of bypass of time delay for transfer to normal source.

3. Malfunction of the annunciator unit or communication link shall not affect functions of the ATS. In the event of a failure of the communication link, the ATS automatically reverts to stand-alone, self-contained operation. No ATS sensing, controlling, or operating function depends on the remote panel for proper operation.

B. Remote Annunciator and Control Panel Features:

1. Description: Solid-state control and indicating panel. Group controls and indicating lights for each transfer switch together. Label each group indicating the transfer switch it controls, the location of that switch, and the load it serves.

2. Provide digital communications matched to that of the transfer switches to be supervised.

3. Provide surface mounted modular, steel cabinet except as indicated.
2.6 FINISHES

A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions under which transfer switches are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.2 INSTALLATION OF AUTOMATIC TRANSFER SWITCHES:

A. Install transfer switches, including associated control devices as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that transfer switches comply with requirements. Comply with applicable requirements of NEC and NFPA pertaining to wiring practices and installation of electrical power transfer switches.

B. Coordinate with other electrical work, including raceways, and electrical boxes and fittings, as necessary to interface installation of transfer switch work with other work.

C. Tighten factory-made connections, including connectors, terminals, bus joints, mountings, and grounding. Install field-connected connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values. When manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B.

3.3 WIRING TO REMOTE COMPONENTS:

A. Match the type and number of cables and conductors to the control and communications requirements of the transfer switches used. Increase raceway sizes at no additional cost to the Owner if necessary to accommodate required wiring.

3.4 GROUNDING:

A. Make equipment grounding connections for transfer switch units as indicated and as required by the NEC.

3.5 FIELD QUALITY CONTROL:

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise field tests.

B. Preliminary Tests: Perform electrical tests as recommended by the manufacturer and as follows:

1. Measure phase-to-phase and phase-to-ground insulation resistance levels with insulation resistance tester, including external annunciator and control circuits. Use test voltages and procedure recommended by the manufacturer. Meet manufacturer's specified minimum resistance.

2. Check for electrical continuity of circuits and for short circuits.

C. Field Tests: Give 7-day advance notice of the tests and perform tests in presence of Owner's representative.
D. Coordinate tests with tests of generator plant and run them concurrently.

E. Tests: As recommended by the manufacturer and as follows:

1. Contact Resistance Test: Measure resistance of power contacts for ATSs, NATSs, and BP/ISs. Resolve values in excess of 500 micro-ohms and differences between adjacent poles exceeding 50 percent.

2. Ground Fault Tests: Coordinate with testing specified in Division 16 Section on Overcurrent Protective Devices to ensure sensors are properly selected and located to optimize ground-fault protection where power is being delivered from either source.
   a. Verify grounding points and sensor ratings and locations.
   b. Apply simulated fault current at the sensors and observe reaction of circuit interrupting devices.

3. Operational Tests: Demonstrate interlock, sequence, and operational function for each switch at least 3 times.
   a. Simulate power failures of normal source to ATSs and of emergency source with normal source available.
   b. Simulate low phase-to-ground voltage for each phase of normal source of ATSs.
   c. Verify time-delay settings and pick-up and drop-out voltages.
   d. Verify all control and relay devices operate properly in each sequence.

4. Test Failures: Correct deficiencies identified by tests and prepare for retest. Verify that equipment meets the specified requirements.

5. Reports: Maintain a written record of observations and tests. Report defective materials and workmanship and retest corrected items. Record adjustable relay settings and measure insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 DEMONSTRATION:

A. Training: Furnish the services of a factory-authorized service representative to instruct Owner's personnel in the operation, maintenance, and adjustment of transfer switches and related equipment. Provide a minimum of 4 hours of instruction scheduled 7 days in advance.

B. Post step-by-step procedures for each switch provided.

END OF SECTION 26 36 00
SECTION 26 43 13
SURGE PROTECTIVE DEVICE (SPD)

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Extent of SPD work is indicated by drawings and by requirements of this section.

B. These specifications describe the electrical and mechanical requirements for a high-energy surge protective device (SPD). The specified system shall provide effective, high-energy surge current diversion and be suitable for use as type 1 or Type 2, min. 20kA device per ANSI/UL 1449 Fourth edition.

C. The system shall be constructed using multiple surge-current diversion thermally protected metal oxide varistors (TPMOV). The surge current circuit shall be designed and constructed in a manner that ensures surge current sharing. Use of gas tubes, silicon avalanche diodes or selenium cells are unacceptable unless documentation from a nationally recognized laboratory demonstrates current sharing of all dissimilar components at all surge current levels.

D. The specified system shall be designed, manufactured, tested and installed in compliance with the latest Edition following codes and standards:
   1. Underwriters laboratories; ANSI/UL 1449 4th Edition
   2. UL1283
   3. UL96A
   4. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.34, C62.41, C62.45)
   5. Institute of Electrical and Electronic Engineers 1100 Emerald Book
   6. Federal Information Processing Standards Publication 94 (FIPS PUB 94)
   7. National Fire Protection Association (NFPA 20, 70, 75 and 780)

E. The system shall be UL listed and labeled under ANSI/UL 1449 Fourth Edition and the Voltage Protection Ratings (VPRs) shall be permanently affixed to the SPD. Type 2 units of the product family shall also be Canadian underwriters laboratories (cUL) listed and labeled.

1.2 QUALITY ASSURANCE:

A. Manufacturers: firms regularly engaged in manufacture of SPD equipment of types, ratings, capacities and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Per Laramie County Community College (LCCC) Construction Quality Standards:
   1. All surge protection and transient voltage protection equipment shall be manufactured by Current Technologies, subsidiary of ABB Group. No equals will be considered.

C. The specified system shall be factory-tested before shipment. Testing of each system shall include but shall not be limited to quality control checks, "hi-pot" tests at twice rated voltage plus 1000 volts per UL requirements, IEEE c62.41 category b surge tests, UL ground leakage test, and operation and calibration tests.

D. The SPD shall have been duty life cycle tested following suggested wait times as defined by ANSI/IEEE C62.41 and shall be capable of surviving 500 sequential category C surges of 10,000 amps without failure.
E. The system shall be UL listed as a complete system under the currently adopted UL 1449 standard for surge protective device (SPD) and the rating shall be permanently affixed to the SPD.

1.3 SUBMITTALS:

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

B. Product Data: Provide manufacturer's catalog information showing dimensions, materials, colors, and configurations.

C. Factory Test Reports: Provide factory documentation of specified system's UL 1449 listing, life cycle testing, overcurrent protection, noise attenuation, surge current capacity, and clamping voltage ratings shall be provided. This shall include computer generated graphs and oscillograms. Tests shall follow procedures outlined in ANSI/IEEE for installation category and applicable protection modes of SPD.

D. Shop drawings: submit drawings of SPD equipment indicating unit dimensions, weights, component and connection locations, mounting provisions, connection details and wiring diagrams.

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.

F. Warranty: Submit manufacturer warranty and ensure that forms have been completed in owner’s name and registered with manufacturer. The statement of warrantee shall be provided on manufacturer’s letterhead.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver SPD equipment and accessories individually packaged in factory-fabricated containers. Mount units on shipping skids.

B. Handle equipment carefully to prevent internal component damage, impact, breakage, denting, and scoring enclosure finishes. Do not install damaged equipment; replace and return damaged units to equipment manufacturer.

C. Store equipment in clean dry space, protect units from dirt, fumes, water, construction debris and traffic.

1.5 WARRANTY:

A. The manufacturer shall provide a full five year warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL listing requirements, and any applicable national or local electrical codes.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION:

A. Environmental Requirements:

1. Storage Temperature: -67 degrees F to +185 degrees F (-55 degrees C to +85 degrees C).
2. Operating Temperature: -40 degrees F to +122 degrees F (-40 degrees C to +50 degrees C).
3. Relative Humidity: Operation shall be reliable in an environment with 0 percent to 95 percent non-condensing relative humidity.
4. Audible Noise: The audible noise level of the specified system shall be less than 45 dBA at 5 feet.
5. Magnetic Fields: Unit shall not generate appreciable magnetic field, and shall be capable of use directly in computer rooms in any location without danger to data storage systems or devices.

B. Electrical Requirements:

1. System Operation Voltage: The nominal system operating voltage shall be 120/208V WYE, 4 wire plus ground, or as indicated on drawings.
2. Maximum Continuous Operating Voltage (MCOV): The SPD maximum continuous operating voltage shall not be less than 115 percent of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS overvoltage conditions. Each system shall be factory tested at the MCOV for at least one (1) hour.
3. Operating Frequency: The operating frequency range of the system shall be at least 47 to 63 Hertz.
4. Protection Modes: The SPD shall provide protection as follows:
   a. Line to Line
   b. Line to Ground
   c. Line to Neutral
   d. Neutral to Ground
5. Performance Ratings: Provide SPD surge current capacity based on an 1.2x50 microsecond 20KV open circuit voltage, 8x20 microsecond short circuit current Category C3 Bi-wave per current Edition ANSI/IEEE C62.41 and C62.45 standards as follows: (A balanced surge current capacity shall also be applied Neutral to Ground and Line to Neutral where neutrals are present in the system).
   a. Branch Panelboards
      Per Phase 120 kAmps
      Line to Neutral 60 kAmps
      Line to Ground 60 kAmps
      Line to Line 60 kAmps

2.2 SPD EQUIPMENT:

A. Components: The system shall be a symmetrically balanced, metal oxide varistor (MOV) array system, constructed using surge current diversion modules. Each module shall be capable of withstanding over 1000 pulses of the 10 kAmps IEEE C62.41 Category C surge current without degradation of clamping voltage. The module shall consist of multiple gap-less metal oxide varistors, with each MOV individually fused. The modules shall be designed and constructed in a manner which ensures reasonable MOV surge current sharing. No gas tubes or silicon avalanche diodes shall be used. The status of each varistor shall be monitored and green LED shall be illuminated if the module is in full working order. When module performance is degraded, such as if one or more fuses or varistors have failed, the LED shall indicate a failed module.

B. Connections: Terminals shall be provided for all of the necessary power and ground connections. The terminals shall accommodate wire sizes of #14 to #2/0 AWG for two conductors per required connection. The units shall use standard parallel wiring techniques.
C. Internal Connections: All surge current diversion module intra-unit connections shall be by way of low impedance busbars or wiring. Surge current diversion modules shall use low impedance connections. All module mounting hardware and power wiring shall be captive or remain in place when a module is removed or replaced.

D. Enclosure: The specified system shall be provided in a heavy duty, weather proof enclosure with no ventilation openings. When provided the cover of the enclosure shall be hinged and require a tool for access to internal components. A drawing pocket shall be provided inside the door for storage of unit drawings and installation/operation manual. Indication of surge current module status shall be visible without opening the door.

E. Integral Test Point: The unit shall incorporate an integral test point allowing easy off-line diagnostic testing which verifies the operational integrity of the unit’s suppression/filter system.

2.3 OVERCURRENT PROTECTION:

A. Fusing: all suppression components shall be thermally protected and rated to allow maximum specified surge current capacity. Devices that utilize a single fuse to protect two or more suppression paths are not accepted. Individual surge components shall be UL listed to be capable of interrupting up to 200 kA symmetrical fault current with 480 VAC applied. Replaceable fusing is unacceptable. Overcurrent protection that limits specified surge currents is not acceptable.

2.4 ACCESSORIES:

A. LED indicators shall be provided on the hinged front cover to redundantly indicate unit module status. Additionally, a Form C (one N.O. and one N.C.) summary alarm contact rated for at least 120 VAC and 1 ampere shall be provided for remote annunciation of unit status. The summary alarm contact shall change state if any one or more of the surge current diversion modules has failed.

B. SPD must have an SCCR rating above the available fault current.

PART 3 – EXECUTION:

3.1 INSPECTION:

A. Inspect area and conditions under which SPD equipment is 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 SPD EQUIPMENT:

A. Install SPD as indicated, in accordance with manufacturer’s written instructions and with recognized industry practices to ensure that SPD installation complies with requirements of NEMA standards and NEC, and applicable portions of NECA’s "standard of installation," for installation of units.

B. Coordinate with other work, including electrical wiring work, as necessary to interface installation of SPD with other work.

C. Install electrical protective devices, if any, for each SPD unit.
D. The installing contractor shall install the parallel SPD with short and straight conductors as practically as possible. The contractor shall twist the SPD input conductors together to reduce input conductor inductance.

E. Field installation: the unit shall be installed as close as practical to the facility's wiring system in accordance with applicable national/local electrical codes and the manufacturer's recommended installation instructions. Connection shall be with #2 AWG copper conductor or larger and not be any longer than necessary, avoiding unnecessary bends. Notify engineer prior to installation if unit cannot be installed directly to bus or lead length within 18-24 inches or within manufacturer's required distances, whichever is shorter.

3.3 ADJUSTING AND CLEANING:

A. Touch-up scratched and marred surfaces of equipment to match original finishes; remove dirt and construction debris.

3.4 FIELD QUALITY CONTROL:

A. Upon completion of installation of SPD equipment and after circuitry has been energized with rated power source. Verify that the equipment is operating properly. Where possible, correct malfunctioning units at site; otherwise remove and replace with new units and re-verify operation.

B. Upon completion of installation of TVSS equipment and after circuitry has been energized with rated power source. Verify that the equipment is operating properly. Where possible, correct malfunctioning units at site; otherwise, remove and replace with new units and re-verify operation.

END OF SECTION 26 43 13