Provide new breaker to match existing in equipped space. See detailed one line diagram on sheet E011.

Additional notes:
- Wiregrip must be used in the vertical and horizontal pull boxes. O-2/Gadney™ Cable Supports shall be used for each feeder in the appropriate locations. Cable types/size shall be replaced as noted.
- Splices with an open return in equipment should be avoided.
- Health Science Center at UT Houston.

5KV OVERALL ONE LINE DIAGRAM - RENOVATION

Date: 09/30/2016

Designed By

Checked By
SECTION 26 05 00
ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials and equipment required for complete and functioning electrical systems as required by the contract documents.

B. New Work. The work includes, but is not limited to, the following principal systems and equipment:
   1. Medium Voltage distribution (>1000V).
   2. 480/277 volt distribution.
   3. 208/120 volt distribution.
   4. Switchgear.
   5. Panelboards-Distribution, Branch Circuit and Electronic Grade.
   6. Transformers.
   7. Luminaires, lamps and ballasts.
   8. Fire alarm system.
   9. Lighting controls.
   10. Grounding and bonding system.
   11. Motor controllers.

C. Demolition. Refer to plans for scope of work.

1.2 APPLICABLE PROVISIONS

A. Provisions Specified Elsewhere. Unless modified in this Section, General and Supplementary General Conditions, applicable provisions of Division 01 - General and other provisions of contract documents apply to work of Division 26 - Electrical.

B. Application. Provisions of this Section apply to every section of Division 26 - Electrical, except where specifically modified.

C. Work covered by this Section shall be accomplished in accordance with applicable provisions of the Contract Documents and addenda or directives which may be issued herewith, or otherwise.

1.3 RELATED WORK

A. Existing Conditions - Division 02.

B. Openings - Division 08.

C. Specialties - Division 11.

1.4 REFERENCE CODES AND STANDARDS

A. Standards of the following organizations may be referenced in the specification. Unless noted otherwise, references are to standards or codes current at the time of bidding.

B. Association of Edison Illuminating Companies (AEIC).

C. American National Standards Institute (ANSI).

D. Institute of Electrical and Electronics Engineers (IEEE).

E. Insulated Cable Engineers Association (ICEA).

F. National Electrical Code (NEC).

G. National Electrical Manufacturers Association (NEMA).


I. National Fire Protection Association (NFPA).

J. Underwriters’ Laboratories (UL).


1.5 REGULATIONS AND PERMITS

A. Regulations. Work, materials and equipment must comply with the latest rules and regulations of the following:

3. Occupational Safety and Health Act (OSHA).
4. Americans with Disabilities Act (ADA).
5. Texas Department of Licensing and Regulation (TDLR).
8. State and federal codes, ordinances and regulations.

B. Discrepancies. The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner’s representative in writing, including a proposed resolution, and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified or shown.

C. Permits: Obtain certificates of inspection and other permits required as a part of the work. Submit written evidence to the Owner’s Representative and Architect/Engineer that the required permits and inspections have been secured.
1.6 DRAWINGS AND CONTRACT DOCUMENTS

A. Intent: The intent of the construction Drawings or contract documents, hereinafter referred to as the “Drawings”, is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system. The Drawings, specifications, and related contract documents are cooperative, and work or materials called for in one and not mentioned in the other shall be provided. Electrical Drawings, are generally diagrammatic and show approximate location and extent of the work. Review pertinent Drawings and adjust the work to conditions shown. Install the work complete, including minor details necessary to perform the function indicated.

B. The Contractor shall carefully investigate structural and finish conditions, and shall coordinate the work in order to avoid interference between the various phases of work. The Contractor shall be responsible for the proper routing of raceways, subject to prior review by the Owner's Representative. Work shall be organized and laid out in finished portions of the building so that it will be concealed in furred chases, suspended ceilings, and similar elements of the building, unless specifically noted to be exposed. Work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

C. Discrepancies: In case of doubt as to work intended, or if amplification or clarification is needed, or where discrepancies occur between Drawings, specifications, and actual field conditions, immediately notify the Architect/Engineer and the Owner's Representative in writing, requesting an interpretation, and include a proposed solution.

D. Dimensions: Dimensional information related to new structures shall be taken from the appropriate Drawings. Dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

E. Outlet and Equipment Locations: Coordinate the actual locations of electrical outlets and equipment with building features and equipment as indicated on architectural, structural, mechanical, telecommunications, audio-visual (AV), security, plumbing, and laboratory Drawings. Review with the Owner's Representative proposed changes in outlet and equipment location. Relocation of outlets before installation of up to 5 feet from the position indicated may be directed without additional cost to the Owner. Remove and replace outlets placed in unsuitable locations, when so requested by the Owner's Representative, and at no additional cost to Owner.

1.7 SUBMITTALS

A. Submit the following in addition to and in accordance with the requirements of the Uniform General Conditions and in Division 01, Submittals.
   1. Include inspection and permit certificates and certificates of final inspection and acceptance from the authority having jurisdiction.
   2. Manufacturer's standardized schematic diagrams and catalog cuts shall not be acceptable unless applicable portions are clearly indicated and non-applicable portions clearly deleted or crossed out.
   3. Schematic, connection and/or interconnection diagrams.
   4. Provide submittals as required by individual specification section.

B. Provide the following with each submittal:
   1. Catalog cutsheets with manufacturer’s name clearly indicated. Applicable portions shall be clearly indicated by arrows, circles, or similar markings and non-applicable portions shall be clearly deleted or crossed out.
   2. Line-by-line specification review by equipment manufacturer and contractor with exceptions explicitly defined.
3. Itemize and organize equipment and material submittals by specification Section number; include manufacturer and identifying model or catalog numbers.
   a. Submittal packages for product data, shop drawings, and other required submittals shall be numbered sequentially according to the applicable specification Section number. For example, the first submittal package for Energy-Efficient Dry-Type Transformers shall be identified as Submittal number 262213-01. The second submittal package for Energy-Efficient Dry-Type Transformers would be identified as Submittal number 262213-02. Re-submittal packages shall be identified by an “R” in the sequential numerical suffix.
   b. Where directed by the Owner or the Architect to combine submittals into a common package, the submittal data may be organized in one or more 3-ring binders or similar container. Product data, shop drawings, and other submittal data shall be organized in separate tabs according to paragraph 1.07B.3a, above. That is, submittal data in individual tabs of a common submittal package shall be numbered sequentially, according to the applicable specification Section number.

4. Replace rejected items and resubmit with acceptable items in accordance with the requirements of Division One for Submittals, and with the Uniform General Conditions.

C. Within the specified time window after award of contract, submit list of equipment and materials to be furnished.
   1. Itemize equipment and material by specification section number; include manufacturer and identifying model or catalog numbers.
   2. Replace rejected items with an acceptable item within 2 weeks after notification of rejection.
   3. If a satisfactory replacement is not submitted within a two-week period, Owner will notify contractor as to equipment manufacturer or type and make or material to be furnished. Provide designated items at no additional cost to Owner.

D. Equipment Layout Drawing: 1/8-inch scale minimum drawings indicating all new electrical equipment locations. Dimensions for all equipment shall be indicated on these drawings including dimensions from equipment to walls/pipes. Indicate routing of conduit 2 inches and over on these drawings. Also clearly shows the new steel support system.

E. Coordination Drawings: The Contractor shall prepare one complete set of composite drawings. The shop drawings for sheet metal ductwork shall be used as the basis for this coordination in addition to any existing ductwork & piping. Exact size and locations of piping and ductwork shall be field verified and shown on these plans. When the sheet metal drawings have been prepared, the raceway, luminaires, mechanical piping, plumbing piping, and fire protection piping shall be overlaid and drafted onto the composite drawing. The intent of this process is to define areas of potential conflict and resolve those conflicts prior to fabrication or installation of work. In areas of congestion (where simply overlaying and drafting will create an unreadable product), the plan view scale shall be increased and multiple layered views shall be developed. Elevations of the individual elements shall be established, and elevations shall be drawn to illustrate that the ductwork, piping, raceway, and other systems and components will co-exist within the available space, and that the proper access to equipment, luminaires, valves, filters, etc. has been established for operation, service, removal and replacement. In addition to the above, the Contractor shall also submit the following for review:
   1. Electrical Rooms. Submit 1/4-inch scale coordination drawings of electrical rooms indicating location of equipment. Indicate the exact location of each component in relation to other existing and new mechanical, electrical, and plumbing (MEP) components within each room. Include location(s) and quantity of raceway(s) and
sleeve(s) stubbed up through floor slab for power, lighting, control, grounding, communications, and low-voltage system(s). These coordination drawings shall take into account the configuration of the mechanical, electrical, and telecommunications equipment which has been proposed and approved for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings. In gym area and handball court where new electrical equipment is being located, the coordination drawings shall clearly show the new metal platform, all equipment dimensions and dimensions to all walls and existing pipes etc.

2. Mechanical and Pump Rooms. Submit 1/4-inch scale coordination drawings of mechanical and pump rooms indicating location of electrical equipment. Indicate the exact location of each component in relation to other MEP components within each mechanical and pump room. These coordination drawings shall take into account the configuration of the mechanical and electrical equipment which has been proposed and approved for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.

3. Building Information Modeling (BIM). Where a BIM-model of the project has been developed by the Architect/Engineer or Contractor, the BIM model may be used to develop and produce the coordination drawings. The Contractor and the individual trades shall confirm in writing that the BIM-model and related coordination drawings accurately match the components and systems to be fabricated and installed.

4. Review: The completed “Composite Drawings” shall be submitted to the Architect/Engineer for review prior to installation. Work that proceeds without appropriate coordination and review will be subject to removal and relocation at no additional cost to the Owner.

F. Installation: Where product data or shop drawings are required, do not install equipment or materials until submittals are accepted by the Architect/Engineer and by Owner's Representative. Use only equipment and materials accepted by the Architect/Engineer and by Owner’s Representative. Equipment and materials installed prior to acceptance by the Owner/Engineer and Owner's Representative shall be removed at no additional cost to Owner and replaced at the Contractor's expense.

G. Startup and Test Procedures:
1. Furnish documentation from equipment manufacturer for the startup and field testing procedures for equipment installed as a part of this project.
2. Startup and testing procedures shall include prerequisite conditions, system and equipment alignments and lineups, sequential steps for execution of the test, shutdown procedures, and criteria for satisfactory test completion and test failure.
3. Startup and testing procedures shall address and demonstrate modes of system or equipment operation, including startup, manual, unattended/automatic, and shutdown procedures, as well as procedures for testing and demonstration of abnormal or emergency operating conditions.
4. Include forms and logs to be used during field testing. Forms and logs shall include the range of permissible values for monitored parameters, as applicable.

H. As-Built and Record Drawings:
1. Maintain a master set of as-built drawings that show changes and other deviations from the Drawings. The markups must be made as the changes are done.
2. At the conclusion of the project, these as-built drawings shall be transferred to AutoCAD electronic files, in a format acceptable to the Owner’s Representative, and shall be complete.
3. Prior to final acceptance, deliver to the Owner's Representative the AutoCAD electronic files, the complete set of record drawings showing the as-built condition of the project, and the actual field set of as-built drawings. Also deliver one set of as-
built drawings on CD-Rom or similar electronic media acceptable to the Owner. Drawing files shall be in AutoCAD (.dwg) and Adobe Acrobat (.pdf).

4. Quantity: In accordance with the requirements of Division One and the General Conditions. Where not specified elsewhere, provide 3 hard copies plus one reproducible set.

I. Operating and Maintenance Manuals: As specified in Part 3 of this Section and in Division One, as applicable.

J. Overcurrent Protective Device Coordination Study: Provide preliminary and final study as specified in Section 26 05 73. Make adjustments to materials and submittals under other Sections of Division 26 as required and as recommended by the Overcurrent Protective Device Coordination studies.

1.8 SUBSTITUTIONS

A. Refer to requirements of Division One for substitution of Material and Equipment.

B. Product manufacturers are listed to establish a level of quality for the products. Substitutions may be allowed if the product is equal to or better than what is listed in the design guidelines, as determined by the Architect/Engineer and owner’s Representative upon submittal of comparison products.

C. Samples: When requested by the Owner's Representative or the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. When requested, provide samples of both the specified item and the proposed item for comparison purposes.

D. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop drawings, and sample processing is on the Contractor. Time periods for Architect/Engineer processing and review of submittal data, shop drawings, samples, studies, and reports shall be in accordance with the applicable submittal and substitution requirements of Division One and the General Conditions. The Contractor shall allow sufficient time for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforementioned cycles for processing of submittal data and shop drawings, including time for resubmittal cycles on unacceptable and rejected materials, equipment, components, and systems covered by the data submitted. Construction delays and lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in requests for scheduled construction time extensions and additional costs to the Owner.

E. Acceptance: Acceptance of materials and equipment will be based on manufacturer’s published data and will be tentative subject to the submission of complete shop drawings indicating compliance with the Drawings, specifications, and other applicable Contract Documents, and that adequate and acceptable clearances will exist for entry, servicing, and maintenance. Acceptance of materials and equipment under this provision shall not be construed as authorizing deviations from the Specifications, unless the attention of the Owner’s Representative and the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless pertinent information is properly identified.

F. Replacement; Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment originally specified at no additional cost to the Owner.
1.9 CONTRACTOR QUALIFICATIONS

A. An acceptable Contractor for the work under this division must have personnel with experience, training and skill to provide a practical working system.
   1. The Contractor may be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project. The systems must have served satisfactorily for not less than 3 years. The superintendent must have had experience in installing not less than three such systems.
   2. The Contractor must have personnel with the proper licenses to perform electrical work under this Contract. In accordance with the Texas Electrical Safety and Licensing Act – Title 8, Occupation Code, Chapter 1305, Subchapter D, section 1305.151: “LICENSE REQUIRED. Except as provided by Section 1305.003, a person may not perform electrical work unless the person holds an appropriate license issued or recognized under this chapter.”

B. The Contractor shall follow the safety procedures in addition to, and in accordance with, the requirements of the Project Safety Manual (PSM).
   1. The Contractor shall be responsible for training personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel on hazards particular to this project and update the information as the project progresses.
   2. The Contractor shall secure electrical rooms, to limit access, prior to energizing high voltage (1000V or higher) equipment, and shall control access during the project after energization. The Contractor shall post and maintain warning and caution signage in areas where work is ongoing near energized equipment. The Contractor shall cover energized live parts when work is not being done in the equipment. This includes lunch and breaks.
   3. The Contractor shall strictly enforce OSHA lockout/tagout procedures. Initial infractions shall result in a warning. A second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Condition. Provide new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer's latest standard design for the type of product specified.

B. NEC and UL.
   1. Products must conform to requirements of the National Electrical Code. Where Underwriters’ Laboratories have set standards, listed products and issued labels, products used must be listed and labeled by UL.
   2. Materials and equipment shall be labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended. Where no specifications or specific model numbers are given, provide materials of a standard industrial quality.

C. Space Limitations: Equipment selected must conform to the building features and must be coordinated with them. Electrical installation shall comply with the requirements of Article 110.26 and Article 110.34 of the National Electric Code (NEC) for working space, access, and dedicated equipment space. Do not provide equipment that will not suit arrangement and space limitations. Scaled drawings (1/4” = 1'-0”) of electrical and telecommunication rooms shall be submitted for review by the Architect/Engineer and the Owner’s Representative prior to installing equipment. See paragraph 1.07E above.
D. Factory Finish. Equipment shall be delivered with a hard surface, factory-applied finish so that no additional field painting is required except for touch-up as required.

E. Physical Size of Equipment: Equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless the Contractor demonstrates by product data, shop drawings, and coordination drawings that ample space exists for proper installation, operation, and maintenance.

F. Enclosure: Provide NEMA 1 enclosure for indoor installation and NEMA 3R for outdoor enclosure, unless noted or specified otherwise. The enclosure shall be suitable for the environment per NEC, NEMA and ANSI standards.

G. Conductors in Conduit: Conductors shall be installed in conduit. Exceptions are listed in individual Sections of the Division 26 and Division 28 specifications.

2.2 MANUFACTURER

A. Where two or more units of the same class of material are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer, except as specifically noted in individual Sections of the specifications.

2.3 SUBSTITUTIONS

A. Refer to Division 01 section on Material and Equipment, and to paragraph 1.08 of this Section.

2.4 NAMEPLATES AND DEVICE MARKING

A. Refer to Section 26 05 53, Identification For Electrical Systems.

2.5 AUTOMATED EQUIPMENT AND CONTROLS

A. Equipment and control systems where applicable, shall match, integrate, communicate and cooperate with new and existing systems, such as building automation, energy management, direct digital controls (DDC), fire detection and alarm, circuit breakers, transformers, etc.

PART 3 - EXECUTION

3.1 GENERAL

A. Manufacturer’s Recommendations: The manufacturer’s published directions shall be followed in the delivery, storage, protection, installation, wiring, and connection of equipment and material. Promptly notify the Architect/Engineer and the Owner’s Representative in writing of conflicts between the requirements of the Drawings and specifications and the manufacturer’s directions, in accordance with paragraphs 1.05B and 1.06C of this Section. Obtain instructions from the Owner’s Representative before proceeding with the work. Should the Contractor
perform work that does not comply with the manufacturer’s directions or such instructions from the Owner’s Representative, he shall bear costs arising in connection with the deficiencies.

B. Site Observation: Site observation by the Architect/Engineer is for the express purpose of verifying compliance by the Contractor with the Drawings, specifications, and other applicable Contract Documents. Site observation by the Architect/Engineer shall not be construed as construction supervision, or indication of approval of the manner or location in which the work is being performed, or as being a safe practice or place. Site observation by the Architect/Engineer shall not be construed as inspection by the Authority Having Jurisdiction (AHJ) or other applicable code enforcement authority.

C. Installation: Where product data or shop drawings are required, do not install equipment or materials until submittals are accepted by the Architect/Engineer and by the Owner’s Representative. Use only equipment and materials accepted by the Architect/Engineer and the Owner’s Representative. Equipment and materials installed prior to acceptance by the Architect/Engineer and Owner’s Representative shall be removed at no additional cost to Owner and replaced at the Contractor’s expense.

D. Supervision:
   1. The Contractor of the work under this Division shall keep a competent superintendent or foreman on the job throughout the period of construction. Refer to Division One requirements and the Uniform General Conditions for additional information concerning supervision.
   2. It shall be the responsibility of such superintendent to study the Drawings, specifications, and other applicable Contract Documents, and familiarize himself with the work. He shall coordinate his work with other trades before material is fabricated or installed, and ensure that his work will not cause interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the Contractor. Where interferences cannot be resolved without major changes to the Drawings, the matter shall be referred to the Architect/Engineer and the Owner’s Representative for resolution in accordance with paragraphs 1.05B and 1.06C of this Section.

3.2 PROTECTION OF EQUIPMENT AND MATERIALS

A. General:
   1. The Contractor shall follow the manufacturer’s directions completely in the delivery, storage and handling of equipment and materials.
   2. Equipment and materials shall be tightly covered and protected against dirt, water, chemical, physical or weather damage and theft. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and shall be returned to “as new” condition.
   3. Electrical cable, wire, and conductors shall be stored to prevent moisture and mechanical damage.

B. Moisture. During construction, protect switchboard, transformers, motors, control equipment, and other items from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps or other suitable means. Apply protection immediately on receiving the products and maintain continually.

C. Clean. Keep products clean by elevating above ground or floor and by using suitable coverings.
D. Damage. Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.

E. Finish. Protect factory finish from damage during construction operations and until acceptance of the project. Satisfactorily restore finishes that become stained or damaged.

F. Weather. Protect equipment and materials from weather and sunlight by use of suitable coverings and storage indoors, or in suitable weather-protected containers. Materials and equipment marked by their manufacturer as suitable for storage outdoors may be stored according to manufacturer’s markings. Maintain factory-installed coverings and wrappings until material is to be installed.

3.3 PREPARATION

A. Coordination Drawings: The Contractor shall prepare one complete set of composite drawings. The intent of this process is to define areas of potential conflict and resolve those conflicts prior to fabrication or installation of work. In areas of congestion (where simply overlaying and drafting will create an unreadable product), the plan view scale shall be increased and multiple layered views shall be developed. Elevations of the individual elements shall be established, and elevations shall be drawn to illustrate that the ductwork, piping, raceway, and other systems and components will co-exist within the available space, and that the proper access to equipment, luminaires, valves, filters, etc. has been established for operation, service, removal and replacement. In addition to the above, the Contractor shall also prepare the following:

1. Electrical/Mechanical Rooms. Prepare 1/4-inch scale coordination drawings of electrical rooms indicating location of equipment. Indicate the exact location of each component in relation to other mechanical, electrical, and plumbing (MEP) components within each room. Include location(s) and quantity of raceway(s) and sleeve(s) stubbed up through floor slab for power, lighting, control, grounding, communications, and low-voltage system(s). These coordination drawings shall take into account the configuration of the mechanical, electrical, and telecommunications equipment which has been proposed for use in the project, particularly where it differs in configuration from the equipment shown on the Drawings.

2. Review: The completed “Composite Drawings” shall be prepared prior to installation. Work that proceeds without appropriate coordination will be subject to removal and relocation at no additional cost to the Owner.

B. Test Procedures:

1. Furnish documentation from equipment manufacturer for the startup and field testing procedures for equipment installed as a part of this project.

2. Startup and testing procedures shall include prerequisite conditions, system and equipment alignments and lineups, sequential steps for execution of the test, shutdown procedures, and criteria for satisfactory test completion and test failure.

3. Startup and testing procedures shall address and demonstrate modes of system or equipment operation, including startup, manual, unattended/automatic, and shutdown procedures, as well as procedures for testing and demonstration of abnormal or emergency operating conditions.

4. Include forms and logs to be used during field testing. Forms and logs shall include the range of permissible values for monitored parameters, as applicable.

3.4 SAFETY

A. Implement the following safety procedures in addition to, and in accordance with, the requirements of Division One and the Uniform General Conditions:
1. The Contractor shall be responsible for training personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel of hazards particular to this project and update the information as the project progresses.

2. Prior to energizing panelboards within the scope of work, secure affected electrical rooms to limit access to line voltage. Line voltage shall be defined as above 50 volts, for the purpose of controlling access. During and after energization of panelboards, control access to electrical rooms for the duration of the project. Post and maintain warning and caution signage in areas where work is on-going near energized equipment. Cover energized live parts when work is not being done in the equipment. This includes lunch and breaks.

3. Strictly enforce OSHA lockout/tagout procedures. Initial infractions shall result in a warning. A second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

3.5 INSPECTION

A. Examination. Examine the areas and conditions under which equipment and systems are to be installed, and notify the Owner’s Representative in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Coordination. Carefully investigate structural and finish conditions and coordinate the work in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases, suspended ceilings, and similar elements in finished portions of the building, unless specifically noted to be exposed. Work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

3.6 INSTALLATION

A. Cooperation with Other Trades. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades. Provide other trades, as required, templates, patterns, setting plans and shop details for the proper installation of the work and for purposes of coordinating adjacent work. Electrical power connections for mechanical and plumbing equipment are in this Division unless noted otherwise. Verify electrical characteristics of equipment with other Divisions before roughing in the electrical connections.

B. Workmanship. Work shall be performed by workmen skilled in their trade. The installation shall be complete and installed in a neat and workmanlike manner in accordance with NEC 110.12 and FPM accompanying, and as described in ANSI/NECA 1-2000 “Standard Practices for Good Workmanship in Electrical Contracting”, and other ANSI approved installation standards.

C. Concrete Equipment Pads.

1. Refer to structural Drawings and specifications for design criteria.
2. Where not otherwise indicated, install 2 inch thick reinforced concrete foundation pads for indoor floor-mounted equipment, except where direct floor mounting is required such as at the metal platform. For equipment mounted outdoors, provide concrete foundations a minimum of 6 inches above grade. Provide reinforcing steel as recommended by the structural engineer and as detailed on the Drawings. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 3
inches beyond equipment. Trowel pads smooth and chamfer edges to a 1-inch bevel. Secure equipment to pads as recommended by the manufacturer.

3. Anchor Bolts. Furnish and install galvanized anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the manufacturer of the equipment and shall be located by means of suitable templates. When equipment is placed on vibration isolators, the equipment shall be secured to the isolator and the isolator secured to the floor, pad, or support as recommended by the vibration isolation manufacturer.

D. Setting of Equipment. Provide permanent and temporary shoring, anchoring, and bracing required to make parts stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.

1. Equipment must be leveled and set plumb.
2. Sheet metal enclosures mounted against a wall shall be separated from the wall not less than 1/4 inch by means of corrosion-resistant spacers, or by 3 inches of air for freestanding units. Use corrosion-resistant bolts, nuts and washers to anchor equipment.
3. In sufficient time to be coordinated with work under other divisions, provide shop drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.
4. Provide adequate support for freestanding panels, switchboards, enclosures, and other equipment. This shall include bolting to the floor, concrete equipment pad, or solid structural steel to prevent tipping. Install free-standing electrical equipment on concrete equipment pads in accordance with paragraph 3.05C, this Section, except where equipment is noted and designed for mounting directly on the concrete floor slab. Under no condition shall equipment be fastened to non-rigid building steel such as removable platform steel gratings, handrails, etc.
5. Provide racks and supports, independently mounted at structure, to support electrical equipment and systems supplied and installed under this contract. Do not mount or suspend equipment from supports provided for equipment and systems by other Divisions, except where specifically noted or indicated on Drawings.
6. Refer to Section 26 05 29, Metal Framing and supports, for additional requirements.

E. Sealing of Equipment. Seal openings into equipment to prevent entrance of animals, birds and insects, as well as to prevent ingress of moisture, dust, dirt, and similar contaminants.

F. Motors.

1. Motors are specified in Divisions 21, 22 and 23.
2. Electrical work includes the electrical connection of motors, except those which are wired as a part of equipment.
3. Refer to Division 23 and other applicable Divisions for wiring and connection of motors and equipment furnished by those Divisions.
4. The Contractor shall note that the electrical Drawings are based on the equipment scheduled and indicated on the Drawings. Should mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.
5. Provide interconnecting wiring for the installation of the power required. Provide disconnect switches as required for proper operation, as indicated on the Drawings or required by applicable code. Combination starters, individual starters, and other motor starting apparatus, not specifically scheduled or specified as provided by the equipment manufacturer under the scope of other Divisions shall be provided under the scope of Division 26.
6. Other Divisions will provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review. Diagrams will be based on accepted equipment and be complete full phase and
interlock control drawings, not a series of manufacturer’s individual diagrams. They will be followed in detail. For additional clarification, refer to Division 23, Controls.

G. Concealed Work. Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:
1. Where shown or specified to be exposed. Exposed is understood to mean open to view.
2. Where exposure is necessary to the proper function.
3. Where size of materials and equipment preclude concealment. Obtain the written consent of the Owner’s Representative and the Architect/Engineer to leave materials exposed in finished spaces of the building.

H. Application. Unless otherwise indicated, power will be utilized as follows:
1. 480 volts, three phase: motors 3/4 horsepower and larger.
2. 120 volts, single phase: motors 1/2 horsepower and smaller.
3. 277 volts, single phase: fan powered boxes.
4. 120 volts, single phase: incandescent lighting.
5. 277 volts, single phase: fluorescent and high-intensity-discharge lighting.
6. 120 volts, single phase: convenience outlets, dedicated equipment, lab-track terminal boxes without fans.
7. 208 volts, single and three phase: specialty outlets.
8. 480 volts, three phase: special power and equipment; verify for each unit of equipment.

I. Transformers. Use transformers to change the service to the required utilization voltages.

Connections to Equipment - Other than Division 26. For equipment furnished under other Divisions, and for equipment furnished by the Owner, provide final electrical connections to such items of equipment. Obtain detailed shop drawings of equipment from the applicable Division or supplier indicating the exact number and location of rough-in points. Such final shop drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions. Making adjustments to field conditions is considered a part of the work required.

1. Roughing-in: When roughing-in, provide electrical branch circuits to various items of equipment. Terminate at proper points as indicated on detailed equipment shop drawings, or as directed. Use Drawings accompanying these specifications only for general routing of circuiting. Do not use Drawings accompanying these specifications for rough-in locations.
2. Final Connections: Millwork, casework, and similar equipment will include service fittings such as switches, duplex receptacles, data/communications outlets, and luminaires on the casework or equipment. Provide branch circuit connection to match electrical connection requirements of service fittings.

K. Accessories. Offsets, fittings, expansion joints, anchors and accessories that are required for a complete system shall be provided, even if not specifically indicated on the Drawings or mentioned in the specifications. Offsets, transitions and changes in direction of conduit, cable trays, raceways and busways shall be made to maintain proper headroom. Provide pullboxes, fittings, etc., required as a result of these transitions and changes in direction.

L. Observation prior to cover-up or seal-in of walls and ceilings. Perform the following in accordance with the applicable requirements of Division One and the General Conditions:
1. Prior to the installation of ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the Owner’s Representative so that arrangement can be made for observation or inspection of the above-ceiling area about to be “sealed” off. The Contractor shall provide advance notice in accordance with the applicable
requirements of Division One and the General Conditions. Where not specified, required, or directed elsewhere, provide not less than 10 working days’ advance notice.

2. Above-ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. Electrical work at and above the ceiling, including items supported by the ceiling grid, shall be complete and installed in accordance with contract requirements, including power to luminaires, fans, and other powered items. The purpose of this inspection is to verify the completeness and quality of the installation of the electrical systems and other above ceiling special systems such as cable tray systems. The ceiling supports shall be in place so that access panel and luminaire locations are identifiable, and so that clearances and access provisions may be evaluated.

3. No ceiling materials may be installed until the resulting deficiency list from this inspection is completed and approved by the Owner’s Representative.

M. Finish. Coordinate with Division 9 to paint exposed conduit to match adjacent walls, unless otherwise directed.

3.7 EXISTING FACILITIES

A. Responsibility. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and maintenance of electrical services for new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing such temporary protection upon completion of the work.

B. Services. The Contractor shall provide temporary or new services to existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

C. Access. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, luminaries, air conditioning ductwork and equipment, etc., to provide this access, and shall reinstall same upon completion of work in the areas affected.

D. Existing Devices. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, remove and reinstall in locations approved by the Architect/Engineer devices required for the operation of the various systems installed in the existing construction. This is to include, but is not limited to, temperature controls, system devices, electrical switches, relays, luminaires, fixtures, piping, conduit, etc.

E. Outages. Outages of services as required by the new installation will be permitted, but only at a time approved by the Owner. The Contractor shall coordinate with the Owner’s Representative to arrange for service outages. The Contractor shall allow the Owner sufficient time to schedule for required outages, in accordance with the applicable requirements of Division One and the General Conditions. Where not specified, required or directed elsewhere, allow a minimum of 21 working days for the Owner to schedule for required outages. The time allowed for outages will not be during normal working hours or during hours of research and instruction, unless otherwise approved by the Owner’s Representative. Costs of outages, including overtime charges, shall be included in the contract amount.

F. Adjacent Facilities. Coordinate work among the various trades to minimize disruption to existing processes, procedures, and equipment in spaces adjacent to areas of demolition and
The University of Texas Health Science Center

MSB Switchgear Replacement

Shah Smith & Associates, Inc.

June 24, 2016

ELECTRICAL GENERAL PROVISIONS

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renovation work. Coordinate with Owner’s Representative to schedule work producing noise or structure-born vibrations, including but not limited to cutting, drilling, coring, and use of impact tools.

3.8 EQUIPMENT AND DEVICE MARKING

A. Designations. Identify equipment, devices, feeders, branch circuits and similar items with the same designations as indicated on the Drawings.

B. Nameplates. Externally mark electrical equipment with nameplates identifying each and the equipment served. Supply blank nameplates for spare units and spaces.

C. Refer to Section 26 05 53 for additional requirements.

3.9 SLEEVES, Penetration, Cutting and Patching

A. General. Cut and patch walls, floors, etc., resulting from work in existing construction. Provide for the timely placing of sleeves for raceway and exposed cabling passing through walls, partitions, beams, floors and roof while same are under construction. If openings, sleeves, and recesses are not properly installed and cutting and patching become necessary, it shall be done at no expense to the Owner. Secure permission from the Owner’s Representative before cutting or patching a constructed or existing wall. Where roofs or walls are fire rated, penetrations shall be completely sealed using UL-listed materials and procedures sufficient to preserve the fire rating. Comply with special requirements of local authorities.

B. Structure. Do not cut or core through structural beams, joists, load-bearing walls, grade beams, or similar load-bearing structure. Where limited space is available above the ceilings below concrete beams or other deep projections, notify the Owner’s Representative in writing, including a proposed solution, and request a resolution. Approval shall be obtained from the Owner’s Representative and the Architect/Engineer for each penetration.

C. Penetrations.

1. This contract requires core drilling of floor or wall penetrations as indicated on Drawings. Core drilling shall be in accordance with structural specifications. Floor penetrations shall include a sleeve that extends above the floor 2 inches, except where plugs and caps are specified or indicated flush with floor or foundation pad. Electrical penetrations shall be coordinated with structure during design, and shall be made in compliance with structural requirements specified in the structural Drawings and specifications. Field modifications are required to be reviewed and approved by structural engineer prior to installation.

2. Penetrations shall be sealed in accordance with the requirements of Division 7, Firestopping. Coordinate with Division 7 to provide firestopping systems and materials that are compatible with the penetrations for systems and equipment furnished and installed under Division 26.

3. Provide sleeves for conduit penetrations of smoke, fire, and sound rated partitions. Install sleeve with a minimum of 1 inch diameter where penetrating the exterior drywall.

4. Provide proper sizing of sleeves or core-drilled holes to accommodate their through-penetrating items. In general, provide conduit sleeves two standard sizes larger than their through-penetrating items. Provide larger sleeves as required to allow passage of couplings for through-penetrating items.

D. Sealing and Firestopping.
1. Voids between sleeves or core-drilled holes and pipe passing through fire-rated assemblies shall be firestopped to meet the requirements of ASTM E 814, in accordance with Division 7 requirements for Firestopping.

2. Where the routing of cable tray passes through fire-rated walls, floors or other fire-rated boundaries, coordinate with Division 7 to provide removable firestopping system.

3. Furnish and install UL Systems Classified, intumescent material capable of expanding up to 8 to 10 times when exposed to temperatures beginning at 250° F, for the sealing of holes or voids created to extend electrical systems through fire rated floors and walls, in order to prevent the spread of smoke, fire, toxic gas or water.

4. Fire barrier products shall be used to create through-penetration firestop systems as required. Firestop systems shall be listed in the Underwriter’s Laboratories Building Materials Discovery, Through Penetration Firestop Systems (XHEZ).

5. Install firestop materials and systems according to their UL Systems Classifications, manufacturer instructions, manufacturer recommendations, and the requirements of applicable Division 7 specifications.

E. Conduit Sleeves. Conduit sleeve shall be two standard sizes larger than the size of conduit it serves, except where “Link Seal” casing seals are used in sleeves through walls below grade. Sleeves in floor shall extend a minimum of two inches above the finished floor. Conduit passing through concrete masonry walls above grade shall have 18-gauge galvanized steel sleeves. Sleeves set in concrete floor construction shall be at least 16-gauge galvanized steel except at conduit supports. Sleeves set in concrete floor construction supporting conduit risers shall be standard weight galvanized steel. Sleeves supporting conduit risers 3 inches and larger shall have three 6 inch long reinforcing rods welded at 120 degree spacing to the sleeve, and shall be installed embedded in the concrete or grouted to existing concrete. Where the conduit passes through a sleeve, no point of the conduit shall touch the sleeve. Seal around penetrations through sleeving as indicated under firestopping as specified herein, and in compliance with the requirements of Division 7 specifications.

F. Penetrations Below Grade. Sleeves penetrating walls below grade shall be standard weight black steel pipe with 1/4-inch thick steel plate secured to the pipe with continuous fillet weld. The plate shall be located in the middle of the wall and shall be two inches wider in radius than the sleeve it encircles. The entire assembly shall be hot-dipped galvanized after fabrication. Seal off annular opening between conduit and sleeve with “Link Seal” casing seal as manufactured by Thunderline Corporation of Wayne, Michigan. Size conduit sleeve to accommodate the casing seal. Use Series 300 casing seals for pipe 3/4-inch through 4-inch and Series 400 casing seals for pipe sized 5-inch and larger.

G. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and core drills, and at such locations acceptable to the Owner's Representative. Impact type equipment shall not be used except where specifically accepted by the Owner's Representative. Openings in precast concrete slabs for conduits, outlet boxes, etc., shall be core drilled to exact size.

H. Restoration. Restore openings to “as new” condition under the appropriate specification Section for the materials involved, and match remaining surrounding materials and/or finishes.

I. Masonry. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Provide adequate supports during the cutting operation to prevent damage to the masonry caused by the cutting operation. Structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Owner’s Representative.

J. Structure. No cutting, boring, or excavating which will weaken the structure shall be undertaken. Coordinate with structure for placement of conduit, sleeves, and the like through
beams, joists, slabs, mats, and other structural components and systems prior to forming of those structural components and systems.

K. Watertight. Where sleeves pass through roof or floors requiring waterproof membrane, lead flashing with a density of at least three pounds per square foot shall be built into the membrane a minimum of six inches to provide a watertight installation. Provide other watertight installation materials as detailed on the Drawings and as specified under Division 7 – Roofing.

L. Escutcheons. Provide heavy chrome-plated or nickel-plated plates on conduit passing through walls and ceilings in finished areas. Escutcheons shall be B&C No. 10, or accepted substitution, chrome-plated steel plates with concealed hinges.

M. Roof Penetrations and Flashings. Furnish and install pipe, conduit and duct sleeves, and flashing compatible with the roofing installation for roof penetrations. Coordinate with Division 7.

3.10 CLEANING, ADJUSTING AND START-UP

A. Cleaning. Clean electrical equipment, components, and devices prior to installation of final finish or covers, prior to startup and testing, prior to final observation by Architect/Engineer and Owner's Representative, and as required under individual Sections of the Division 26 specifications.

B. Adjusting. Adjust equipment, devices, and systems as specified under individual Sections of these Specifications and in accordance with manufacturer’s instructions for proper functioning during modes of operation, including emergency and shutdown conditions.

C. Factory Authorized Representative. Where specified for an individual item of electrical equipment, provide a factory authorized representative for adjustment, start-up, and testing of equipment, and instruction of Owner’s operating personnel. Certify that these services have been performed by including a properly executed invoice for these services or a letter from the manufacturer.

3.11 TESTING

A. Test Conditions. Use field startup and testing procedures submitted in accordance with paragraph 1.07H of this Section and accepted by the Owner's Representative and the Architect/Engineer. Place circuits and equipment into service under normal conditions, collectively and separately, as necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's Representative. Furnish instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the Drawings and specifications. Special tests on certain items, when required, are specified in the individual specification Sections. Where testing is specified or otherwise required to be performed by an independent testing company, use an Owner-approved NETA-certified testing company.

B. Test Conditions. Use field startup and testing procedures prepared in accordance with paragraph 3.03B of this Section. Place circuits and equipment into service under normal conditions, collectively and separately, as necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's Representative. Furnish instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the Drawings and specifications. Special tests on certain items, when required, are specified in the individual specification
Sections. Where testing is specified or otherwise required to be performed by an independent testing company, use an Owner-approved NETA-certified testing company.

C. Test Dates. Schedule final acceptance tests sufficiently in advance of the contract completion date to permit adjustment and alterations within the number of days allotted for completion of the contract. Inform the Owner’s Representative in advance of test dates in accordance with the applicable requirements of Division One and the General Conditions. Where not specified, required, or directed otherwise, allow a minimum of at least 10 working days advance notice.

D. Retests. Conduct retests as directed by the Owner's Representative of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Delays resulting from retests do not relieve the Contractor of his responsibility under this contract.

E. Commissioning. Coordinate with commissioning agent, as applicable, for field testing and commissioning of electrical components and systems.

F. Test Reports. Submit copies of test reports to the Architect/Engineer in accordance with Division One requirements.

3.12 OPERATING AND MAINTENANCE MANUALS

A. General. The Contractor shall provide, in loose-leaf binders, complete operating and maintenance data of each manufactured item of equipment used in the electrical work at least four weeks before Architect/Engineer’s final review and observation of the project. Descriptive data and printed installation, operating and maintenance instructions for each item of equipment will be included. A complete double index will be provided as follows.

B. Format and content. The Operating and Maintenance Manual will be submitted in quantities and format as specified under Division One for Submittals. Provide quadruplicate where quantity is not specified. Operating and Maintenance Manual shall include:

1. Descriptive data of each system and piece of equipment, including ratings, capacity, performance data, operating curves and characteristics, and wiring diagrams.

2. Full detailed spare parts list, including source of supply for each piece of equipment.

3. Printed instructions describing installation, operation, service, maintenance, and repair of each piece of equipment.

4. Typewritten test reports of tests made of materials, equipment and systems under this Division. Test reports will include the dates of the tests, name of person conducting and witnessing the tests, and record of conditions relative to the tests.

5. Copies of “Reviewed” shop drawings and submittals.

6. Print copies of the record Drawings. Refer to paragraph 1.07I of this Section.

END OF SECTION
SECTION 26 05 19

INSULATED CONDUCTORS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section specifies the furnishing and installation of insulated conductors.

1.2 REFERENCE STANDARDS

A. AEIC No. 6 - Specifications for Ethylene-Propylene-Rubber-Insulated Power Cables 5,000 to 35,000 Volts.


C. ANSI/UL 83 - Thermoplastic-Insulated Wires and Cables.

D. ANSI/UL 1072 - Medium-Voltage Power Cables.

E. IEEE No. 48 - Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations.

F. ICEA S-61-402 (NEMA WC 5) - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

G. ICEA S-68-516 (NEMA WC 8) - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

H. ANSI/UL 2196 “Tests for Fire Resistive Cables”

I. CSA C22.2 #124

J. UL Fire Resistance Directory

1.3 SUBMITTALS

A. Provide product data on the following:

1. 600-volt conductor, splicing and terminating materials.

2. 5 kV insulated conductor, splicing and terminating materials.

B. Provide cable high voltage factory test reports.

PART 2 – PRODUCTS

2.1 IDENTIFICATION

A. Provide new insulated conductors marked according to NEC Article 310.
2.2 600-VOLT INSULATED CONDUCTORS

A. Size. As shown on the drawings.

B. Construction.
   1. Conductor. Soft-drawn, annealed copper. Solid for #12 and #10 and Stranded for all other sizes.
   2. Insulation. Unless otherwise noted on the drawings, use THHN/THWN-2 for general wiring. Use XHHW-XHHW-2 for conductors installed below grade.

C. Use. For general wiring use No. 12 minimum. For field-installed control wiring use No. 14 or larger stranded conductors.

D. Listing. Single Conductor. UL 83.

2.3 5,000-VOLT INSULATED CONDUCTORS (133% INSULATION)

A. Size. As shown on the drawings.

B. Single Conductor Construction.
   1. Single uncoated annealed copper conductor with Class B stranding.
   2. Extruded semi-conducting thermosetting conductor screen firmly bonded to the overlaying insulation.
   3. Ethylene-propylene-rubber (EPR) insulation 115 mils thick.
   4. Extruded semi-conducting thermosetting insulation screen.
   5. Copper shielding tape 5 mils thick helically applied with a minimum 12.5 percent overlap or 6 corrugated drain wires embedded in jacket.
   6. Polyvinyl chloride jacket 80 mils thick.

C. High Voltage Factory Test.
   1. Corona level test with a maximum partial discharge of 5 picocoulombs.
   2. AC test: 13 kV for 5 minutes.
   3. DC test: 35 kV for 15 minutes.
   4. Insulation resistance test: IR constant to be 50,000 megohms per 1000 feet minimum.
   5. Use test procedures given in ICEA S-68-516 and AEIC No. 6.
   6. Certified test reports with test data and corona level plots are to be submitted for review prior to shipment.
   7. Engineer may witness test.

D. Type. Single Conductor. MV-105.

E. Listing. UL 1072.

2.4 HIGH VOLTAGE TERMINATIONS

A. Terminations.
   1. Terminations - Medium voltage terminations shall be equal to 3M 5630K series, Class 1, 5-35 kV, cold-shrink rubber termination kits.

B. Compatibility. Terminating materials must be compatible with the cable supplied. Submit proof of the acceptability by the cable manufacturer of any splicing or terminating materials.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Protection. Unless otherwise indicated, mechanically protect conductors for systems by installing in raceways. Do not install the conductors until raceway system is complete and properly cleaned. Use Polywater J cable lubricant when pulling conductors. Do not bend any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors, or less than twelve times the outer diameter of the completed 15 kV cable. Do not exceed manufacturer's recommended values for maximum pulling tension.

B. Splices and Terminations. Use pressure-type lugs or connectors for terminations or splices of all stranded conductors. Use ring-tongue type terminators on all control wiring. Below grade terminations shall be waterproof.

C. Appearance. Neatly and securely bundle or cable all conductors in an enclosure using nylon straps with a locking hub or head on one end and a taper on the other.

3.2 600-VOLT INSULATED CONDUCTORS

A. Size. Install conductor sizes as indicated.

B. Home Runs. Provide branch circuit homeruns as indicated on plans. Homerun designations are indicated on Sheet E-001. Provide the number of homeruns as indicated on plans. A maximum of 6 phase conductors may be installed in one conduit. Include a separate neutral conductor with each phase conductor for all 120V circuits. Common neutrals are not permitted. For 277V lighting circuits one neutral conductor may be used for three phase conductors. Use home run circuit numbers as indicated for panelboard connections. For isolated ground circuits provide an additional ground conductor as indicated on the panel schedules. Provide No. 10 AWG conductor for the entire circuit length for single-phase, 20 ampere circuits for which the distance from panelboard to the last outlet is more than 100 feet for 120 volt circuits and 200 feet for 277 volt circuits.

C. Color Code. Use factory-colored insulated conductors for No. 10 and smaller conductors and color code larger insulated conductors with an approved field-applied tape. Use different colors for control wiring. Follow the color scheme below.

<table>
<thead>
<tr>
<th>Line</th>
<th>208/120</th>
<th>480/277</th>
</tr>
</thead>
<tbody>
<tr>
<td>A or L1</td>
<td>Black</td>
<td>Brown</td>
</tr>
<tr>
<td>B or L2</td>
<td>Red</td>
<td>Purple</td>
</tr>
<tr>
<td>C or L3</td>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>Gray</td>
</tr>
</tbody>
</table>
Line  | 208/120 | 480/277  
---   | ------- | -------  
A or L1 | Black   | Brown   
Ground  | Green   | Green   
Switch Leg  | Pink    | Pink    

Where more than one conductor of the same phase or more than one neutral conductor occur at the same outlet or junction box, these conductors shall be identifiable from each other by use of stripes or distinguishing markings. All wiring associated with isolated ground receptacles (line, neutral, ground) shall have a yellow tracer on each conductor.

D. Field Testing. Insulation resistance of all conductors shall be tested. Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps and connections are made except connection to or into its source and point (or points) of termination. Insulation resistance of conductors which are to operate at 600 volts or less shall be tested by using a Biddle Megger of not less than 1000 volts d-c. Insulation resistance of conductors rated at 600 volts shall be free of shorts and grounds and have a minimum resistance phase-to-phase and phase-to-ground of at least 10 megohms. Conductors that do not exceed insulation resistance values listed above shall be removed at Contractor's expense and replaced and test repeated. The Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed, and shall forward copies of the test readings to the Owner in accordance with Section 26 05 00. These test reports shall identify each conductor tested, date and time of test and weather conditions. Each test shall be signed by the party making the test.

3.3 5 KV INSULATED CONDUCTORS

A. Bonding. At each termination, bond tape shield to grounding conductor.

B. Terminations. Provide terminations as specifically indicated. Have terminations installed by an experienced cable terminator in strict accordance with the termination manufacturer's instructions and the cable manufacturer's recommendations. Submit cable terminator's qualifications for Owner's approval.

C. Fireproofing. Fireproof each individual high voltage insulated conductor for entire length exposed in existing manhole PMH 22D. Use Scotch 77 tape with Scotch 69 glass cloth overlay wrapped in the opposite direction. Provide a minimum 25 percent overlap of each tape layer.

D. Installation. Wrap cables horizontally around manhole a minimum of one time before exiting. Cable racks for cable support are existing. Use plastic cable ties to secure cables to racks.

E. Identification. Identify each circuit in manhole with a laminated plastic tag securely fastened to the conductors with tie wrap.

F. Field Testing:
   1. High potential proof tests shall be made on all high voltage cables before final inspection and acceptance of work. Thirty days before the installation of cables is complete and ready for testing, the Contractor shall notify the Owner for approval of the testing company. The Contractor shall cooperate with and give all necessary assistance to this agency while the tests are being conducted. In the event of a test failure, Contractor shall repair any defects in installation and re-test at no additional cost to Owner.
2. A non-destructive dc testing service, such as "Kenotron," Westinghouse “High Pot Tester," or approved substitution, capable of generating approximately 100,000 Vdc under normal leakage conditions of acceptable cable shall be used for the tests.

3. All cables shall be tested in place with terminations made up but not connected to switchgear or any other load device or dead-end seal. Cables with dead-end seals shall be temporarily opened and resealed.

4. In case of failure during the test, the Contractor shall locate the faulty component. The Owner shall be notified before repairs are made.

5. Should the test reports indicate that the condition of the cable is unsatisfactory, in the opinion of the Owner, the Contractor shall make all repairs and/or replacements as necessary. Additional tests shall be made at the Contractor's expense, on all repaired sections using the same testing agency. Cable installations will not be accepted until satisfactory certified proof test reports are obtained.

6. Adequate means shall be taken to ensure safety during the tests and all safety instructions of the test operator shall be carried out.

7. Prior to each high potential test, each high voltage cable conductor shall be separately "megged" with a 2,500-volt mega-ohms meter, or equal, from conductor to sheath or ground. Low megger readings of less than 25 mega-ohms shall be cause for rejection of the cables.

G. Each cable shall be tested for a minimum of 10 minutes or until the current reading levels off and remains steady for at least 3 minutes. The potential shall be raised at a slow uniform rate with current readings taken every 15 seconds until full test voltage is reached; thereafter, current readings shall be recorded separately. The removal of the voltage shall be done in a manner to prevent damaging the cable.

H. The test voltage shall be in accordance with ICEA recommended values except where the cable terminates in a switch or switchgear with a lower recommended test value, in which case the lower value shall be used. Cables with one or more switching points in a cable run shall be sectionalized with the switches and tested in sections in order to test the cable at the highest possible voltage which the ICEA recommends.

END OF SECTION
SECTION 26 05 26

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This section specifies the furnishing and installing of grounding and bonding equipment for electrical systems.

1.2 REFERENCE STANDARDS


C. ANSI/TIA/EIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.

D. ANSI/UL 467 - Grounding and Bonding Equipment.


G. NFPA 70 - National Electrical Code (NEC).


I. UL 96A - Master Labeled Lightning Protection System, Installation Requirements.

1.3 SUBMITTALS

A. Product Data. Submit product data sheets, including complete descriptive information on materials and installation methods.

B. Approvals: Secure formal approval of shop drawings and product data prior to ordering material. Secure approvals in sufficient time to allow installation of concealed system components without delaying the project.

C. Testing: Submit documentation for field testing of completed grounding system, as required under paragraph 3.7B of this Section.

D. Note to specifier: edit for Owner preferences on file format and media

E. As-Built Record Drawings. The Contractor shall maintain a master set of As Built record drawings that shows changes and deviations from the Drawings, in accordance with
Division One requirements and Section 26 00 00. Deliver As-Built record drawings to Owner upon Owner acceptance of project. Where not specified otherwise in Division 1 or the General and Supplementary Conditions of the construction contract, deliver one set of As-Built record drawings plotted full-scale on mylar with permanent ink, prepared to 1/8-inch scale with 1/8-inch text. Also deliver one set of As-Built record drawings on CD-Rom or similar electronic media acceptable to the Owner. Drawing files shall be in AutoCAD (.dwg) and Adobe Acrobat (.pdf).

PART 2 - PRODUCTS

2.1 GROUND RODS
   A. None required

2.2 CONNECTIONS
   A. Materials. Unless otherwise noted, provide exothermic welded type grounding connections for bonds and connections made below grade, embedded in structure, or otherwise concealed. For above grade connections not embedded in structure or otherwise concealed, provide mechanical bolted-type connections utilizing high-conductive copper alloy or bronze lugs or clamps. Where required, provide plated connectors which will not cause electrolytic action between the conductor and the connector.
   
   B. Listing. UL 467.

2.3 CONDUCTORS
   A. Materials. Provide grounding conductors fabricated from annealed copper with conductivity ≥ 98 percent IACS conductivity.
      1. Use solid conductor for No. 12 and No. 10 AWG.
      2. Use stranded conductor for No. 8 AWG and larger.
      3. Use stranded conductor for applications subject to continuous vibration, such as engine generators and terminations at motors.
      4. Use stranded, tinned, annealed copper cable for #2 AWG or larger installed inside the building or structure.
   
   B. Insulation. Where insulated grounding conductors are specified or required, provide green-colored 600-volt rated insulation, type XHHW, THWN, or RHW. Insulation type shall be compatible with associated power and lighting system conductors.
   
   C. Location and Application.
      1. Inside building or structure. Provide insulated copper grounding conductors, except where bare copper grounding conductors are indicated on Drawings or specified in this or other Sections.
      2. Outside building or structure. Use bare copper grounding conductors, including below-grade building grounding ring (counterpoise).
   
   D. Listing. UL 83.

2.4 GROUND BUS
A. Where a field-provided ground bus-bar is required or indicated, provide bus-bar drilled and tapped with double-lug terminations for the quantity of ground connections indicated on the Drawings plus 25% spare capacity, wall-mounted on insulated supports. Use round-edge copper bar with > 98 percent International Annealed Copper Standard (IACS) conductivity. Size the bus-bar for not less than 25 percent of the aggregated cross-sectional area of the related feeders. A minimum cross-sectional size of 1/4 inch by 2 inches is required; where ground bus-bar of larger dimensions is indicated on plans or specifications provide the bus-bar with the larger dimensions. See E 2.4B for chemical ground rod measurements in test well.

2.5 MANUFACTURER

A. Copperweld.
B. Cadweld.
C. Burndy.
D. Harger.

PART 3 - EXECUTION

3.1 GENERAL

A. Install grounding system in accordance with the requirements of the National Electrical Code (NEC), Article 250, and other applicable codes and standards. Coordinate installation of grounding and lightning protection system components with structural and civil work and placement of building structural mat.

B. Install grounding conductors continuous, without splice or connection, between equipment and grounding electrodes. Connection to ground busbars is permitted as an exception to the restriction against splices in grounding conductors. Grounding conductors shall be as short and straight as possible, and protected from mechanical damage.

C. Connect grounding electrode conductors to metal water pipe using suitable ground clamp, where metal water pipe is available and accessible and not protected by an insulating anti-corrosion covering. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter. The grounding electrode conductor shall not be spliced

D. Install fusion welded (exothermic) grounding connectors where they are below grade, concealed, or inaccessible. Above grade at accessible locations, use copper or bronze lugs and clamps. Grounding and lightning protection system connections made in conjunction with placement of the building structural mat shall be exothermic ground connectors.

E. Strap grounding clamps shall not be used. Connections requiring bolting shall be made up with Monel metal bolts, washers and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal.

F. Where grounding conductors are installed in metallic raceway, bond to each end of metallic raceway where grounding conductors enter or exit the metallic raceway system. Metallic raceway systems that would form electrically inductive chokes shall not be used.
G. Conductor connections shall be made by means of solderless connectors such as serrated bolted clamps or split bolt and nut type connectors.

3.2 SYSTEM DESCRIPTION

A. Ground the electrical service neutral at service entrance equipment. Provide a main bonding jumper between the neutral and ground bus of the 480-volt main switchgear. Provide a separate grounding electrode conductor in conduit with grounding bushings on both conduit ends from the switchgear to the master ground bus-bar (MGBB) at the main electrical room. Bond MGBB to cold water metallic service pipe in contact with at least 10 feet of earth, and connect to opposite points of the building grounding ring (i.e. counterpoise) system by two main grounding conductors.

B. Provide ground bus-bar, wall-mounted on insulated supports at 8'-0" AFF in electrical rooms, and radially connected to a master ground bus-bar in the main electrical room. See paragraph 3.5A, this Section.

C. Separately Derived Systems: Ground the neutral of each separately derived system in accordance with NEC-250.30 and paragraph 3.3G, this Section.

D. Provide communications system-grounding conductor at point of service entrance and connect to separate grounding electrode. Bond together the communications system grounding electrode and the electrical service-grounding electrode. Separate grounding systems without interconnecting bonds or jumpers are prohibited.

E. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

3.3 SYSTEM GROUND

A. System Neutral. Where a system neutral is used, ground the system neutral as required by NEC Article 250 and as indicated on Drawings. Ground the system neutral only at the point of service and isolate it from ground at all other points in the system.

B. Size. Size the system grounding electrode conductors as indicated on plans.

C. Separately Derived Systems. Ground neutrals of separately derived systems such as generators and transformers in accordance with NEC 250.30 and as indicated on Drawings.
   1. For each separately derived system, ground the neutral to system ground via the nearest ground busbar specifically provided for the purpose of grounding power distribution systems. Use unspliced grounding conductor from the neutral of the separately derived system to the ground busbar.
   2. Grounding conductors shall be as short and straight as possible, protected from mechanical damage, without splice or joint except as permitted by NEC 250.30 and paragraphs 3.1B and 3.3G.1 of this Section, above.
   3. Transformers: Bond the center point (neutral or X0 terminal) of each wye-connected transformer to system ground at one point only. This point shall be ahead of the first overcurrent protective device (OCPD) connected to the secondary winding of the transformer. Refer to the applicable transformer specification for additional requirements.
3.4 EQUIPMENT GROUND

A. Electrical Rooms: Provide a ground bus in electrical rooms, and at other locations indicated on Drawings.
   1. Mount busbar as indicated on plans.
   2. Connect busbar by grounding conductor to the main ground busbar at the main electrical room. Size grounding conductor as shown on Drawings. Where size is not indicated, use grounding conductor with cross-sectional area equivalent to the ground busbar.
   3. Connect to the ground bus noncurrent-carrying metallic parts of electrical equipment and enclosures in the room.
   4. Bond grounding conductors to the bus as further indicated on Drawings.

B. Raceway Systems and Equipment Enclosures.
   1. Bond cabinets, cable trays, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, switchboards, panelboards, transformer enclosures, other electrical equipment and metallic enclosures. Bond equipment and enclosures to the continuous-grounded, metallic raceway system in addition to other specific grounding shown. Ground each outlet by the use of an approved grounding clip attached to the outlet box in such a position to be readily inspected upon removal of the cover plate, or by the use of an approved grounding yoke type receptacle.
   2. Provide bonding jumpers and grounding conductors throughout the raceway system to ensure electrical continuity of the grounding system and the raceway.
   3. Provide grounding-type insulated bushings for metal conduits 1-1/2 inches and larger terminating in equipment enclosures containing a ground bus. Connect the bushing to the ground bus in the equipment enclosure.
   4. Provide a green insulated equipment grounding conductor for each feeder and branch circuit. Terminate each end of grounding conductor on a grounding lug, bus, or bushing.
   5. Provide internal grounding conductor on liquid tight flexible metal conduit (“sealtite”) with ground bushings.
   6. Provide a flexible bonding jumper for isolated metallic piping and ductwork and around expansion fittings and joints.

C. Size. Where grounding and bonding conductors are not sized on Drawings, size the grounding conductors in accordance with NEC Table 250.122. Size bonding jumper so that minimum cross-sectional area is greater than or equal to that of the equivalent grounding conductor as determined from NEC Table 250.122.

D. Taps, Splices and Connections: Make grounding (earth) conductor approximately 2 inches longer than the ungrounded (phase) conductors at both ends.
3.6 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Testing: Test the completed grounding system by fall-of-potential method. Measure ground resistance from system grounding electrode main conductors to convenient ground reference point using suitable ground testing equipment.
   1. Prepare test procedures and test forms to be used for field testing of completed grounding system. Procedures and forms shall include documentation of test equipment proposed for use in field testing of completed grounding system.
   2. Resistance shall not exceed 1 ohm.
   3. Testing points shall include measurement of ground resistance from system neutral at electrical service entrance to convenient ground reference point using suitable ground testing equipment.
   4. Where measured resistance to ground exceeds 1 ohm, add additional ground rods to grounding system to achieve system resistance to ground of 1 ohm or less, and document measured resistance to ground after ground rods are added. Repeat as required to achieve resistance to ground of 1 ohm or less, at no additional cost to Owner.

C. Documentation: Submit report of field testing of completed grounding system to Architect/Engineer and to Owner’s Representative.

END OF SECTION
SECTION 26 05 29
METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the furnishing and installation of metal framing, including channels, fittings, clamps, hardware, electrical accessories and brackets.

1.2 SUBMITTALS

A. None required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Make channels, fittings, clamps, electrical accessories and brackets of sheet steel or of malleable cast iron. Fabricate threaded fasteners of carbon steel.

2.2 COATINGS

A. Hot-dip galvanize all steel components utilized indoors. Provide stainless steel framing for outdoor applications.

2.3 SIZES

A. Provide channels fabricated from not less than 12-gage sheet steel, 1-5/8 inches wide and not less than 1-5/8 inches deep.

PART 3 - EXECUTION

3.1 APPLICATION

A. Hot-dip galvanized steel shall be used in all areas except use stainless steel components when exposed to the weather, in the crawl space and when located in a corrosive atmosphere.

3.2 SUPPORTS

A. Provide metal framing to support large or heavy wall-mounted equipment, wall-mounted raceways and ceiling-hung raceways. Use stainless steel channel to mount the exhaust fan disconnect switches on the roof. Supports shall be mounted independent of the fan enclosure. Secure support to roof.
3.3 ANCHOR BOLTS
   A. Use 1/2 inch diameter by 3 inches long expansion bolts to attach framing to concrete. Space bolts a maximum of 24 inches on center, with not less than two bolts per piece of framing.

3.4 TOUCH-UP
   A. Touch up all scratches or cuts on steel components with an approved zinc chromate or a 90 percent based zinc paint.

END OF SECTION
SECTION 26 05 33

RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the furnishing and installation of electrical raceway systems.

1.2 REFERENCE STANDARDS

A. ANSI/ANSI C80.1 - Rigid Steel Conduit - Zinc-Coated.
B. ANSI/ANSI C80.3 - Electrical Metallic Tubing - Zinc-Coated.
C. ANSI/UL 1 - Flexible Metal Conduit.
D. ANSI/UL 360 - Liquid-tight Flexible Steel Conduit.
E. ANSI/UL 467 - Electrical Grounding and Bonding Equipment.
F. ANSI/UL 797 - Electrical Metallic Tubing.
G. ANSI/UL 870 - Wireways, Auxiliary Gutters and Associated Fittings.
H. NEMA VE 1 - Metallic Cable Tray Systems.
I. UL 6 - Rigid Metal Conduit.

PART 2 - PRODUCTS

2.1 CONDUIT AND FITTINGS

A. Rigid Metal Conduit.
2. Fittings. Threaded steel or malleable iron, either cadmium plated or hot-dipped galvanized.

B. Electrical Metallic Tubing (EMT).
2. Fittings. Steel compression type or steel set screw fittings, either cadmium plated or hot-dipped galvanized. Connectors shall have insulated throat bushings.

C. Rigid Nonmetallic Conduit.
2. Fittings. Solvent weld socket type.

D. Flexible Metal Conduit.
2. Fittings. One-screw and two-screw for 1-1/2 inches and larger, double-clamp steel or malleable iron, either cadmium plated or hot-dipped galvanized.

E. Liquid-tight Flexible Steel Conduit.
1. Conduit. Spiral-wound, square-locked, hot-dipped galvanized steel strip plus a bonded outer jacket of PVC.
2. Fittings. Compression type, malleable iron, with insulated throat, either cadmium plated or hot-dipped galvanized.

F. Elbows.
1. Provide large radius elbows.

2.2 WIREWAYS

A. Material. Not less than 16-gage sheet steel.

B. Dimensions. Cross section dimensions not less than 4 inches by 4 inches.

C. Finish. Not less than two coats of enamel over a rust-inhibiting prime coat.

D. Type.
1. Indoors. NEMA 1.
2. Outdoors. NEMA 4X.

PART 3 - EXECUTION

3.1 CONDUIT AND FITTINGS

A. Minimum Trade Size. 3/4 inch, except that 1/2-inch flexible metal conduit may be used in lengths not exceeding 72 inches for tap conductors supplying lighting fixtures.

B. Types According to Use.
1. Use hot dipped galvanized rigid steel conduit (RGS) outside above ground where exposed to weather. Use RGS for 5Kv feeders. Rigid aluminum may also be used in lieu of rigid steel.
2. Use EMT in interior walls or ceiling spaces and where exposed in open work areas, mechanical rooms or electrical rooms. Conduit that enters or leaves the top of panelboards or enclosures may be EMT, provided such panelboards and enclosures are located in mechanical or electrical rooms. EMT shall not be used for 5Kv feeders.
3. Conduits may not be embedded in slabs without approval of the owner and the structural engineer.
5. Connect all indoor electrical equipment subject to vibration or movement with flexible metal conduit 24 inches minimum length. Where the equipment is located in a duct or plenum used for environmental air, the length of conduit shall not exceed 4 feet and the conduit shall be flexible metal conduit. Where the equipment is located outdoors or exposed to water, liquid-tight flexible metal conduit shall be used.
6. Transitions.
a. Continue the heavier, more protective type conduit application not less than 4 inches into the area where lighter, less protective type conduit is permitted.

b. For below-grade to above-grade outdoor locations, extend concrete encasement around conduit 4 inches above finished grade and slope top away from conduit with a 6-inch-per-foot slope.

c. For below-grade to above-grade locations using PVC to metal conduit, make the transition from PVC to metal conduit before turning up with RGS elbow.

C. Preparation. Place sleeves in walls and floor slabs for the free passage of cables or conduits. Set sleeves in place a sufficient time ahead of concrete placement so as not to delay the work. Seal all openings and voids around sleeves through floors and walls. Be sure that plugs or caps are installed before concrete placement begins.

D. Installation Requirements.

1. Metallic conduits must be continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, motor control centers, etc. The conduit must enter and be secured to enclosures so that each system is electrically continuous throughout. Where knockouts are used, provide double locknuts, one on each side. For EMT terminations, provide insulated throat bushings and on rigid metallic conduits, provide nonmetallic insulating bushings for conductor protection. Where feeder conduits, 1-1/2 inches and larger, terminate in equipment having a ground bus, such as in switchgear, motor control centers and panelboards, provide conduit with an insulated grounding bushing and extend a suitable grounding wire to the ground bus.

2. Have rigid nonmetallic conduit adequately solvent welded at joints to form a tight, waterproof connection.

3. Run concealed conduit as directly and with the largest radius bends as possible. Run exposed conduit parallel or at right angles to building or other construction lines in a neat and orderly manner. Conceal conduit in finished areas. Unless otherwise shown, remaining conduit may be exposed. Provide chrome-plated floor and ceiling plates around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Select properly sized plates to fit the conduit when securely locked in place.

E. Installation Methods.

1. Install each entire conduit system complete before pulling in any conductors. Clean the interior of every run of conduit before pulling in conductors to guard against obstructions and conduit omissions.

2. Cut all joints square, then thread and ream smooth. Coat cuts, threads or scratches on steel conduit with an approved zinc chromate or with a 90 percent based zinc paint. When dry, draw up tight.

3. Make bends with minimum 24" radius. Make field bends using equipment designed for the particular conduit material and size involved. Bends must be free from dents or flattening. Use no more than the equivalent of four 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.

4. Conduit bodies may be used in lieu of conduit ells where ease of installation and appearance warrants their use. Conduit bodies larger than 1 inch may be used only where approved.

5. Securely fasten and support conduit to structure or metal framing using hot-dipped galvanized, malleable iron pipe straps or other approved means. Wires of any type may not be used for securing conduits. Branch circuit raceways which are 1 inch or smaller may be attached to wall studs by use of manufactured clips.

6. Provide a No. 30 nylon pulling line in conduits in which wiring is not installed under this work. Identify both ends of the line by means of labels or tags reading “Pulling Line - Telephone,” etc.

7. Suitably cap conduit during construction to avoid water, dirt and trash entrance.
8. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceway systems.

9. Use expansion fittings in conduit that terminates at sensitive equipment.

10. With a coupling, terminate concealed conduit for future use at structural surfaces. Install a pipe plug flush with the surface.

11. Openings around electrical penetrations of fire-resistance rated walls, partitions, floors or ceilings shall be firestopped to maintain the fire resistance rating using approved methods.

3.2 WIREWAYS

A. Install wireways, where shown, according to NEC Article 376. Field apply a 90 percent zinc paint coating over cuts or scratches before any other finish is applied.

B. Maintain electrical continuity between sections of cable tray using manufacturer provided splice plates and bond cable trays at the both ends to building ground plates to provide a continuous grounding path. Install copper braided bonding jumpers around expansion joints and hinged adjustable splice plates where electrical discontinuity occurs. Install cable trays, where shown, according to NEC Article 392. Install cable trays in accordance with manufacturer's recommendations.

END OF SECTION
SECTION 26 05 37

BOXES

PART 1 – GENERAL

1.1 SUMMARY

A. This Section specifies the furnishing and installation of outlet boxes, junction boxes and pull boxes.

1.2 REFERENCE STANDARDS

A. ANSI/NEMA Publication No. OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers and Box Supports.
B. ANSI/UL 514A - Metallic Outlet Boxes.
C. ANSI/UL 514B - Fittings for Conduit and Outlet Boxes.

1.3 SUBMITTALS

A. Provide product data.

PART 2 – PRODUCTS

2.1 OUTLET BOXES

A. Flush Device Boxes. Provide galvanized steel boxes of sufficient size to accommodate wiring devices to be installed at outlet. Provide an extension ring for the device(s) to be installed. Square or rectangular boxes may be used. Unless otherwise noted, provide minimum 2-1/8-inch deep by 4-inch square minimum size box. For data outlets provide minimum 2-1/8-inch deep by 4-11/16 inch square minimum size box.

B. Exposed or flush Device Boxes. Provide FS or FD cast boxes for surface mounting in areas having exposed rigid metal conduit systems.

C. Boxes for Lighting Fixtures. Provide galvanized steel octagonal boxes with fixture stud supports and attachments as required to properly support ceiling and bracket-type lighting fixtures. Unless otherwise noted, provide 2-1/8-inch deep by 4-inch box.

D. Masonry Boxes. Provide galvanized steel, 3-1/2-inch deep, masonry boxes for all devices installed in masonry walls.

E. Switch Boxes. Not permitted.

F. Listing. UL 514.

2.2 JUNCTION, PULL AND SPLICE BOXES

A. Construction. Provide galvanized steel boxes conforming to NEC Article 314.
B. Interior Spaces. Provide NEMA 1 type boxes at least 4 inches deep
C. Exterior Spaces. Provide NEMA 4X type boxes at least 4 inches deep.
D. Embedded. Provide NEMA 4 cast iron type with flush flanged cover when cast in concrete.
E. Listing. UL 514.

PART 3 – EXECUTION

3.1 OUTLET BOXES

A. Flush Boxes. Unless otherwise indicated, mount all outlet boxes flush within 1/4 inch of the finished wall or ceiling line. Provide galvanized steel extension rings where required to extend the box forward in conformance to NEC requirements. Attach ring with at least two machine screws. Securely fasten outlet boxes. Provide plaster covers for all boxes in plastered walls and ceilings.

B. Fixture Boxes. Where boxes for suspended lighting fixtures are attached to and supported from suspended ceilings, adequately distribute the load over the ceiling support members.

C. Mounting Height. Mounting height of a wall-mounted outlet box means the height from finished floor to horizontal center line of the cover plate. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation. Where outlets are indicated adjacent, but with different mounting heights, line up outlets to form a symmetrical vertical pattern on the wall. Verify the final location of each outlet with Owner's representative before rough-in. Remove and relocate any outlet box placed in an unsuitable location.

D. Back-to-Back Boxes. Do not connect outlet boxes back to back unless approval is obtained from the Owner's representative. Where such a connection is necessary to complete a particular installation, fill the voids around the wire between the boxes with sound insulating material.

E. Box Openings. Provide only the conduit openings necessary to accommodate the conduits at the individual location.

3.2 JUNCTION AND PULL BOXES

A. Installation. Install boxes as required to facilitate cable installation in raceway systems. Provide a junction box for terminating of flexible metal conduit to light fixtures. In general provide boxes in conduit runs of more than 100 feet.

B. Covers. Provide boxes so that covers are readily accessible and easily removable after completion of the installation. Include suitable access doors for boxes above inaccessible ceilings. Select a practical size for each box and cover.


END OF SECTION
SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Nameplates and tape labels.
B. Wire and cable markers.
C. Conduit color coding and labeling.

1.2 REFERENCES

A. NFPA 70 – National Electrical Code (NEC).

1.3 SUBMITTALS

A. Provide submittals in accordance with and in addition to Section 26 00 00, Electrical General Provisions, and Division 01, for submittal requirements.
   1. Furnish nameplate identification schedules to Owner’s Representative for review and acceptance, listing equipment type and nameplate data with letter sizes and nameplate material.
   2. Nameplate Schedules. Prior to fabrication of nameplates, furnish to Owner for review and acceptance a schedule of nameplates for electrical equipment. For each equipment and circuit identified, provide 4-line nameplate as follows:
      a. Line 1: Device designation, switchgear or MCC cubicle, switchboard circuit, etc. as indicated on plans, schematics, or schedule Drawings.
      b. Line 2: Leave blank for Owner’s use.
      c. Line 3: Source or voltage characteristics, as applicable.
      d. Line 4: Load served.
   3. Refer to Parts 2 and 3 of this Section for nameplate requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Equipment Nameplates:
   1. For normal power electrical equipment, provide engraved three-layer laminated plastic nameplates, engraved white letters on a black background.
   2. For emergency equipment, provide engraved three-layer laminated plastic nameplates with engraved white letters on a red background.
   3. For UPS powered equipment, provide engraved three-layer laminated plastic nameplates with engraved white letters on an orange background.
   4. For fire alarm system, provide engraved three-layer laminated plastic nameplates with white letters on a yellow background.
   5. For security and CCTV system panels, provide engraved three-layer laminated plastic nameplates with white letters on a blue background.
6. Nameplate minimum size shall be 1 inch high by 3 inches long with engraved white letters. Generally, the number and name shall be at least 1/4 inch high and other data at least 1/8 inch high.

B. Underground Warning Tape:
1. Manufactured polyethylene material and unaffected by acids and alkalines.
2. 3.5 mils thick and 6 inches wide.
3. Tensile strength of 1,750 psi lengthwise.
4. Printing on tape shall include an identification note “BURIED ELECTRIC LINE”, and a caution note “CAUTION”. Repeat identification and caution notes over full length of tape. Provide with black letters on a red background.
5. Detector Strip. Metallic tape or similar detector strip, integral to warning tape.

C. Conductor Color Tape and Heat Shrink:
1. Colored vinyl electrical tape shall be applied perpendicular to the long dimension of the cable or conductor.
2. In applications utilizing tray cable, heat shrinkable tubing shall be used to obtain the proper color coding for the length of the conductor in the cabinet or enclosure. Variations to the cable color coding due to standard types of conductor or cables are not acceptable.

D. Conduit Labels (15 kV Conduits Only): 2-inch black letters on yellow background reading “DANGER - 4160 VOLTS”, for example. Labels shall have adhesive backing, and shall be installed at intervals not exceeding 50 feet and on pull boxes located to be visible from floor.

E. Warning labels: Provide warning labels with black lettering on red background with a minimum of 1/2 inch lettering.

F. Tape Labels: Provide device labels of plastic adhesive tape, with minimum 1/4-inch letters for labeling receptacles, switches, control device stations, junction and pull boxes and manual motor starter units, etc.
1. Normal power. Black letters on clear background. Provide white letters on black background where specifically indicated on Drawings or specified in other Sections.
2. Emergency/standby power. Red letters on clear background. Provide white letters on red background where specifically indicated on Drawings or specified in other Sections.
3. UPS power. Orange letters on clear background. Provide white letters on orange background where specifically indicated on Drawings or specified in other Sections.
4. Provide device label with black letters, one half inch wide tape with one quarter inch high letters, minimum.
5. Manufacturer. Brother type “P-Touch”, or accepted substitution.

G. J-Box and Cover plate Voltage Labels: Black stenciled letters 1/4 inch high. Adhesive back tapes may be used if a clear tape is applied over the label for protection.

PART 3 - EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in individually wrapped factory-fabricated fiberboard-type containers.
B. Store materials in a clean and dry space, elevated above grade, and protected from weather and sunlight.

C. Handle materials carefully to avoid damage, breaking, denting and storing. Damaged materials shall be rejected and shall not be installed.

3.2 INSTALLATION

A. Degrease and clean surfaces to receive nameplates or tape labels.

B. Install nameplates parallel to equipment lines.

C. Secure plastic nameplates to equipment fronts using stainless steel self-tapping screws or rivets. Use of adhesives shall be per Owner’s approval. Stick-on or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates. Secure nameplate to outside face of flush mounted panelboard doors in finished locations.

D. Designations: Externally mark equipment, feeders, branch circuits and similar items with nameplates with the same designations as indicated on the Drawings.

3.3 WIRE AND CONDUCTOR IDENTIFICATION

A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, ground busbars and at load connection.
   1. Identify with branch circuit or feeder number for power and lighting circuits.
   2. Label control conductor with number as indicated on schematic and interconnection diagrams or equipment manufacturer’s shop drawings for control wiring.
   3. Label grounding conductors at ground busbars, electrical equipment, and test wells with metal tags indicating the cable purpose and point of termination at opposite end of cable. Securely fasten metal tags along the length of the grounding cable or conductor. Place metal tags to avoid creating short circuits, inadvertent grounding paths, or other contact with grounded or energized terminals, conductors, or components.

B. Existing Facilities. Where the Contractor encounters conductor identification in existing electrical distribution systems different from the colors scheduled in this Section, notify the Owner’s Representative in writing and propose a resolution, in accordance with the requirements of Part 1 of Section 26 00 00, Electrical General Provisions.

C. Conductors for power and lighting circuits shall be identified per the following schedule.

<table>
<thead>
<tr>
<th>Conductor</th>
<th>480/277V</th>
<th>208/120V</th>
<th>Medium Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A</td>
<td>Brown</td>
<td>Black</td>
<td>One White Band</td>
</tr>
<tr>
<td>Phase B</td>
<td>Purple</td>
<td>Red</td>
<td>Two White Bands</td>
</tr>
<tr>
<td>Phase C</td>
<td>Yellow</td>
<td>Blue</td>
<td>Three White Bands</td>
</tr>
<tr>
<td>Neutral</td>
<td>Gray</td>
<td>White</td>
<td>N/A</td>
</tr>
<tr>
<td>Grounding</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
</tbody>
</table>
D. Where more than one conductor of the same phase or more than one neutral or ground conductor occurs at the same outlet or junction box, these conductors shall be identifiable from each other by use of stripes or distinguishing markings. The neutral tracer color shall match the phase conductor color with which it is associated.

E. Switch leg conductors. Pink.
   1. The color of switch leg conductors shall be pink, marked with tape matching the color of the associated branch circuit phase conductors.

F. Low voltage wiring systems. Conduits for low voltage circuits shall be identified as follows.
   1. Fire Alarm. Red
   2. Security. Blue and Yellow. Coordinate wiring color with Division 27 and telecommunications supplier
   3. Clock. Green and White
   4. Telephone. White. Coordinate wiring color with Division 27 and telecommunications supplier
   5. Data. Bright Blue. Coordinate wiring color with Division 27 and telecommunications supplier.
   6. HVAC Controls. Dark Blue. Coordinate wiring color with Division 23 and controls supplier.

3.4 NAMEPLATES

A. Provide nameplates of minimum letter height as scheduled below. Nameplates shall be same as equipment names indicated on the Drawings.
   1. Externally mark electrical equipment with nameplates identifying each and the equipment served.
   2. Supply blank nameplates for spare units and spaces.

B. Nameplate Fasteners. Fasten nameplates to the front of equipment by means of stainless steel self-taping screws. Stick-on or adhesives are not allowed unless the NEMA enclosure rating is compromised, then use only epoxy adhesive to attach nameplates.

C. 5 KV-Class Switchgear.
   1. On main switches or circuit breakers: 3/8 inch: identify the equipment designation. 1/4 inch: identify system voltage and characteristics (i.e., 4.16 KV, 3PH, 3W).
   2. For each switch or circuit: 3/8 inch: identify the circuit or cubicle. 1/4 inch: identify the load served.

D. 480-volt/208-volt Switchboard/switchgear:
   1. On the main switches or circuit breakers: 3/8 inch: identify the equipment designation. 1/4 inch: identify the source and voltage characteristics (i.e., 480/277V, 3PH, 4W).
   2. For each branch circuit protective device: 3/8 inch: identify the circuit or cubicle. 1/4 inch: identify the load served.

E. Individual Circuit Breakers in Distribution Panelboards, Disconnect Switches, Motor Starters, and Contactors: 1/4 inch: identify source to device and the load it serves, including location.
F. Dry Type Transformers Not in Substations: 3/8 inch: identify equipment designation. 1/4 inch: identify primary and secondary voltages, primary source, and secondary load and location.


H. Provide complete circuit directory for each new panel board. Provide complete circuit directory for each existing panelboard with circuits added, removed, demolished, moved, renovated, or otherwise altered as part of this project or as work required by or incidental to this project. Refer to Section 26 24 16 for directory requirements.

I. Identification tags on items in finished areas, such as special switches, etc., shall be securely attached on, or in the immediate vicinity, of the item. Supply blank nameplates for spare units and spaces.

3.5 ENCLOSURE COLOR CODING

A. The following systems shall have each enclosure and cover completely painted as follows:
   1. Fire Alarm. Red, with black “FA” text.

B. The following systems shall have each junction and pull box cover completely painted per the following:

<table>
<thead>
<tr>
<th>System</th>
<th>Color of Box Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telecommunications</td>
<td>Brown</td>
</tr>
<tr>
<td>DDC</td>
<td>Green</td>
</tr>
<tr>
<td>Emergency Power</td>
<td>Red, with black “E” text</td>
</tr>
<tr>
<td>Security**</td>
<td>White</td>
</tr>
<tr>
<td>Fire Alarm</td>
<td>Red, with black “FA” text</td>
</tr>
</tbody>
</table>

**Security shall include, but not be limited to, the following systems:
- Card Access
- Duress Alarms
- Perimeter Door Alarms

C. CCTV

3.6 EQUIPMENT AND DEVICE MARKING

A. Pull, Junction and Outlet Boxes.
   1. With 1/2-inch high permanent lettering, identify conduits connected to pull, junction and outlet boxes with the complete circuit number of the conductors contained therein. Identify complete circuit numbers on box cover and on the conduit.
2. Where multiple circuits are contained in a box, identify the circuit conductors with permanent tags which indicate circuit designation. Identify both phase and associated neutral conductors.

3. Boxes and covers containing emergency power or emergency lighting circuits shall be painted red. Factory finish is acceptable in lieu of painting in the field. No other raceway, conduit, boxes, or enclosures shall be painted red.

4. Fire alarm boxes and covers shall be painted red. Using permanent lettering, identify box cover as “F/A” or “FAS”, with fire alarm zone served. Factory finish is acceptable in lieu of painting in the field. No other raceway, conduit, boxes, or enclosures shall be painted red.

B. Equipment and Raceways Over 600 Volts: Provide “WARNING - HIGH VOLTAGE - KEEP OUT” signs on equipment. With 2-inch-high lettering, mark exposed raceways containing conductors operating in excess of 600 volts every 50 feet, or in each room or space or compartment of penetration, and at each wall or floor penetration, with the words “WARNING - HIGH VOLTAGE –13,200 VOLTS”.

C. Power Receptacles: Use a clear plastic tape label, nameplate or engraved device plate to identify power receptacles where the nominal voltage between a pair of contacts is greater than 150 volts with circuit number, voltage and phases. If nameplates are used, attach to wall directly above device plate. Nominal 120 volt power receptacles shall be labeled with the complete circuit number.

D. Snap Switches:
   1. Where the equipment served is not in sight of the snap switch, or where snap switch controls dedicated outlets or special equipment, provide a clear plastic tape label or an engraved switch plate to identify equipment served.
   2. Where snap switches are grouped together, provide clear plastic tape labels or engraved switch plates to identify non-lighting equipment served.

E. Dedicated Outlets: For dedicated outlets, provide a clear plastic tape label or an engraved cover plate indicating the equipment served. Dedicated is understood to be specific equipment listed by equipment number in the panel schedules or identified on the plans. Dedicated also includes computer outlets.

F. Remote Ballasts: For remote ballasts not within five feet of their luminaire, provide appropriate permanent lettering on both the ballasts and the luminaire to identify which units are mated to the other.

END OF SECTION
SECTION 26 05 73

SHORT-CIRCUIT/COORDINATION STUDY

PART 1 GENERAL

1.1 SUMMARY

A. Provide a complete short-circuit and protective device coordination study for the emergency/standby power electrical distribution systems. The extent of the study shall be from the existing Centerpoint Energy (CNP) main service on the normal side and the new generator for the standby/emergency portion. The study shall include all new equipment. An arc flash study is not required. The arc flash study will be completed by the project engineer.

1.2 SUBMITTALS

A. A preliminary short-circuit study shall be submitted to the design engineer either before or at the same time as the equipment submittals. If equipment submittals such as switchgear, switchboards, panelboards etc. are submitted without a preliminary study, they will be returned Rejected.

B. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. The report shall include the following sections:
   1. Executive Summary.
   2. Descriptions, purpose, basis and scope of the study.
   3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
   4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
   5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
   6. Recommendations for system improvements, where needed.
   7. One-line diagram.

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

B. American National Standards Institute (ANSI):
   1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

Short Circuit and Protective Device Coordination Study
26 05 73 - 1

C. The National Fire Protection Association (NFPA)

1.4 QUALIFICATIONS
A. The short-circuit and protective device coordination studies shall be conducted under the supervision and approval of a Licensed Professional Electrical Engineer licensed in the state of Texas and skilled in performing and interpreting the power system studies.

B. The Licensed Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm and have a minimum of five (5) years of experience in performing power system studies. In addition, the licensed engineer shall be based and work in the Houston, Tx area.

1.5 COMPUTER ANALYSIS SOFTWARE
A. The studies shall be performed using the latest revision SKM Systems Analysis Power Tools.

PART 2 PRODUCTS

2.1 DATA COLLECTION
A. The Contractor shall be responsible for collecting all data for the studies except as follows. CNP fault current information has been provided at the end of this specification. Existing relay settings have been provided on the one line diagrams. The contractor is responsible for all other data collection.

2.2 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY
A. Provide a short circuit study for all new equipment.

B. Provide the following:
   1. Calculation methods and assumptions.
   2. Selected base per unit quantities.
   3. One-line diagram of the system being evaluated.
   4. Source impedance data, including electric utility system and motor fault contribution characteristics.
   5. Tabulations of calculated quantities.
   6. Results, conclusions, and recommendations.
   7. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a line to ground fault at each piece of equipment/bus as described in 1.01.

C. Protective Device Evaluation:
1. Evaluate equipment and protective devices and compare to short circuit ratings.
2. Adequacy of all equipment to withstand short-circuit stresses.


E. Transformer design impedances shall be used only when test impedances are not available.

2.3 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs. The phase curves shall be plotted on separate sheets from the ground fault curves. For the normal power side, the PDC study shall begin at existing switchgear PSWGRA and extend downstream to all new devices. For the standby/emergency system, the study shall begin at the new generator and extend downstream to all new devices. A new breaker will be installed in PSWGRA and connected to an existing Cutler Hammer Digitrip 3000 relay. The CH 3000 relay values shall be set per the study. The existing CH 3000 relay values for the main breakers in PSWGRA/B are noted at the end of this specification for reference. In addition, all relays in new paralleling switchgear PSE and all new 480V/208V circuit breakers shall be set per the study. Any existing relays in switchgear PSWGRA/B that are being reused shall also be set for the new load.

B. Plot the following characteristics on the TCC graphs where applicable:
   1. Equipment name based on Bid documents.
   2. Electric utility’s overcurrent protective device.
   3. Medium voltage (4.16kV) equipment overcurrent relay settings.
   4. Medium and low voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands.
   5. Low voltage (480V/208V and below) equipment circuit breaker trip device settings, including manufacturer’s tolerance bands.
   6. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
   7. Ground fault protective devices, as applicable.
   8. Pertinent motor starting characteristics and motor damage points, where applicable.
   9. Pertinent generator short-circuit decrement curve and generator damage point.

C. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.4 ARC FLASH HAZARD ANALYSIS-NOT REQUIRED

2.5 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:
   1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
   2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
   3. Reactor data, including voltage rating, and impedance.
4. Generation contribution data, (synchronous generators and Utility), including short-circuit sub-transient reactance (X''d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.

5. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage.
   b. Calculated fault current magnitude and angle.
   c. Fault point X/R ratio.
   d. Equivalent impedance.

2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage.
   b. Calculated symmetrical fault current magnitude and angle.
   c. Fault point X/R ratio.
   d. Calculated asymmetrical fault currents:
      1) Based on fault point X/R ratio.
      2) Based on calculated symmetrical value multiplied by 1.6.
      3) Based on calculated symmetrical value multiplied by 2.7.
   e. Equivalent impedance.

3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
   a. Voltage.
   b. Calculated symmetrical fault current magnitude and angle.
   c. Fault point X/R ratio.
   d. No AC Decrement (NACD) Ratio.
   e. Equivalent impedance.
   f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis.
   g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis.

C. Recommended Protective Device Settings:

   1. Phase and Ground Relays:
      b. Current setting.
      c. Time setting.
      d. Instantaneous setting.
      e. Recommendations on improved relaying systems, if applicable.

   2. Circuit Breakers:
      a. Adjustable pickups and time delays (long time, short time, ground).
      b. Adjustable time-current characteristic.
      c. Adjustable instantaneous pickup.
      d. Recommendations on improved trip systems, if applicable.

PART 3 EXECUTION

3.1 FIELD ADJUSTMENT
A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

CNP DATA

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**MAJOR UNDERGROUND FAULT DUTY & PROTECTION DATA FORM**

**BASE VALUES**

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<thead>
<tr>
<th>BASE VALUES</th>
<th>THEV IMPEDANCE</th>
<th>LLL FAULT</th>
<th>LG FAULT</th>
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**SERVICE TRANSFORMER DATA**

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**FUSE DATA**

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**PHASE RELAY (511,510N50L) per transformer**

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**GROUND RELAY (510) per transformer**

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**NEAREST UPSTREAM PROTECTION DATA**

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<tbody>
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<td>RELAY 1</td>
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<td>4190V</td>
</tr>
</tbody>
</table>

**NOTES**

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**GENERAL DISCLAIMER**

The fault data provided is based on the existing configuration of the electrical distribution system at the time the data was generated and is subject to change as modifications are made to the utility system. CenterPoint Energy does not warrant the accuracy of the furnished data beyond the time at which it was calculated, and disclaims all liability or damages of any kind that may result from the use of this information for any purpose.
EXISTING PSWGRA/B MAIN BREAKER RELAY DATA

PSWGR-A AND B MAIN BREAKERS

**PHASE SETTINGS**
- PHASE CT RATIO: 1200:5
- TAP PICKUP 51P1P: 0.8
- CURVE SHAPE: I2T
- TIME MULT: 10
- INST (xCT)50P1P: N/A
- SHORT TIME PICKUP: 1.75
- SHORT TIME DELAY: 1

**GROUND SETTINGS**
- GROUND CT RATIO: 200:5
- TAP PICKUP 51N1P: 1
- CURVE SHAPE: G-FLAT
- TIME MULT: 0.7
- INST (xCT)50P1P: N/A
- SHORT TIME PICKUP: 9
- SHORT TIME DELAY: 1

END OF SECTION