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SECTION 26 00 00 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. General Requirements specifically applicable to Division 26.

B. The Contractor shall be responsible for:

1. The work included consists of furnishing all materials, supplies, equipment and tools, and performing all labor and services necessary for installation of a completely functional power, lighting, fire alarm and signaling systems. Complete systems in accordance with the intent of Contract Documents.

2. Coordinating the details of facility equipment and construction for all Specification Divisions, which affect the work covered under this Division.

3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.

4. Temporary power service and lighting for construction. Coordinating all shutdown dates and schedules with Owner's Representative and obtain all work-permits required by Owner.

C. Intent of Drawings:

1. The Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every device or raceway in its exact location, unless specifically dimensioned. 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 raceway, subject to prior review by the Owner and Engineer. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

2. The intent of the Drawings is to establish the type of systems and functions, but not to set forth each item essential to the functioning of the system. The drawings and specifications are cooperative, and work or materials called for in one and not mentioned in the other shall be provided. Review pertinent drawings and adjust the work to conditions shown. In case of doubt as to work intended, or where discrepancies occur between drawings, specifications, and actual conditions, immediately notify the Architect/Engineer and the Owner's representative, and propose a resolution.

3. 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.

4. 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.

5. 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.
1.2 RELATED WORK
   A. This Section shall be used in conjunction with all other specifications and related Contract Documents to establish the total general requirements for the project electrical systems and equipment.

1.3 DESIGN CRITERIA
   A. Equipment and devices to be installed outdoors or in enclosures where the temperatures are not controlled shall be capable of continuous operation under such conditions per manufacturer’s requirements.
   B. Compliance by the Contractor with the provisions of this Specification does not relieve him of the responsibilities of furnishing equipment and materials of proper design, mechanically and electrically suited to meet operating guarantees at the specified service conditions.
   C. Electrical components shall be UL listed and labeled, or Owner approved Nationally Recognized Testing Laboratories.

1.4 REFERENCE CODES AND STANDARDS, REGULATORY REQUIREMENTS
   A. Standards of the following organizations as well as those listed in Division 01, may be referenced in the specification. Unless noted otherwise, references are to standards or codes current or currently adopted at the time of bidding.
      1. Association of Edison Illuminating Companies (AEIC)
      2. American National Standards Institute (ANSI)
      3. Institute of Electrical and Electronics Engineers (IEEE)
      4. Insulated Cable Engineers Association (ICEA)
      5. National Electrical Code (NEC, NFPA 70)
      6. National Electrical Manufacturers Association (NEMA)
      7. National Fire Protection Association (NFPA)
      8. Underwriter’s Laboratories (UL)
      10. International Energy Conservation Code (IECC)
   B. Work, materials and equipment must comply with the latest rules and regulations of the following.
      1. National Electrical Code (NEC)
      2. Occupational Safety and Health Act (OSHA)
      3. American with Disability Act (ADA)
      5. University of Texas (UT) System
      6. Applicable state and federal codes, ordinances and regulations
   C. 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 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 shown.
D. Contractor shall obtain permits and arrange inspections required by codes applicable to this Section and shall submit written evidence to the Owner and Engineer that the required permits, inspections and code requirements have been secured.

1.5 SUBMITTALS
A. Submit the following in addition to and in accordance with the requirements of Division 01 for submittal requirement.
   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 of it are clearly indicated and non-applicable portions clearly deleted or crossed out.
   3. All schematic, connection and/or interconnection diagrams in accordance with the latest edition of NEMA.
   4. Provide submittals as required by individual specification Section.
B. Provide the following with each submittal:
   1. Catalog cuts with manufacturer’s name clearly indicated. Applicable portions shall be circled or otherwise highlighted and non-applicable portions shall be crossed out.
   2. Line-by-line specification review by equipment manufacturer and contractor with any exceptions explicitly defined.
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 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.
D. 
E. 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 may notify contractor as to equipment manufacturer or type and make or material to be furnished. Provide designated items at no additional cost to owner.
   4. At the discretion of the Owner’s representative, continued, uncorrected submittals may result in paying for the additional engineering review time.
F. 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.

G. 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.

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

I. 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.

1.6 SAFETY

A. The Contractor shall follow the safety procedures in addition to, and in accordance with, the requirements of Project Safety Manual (PSM).

1. The Contractors shall be responsible for training all 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 all electrical rooms, to limit access, prior to energizing any switchgear and shall control access during the project after energization.

3. The Contractor shall post and maintain warning and caution signage in areas where work is going near energized equipment. The Contractor shall appropriately cover and protect all energized live parts when work is not being done in the equipment. This includes lunch and breaks.

4. The Contractor shall ensure that all conductors are properly capped off during installation, before and after being energized.

5. The Contractor shall strictly enforce OSHA lock out/tag out 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.
1.7 SHORING AND EQUIPMENT SUPPORTS

A. The Contractor shall provide all permanent and temporary shoring, anchoring, and bracing required to make all parts absolutely stable and rigid; even when such shoring, anchoring, and bracing are not explicitly called for.

B. The Contractor shall adequately support all freestanding panels, motor control centers, enclosures, and other equipment. This shall include bolting to the floor or solid structural steel to prevent tipping. Install free-standing electrical equipment on 4" thick concrete housekeeping pads that are provided by others. Under no condition shall equipment be fastened to non-rigid building steel (i.e., removable platform steel gratings, handrails, etc.).

C. The Contractor shall provide racks and supports, independently mounted at structure, to support electrical equipment and systems supplied and installed under this contract. At no time shall the Contractor mount or suspend equipment from other disciplines’ supports.

1.8 TEMPORARY POWER REQUIREMENTS

A. Provide a power distribution system, in accordance with the NEC requirements, sufficient to accommodate construction operations requiring power, including power tools, electrical heating, lighting, and start-up/testing of permanent electric-powered equipment prior to its permanent connection to electrical system. Provide proper overload protection. Ground fault circuit interrupters (GFCI) are to be used on all 120-volt, single-phase, 15 and 20 amp receptacle outlets where portable tools and equipment are used. Ground fault circuit interrupters shall be tested weekly by the Contractor.

B. Temporary power feeders shall originate from a distribution panel. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord.

C. Branch circuits shall originate in an approved receptacle or panelboard. The conductors shall be multi-conductor cord or cable per NEC for hard and extra-hard service multi-conductor cord. Each branch circuit shall have a separate equipment grounding conductor.

D. All receptacles shall be of the grounding type and electrically connected to the grounding conductor.

E. Provide NEC compliant temporary lighting by factory-assembled lighting strings or by manually-assembled units. All lamps for general lighting shall be protected from accidental contact or breakage. Protection shall be provided by installing the lights a minimum of 7 feet from the work surface or by lamp holders with guards. Branch circuits supplying temporary lighting shall not supply any other load. Provide sufficient temporary lighting to ensure proper workmanship by combined use of day lighting, general lighting, and portable plug-in task lighting. Comply with OSHA required foot-candle levels and submit plan for approval by the owner.

F. For temporary wiring over 600 volts, suitable fencing, barriers, or other effective means shall be provided to prevent access of anyone other than authorized and qualified personnel.

G. Temporary power cords shall be kept off the ground or floor. The Contractor shall provide temporary supports as required to keep temporary cords off the ground or floor.

1.9 SUBSTITUTION OF MATERIALS AND EQUIPMENT:

A. Refer to Uniform General Conditions and Supplementary General Conditions for substitution of materials and equipment.

B. The intent of the Drawings and/or Specifications is neither to limit products to any particular manufacturer nor to discriminate against an “APPROVED EQUAL” product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer’s name appears in these Specifications, it is not to be construed that the
manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

C. The specified products have been used in preparing the Drawings and Specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the designer is final.

D. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

E. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop Drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame 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 of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

F. All equipment installed on this project shall have local representation; local factory authorized service, and a local stock of repair parts.

G. 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 contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the Specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

H. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the Specifications.

I. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

J. 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 specified at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and Equipment: Labeled and/or listed as acceptable to the authority having jurisdiction as suitable for the use intended. Materials shall be of a standard industrial quality if no specifications or specific model numbers are given.

B. 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.
C. All materials shall be new and unused.

D. Provide non-metallic material in corrosive areas or as otherwise specified.

E. All electrical equipment, conduit, and boxes mounted outside shall be supported using corrosion resistant (stainless steel or galvanized) products, e.g. Unistrut, hangers, rods, bolts, nuts, washer, etc...

F. 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.

G. Products must conform to requirements of the National Electrical Code.

H. 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.

I. 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 of the National Electric Code for working space, access, and dedicated equipment space. Do not provide equipment that will not suit arrangement and space limitations. If arrangement or equipment is different from construction drawings, scaled drawings (1/4" = 1'-0") of electrical and telecommunication rooms shall be submitted for review and approval by the Architect/Engineer and the Owner’s Representative prior to installing equipment.

J. 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.

K. 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.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. Install work in compliance with NEC.

B. Install material and equipment in accordance with manufacturers’ instructions. Use calibrated torque wrenches and screwdrivers to tighten all terminals, lugs, and bus joints.

C. Comply with startup procedures as defined by Construction Manager and Owner.

D. Arrange electrical work in a neat, well-organized manner. Do not block future connection points of electrical service. Install all electrical work parallel or perpendicular to building lines unless noted otherwise, properly supported with purpose-designed apparatus, in a neat manner.

E. Apply, install, connect, erect, use, clean, adjust, and condition materials and equipment as recommended by the manufacturers in their published literature.

F. Make openings through masonry and concrete by core drilling in acceptable locations. Restore openings to original condition to match remaining surrounding materials.

G. Concrete Equipment Pads.
   1. Refer to structural Drawings and specifications for design criteria.
   2. Where not otherwise indicated, install 3-1/2 inch thick concrete foundation pads for indoor floor-mounted equipment, except where direct floor mounting is required. For equipment mounted outdoors, provide concrete foundations a minimum of 5 1/2 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 4 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.

H. 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, 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 Securing and Support Methods, for additional requirements.

I. 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.

J. 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 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 contractor initiated changes to the issued design result in mechanical equipment 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 for equipment under those Divisions. Diagrams shall be submitted to the Architect/Engineer for review upon request. 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 the other Divisions as applicable.

K. 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.

L. Application. Unless otherwise indicated or approved by A/E and Owner’s Representative, 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.

M. Transformers. Use transformers where indicated or as otherwise required to change the service to the required utilization voltages.

N. 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: 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: Where millwork, casework, and similar equipment includes service fittings such as switches, duplex receptacles, data/communications outlets, and luminaires on the casework or equipment, provide branch circuit connections to match electrical connection requirements of service fittings.

O. Accessories. Offsets, fittings, expansion joints, anchors and accessories that are reasonably 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 and clearances. Provide pullboxes, fittings, etc., required as a result of these transitions and changes in direction.

P. 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, such as 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 from view. The Contractor shall provide advance notice in accordance with the applicable requirements of Division One and the General Conditions. Where not specified 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.

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

1. **3.2 SERVICE CONTINUITY**

R. Coordinate with Owner's Representative to maintain continuity of electric service to all functioning portions of process or buildings during the hours of normal use. Phase construction work to accommodate Owner's occupancy requirements.

S. Arrange temporary outages for cutover work with the Owner. Keep the outages to a minimum number and minimum length of time.

T. All service outages shall be requested in writing a minimum of two weeks prior to the date. Owner reserves the right to postpone shutdowns up to 24 hours prior to the shutdown at no additional cost. Outage requests shall include a schedule of the work to be performed and the time requirements.

U. The Contractor shall obtain all appropriate Owner permits for working in equipment.

3.3 **HAZARDOUS LOCATIONS**

A. Equipment, wiring, devices, and other components located within hazardous areas are to be of the appropriate type per NFPA requirements.

B. Ground exposed non-current carrying parts of entire electrical system in hazardous areas, in accordance with NEC and as instructed by Owner.

3.4 **SLEEVES AND SEALS**
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. If 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 firestopping requirements of Division 7. 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, and unless noted otherwise, 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 a "Link-Seal" or equivalent casing seal or equivalent product. Size conduit sleeve to accommodate the casing seal.

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. Unless otherwise directed by the A/E, 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 as indicated, or by 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.

3.5 CONSTRUCTION REVIEW

A. The Engineer or Owner's representative will review and observe installation work to insure compliance by the Contractor with requirements of the Contract Documents.
B. Review, observation, assistance, and actions by the Engineer or Owner’s representative shall not be construed as undertaking supervisory control of the work or of methods and means employed by the Contractor. The review and observation activities shall not relieve the Contractor from the responsibilities of these Contract Documents.

C. The fact that the Engineer or Owner’s representative do not make early discovery of faulty or omitted work shall not bar the Engineer or Owner’s representative from subsequently rejecting this work and insisting that the Contractor make the necessary corrections.

D. Regardless of when discovery and rejection are made, and regardless of when the Contractor is ordered to correct such work, the Contractor shall have no claim against the Engineer or Owner’s representative for an increase in the Contract price, or for any payment on account of increased cost, damage, or loss.

3.6 WARRANTY

A. Provide warranties in accordance with the requirements of Uniform General and Supplementary Conditions (UGC).

3.7 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.

3.8 TESTING

A. Test Conditions. Use field startup and testing procedures submitted in accordance with 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 this Section and Division. 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 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.

3.9 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.

1. 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:

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

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

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

5. 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.

6. Copies of "Reviewed" shop drawings and submittals.

B. Print copies of the record Drawings. Refer to requirements this Section.

END OF SECTION
SECTION 26 05 00 – BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Hinged cover enclosures and cabinets
B. Contactors
C. Control relays
D. Push buttons, and selector switches
E. Terminal blocks and accessories
F. Penetration sealing systems (fire stops)
G. Electrical/control portion of HVAC work covered by Division 23 pertaining to basic electrical materials and methods shall follow the requirement set forth by this and all specifications.

1.2 APPLICABLE CODES AND STANDARDS

A. NFPA 70, National Electrical Code (latest adopted edition)
B. National Electrical Safety Code, (NFPA 70E)
C. Applicable publications of NEMA, ANSI, IEEE and IESNA
D. Underwriters Laboratories, Inc. Standards (UL)
E. Federal, city, state, and local codes and regulations having jurisdiction
F. OSHA recognized Nationally Recognized Testing Laboratories
G. OSHA requirements
H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
I. NEMA WD 1 – General-Purpose Wiring Devices
J. UL 98 - Enclosed Switches

1.3 INTENT

A. This Section is not, and shall not be interpreted to be a complete listing of all materials or equipment that is Contractor furnished and erected. It is intended to clarify and further define the Contractor scope of work, procurement, and responsibilities for those incidental materials that are not specified by other specifications, but important to a complete and operational system.
B. The Contractor shall furnish all equipment and materials, whether or not specified in other Sections of specification and on drawings, for installation and connection required to place equipment into satisfactory operating service. The Contractor shall review the Drawings and specifications for clarification of his responsibility in the handling and installation of equipment and material. Where applicable, and not in contradiction with the Drawings and specifications, the Contractor shall install and connect the equipment in accordance with the manufacturer's recommendations and instructions.

C. All materials and equipment shall be of types and manufacturer specified wherever practical. Should materials or equipment so specified be unattainable, the Contractor shall submit the description and manufacturer's literature, reason for substitution request and shall secure the approval of the Engineer before substitution of other material or equipment is purchased. This Section establishes performance requirements and the quality of equipment acceptable for use and shall in no way be construed to limit procurement from other manufacturer.

1.4 SUBMITTALS

A. Provide submittals in addition and in accordance with Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

B. Submit manufacturer's literature and specification data sheets for each type of basic material, which is applicable to the project.

1.5 DELIVERY, STORAGE AND HANDLING

A. Provide factory-wrapped waterproof flexible barrier material for covering materials, where applicable, to protect against physical damage in transit. Damaged materials shall be removed from project site.

B. In their factory-furnished coverings, store materials in a clean, dry indoor space, which provides protection against the weather.

PART 2 - PRODUCTS

2.1 ENCLOSURES AND CABINETS

A. Enclosures and cabinets for all Contractor furnished electrical equipment and devices shall be suitable for the location and environmental conditions and shall be of the NEMA type as shown in Table 26 05 00-1. Exceptions shall be specifically designated on the Drawings.

<table>
<thead>
<tr>
<th>Location</th>
<th>Environment</th>
<th>Enclosure Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor Utility</td>
<td>Dry, subject to dust, falling dirt and dripping non-corrosive liquids</td>
<td>NEMA 12</td>
</tr>
<tr>
<td>Indoor</td>
<td>Clean, Dry</td>
<td>NEMA 1</td>
</tr>
<tr>
<td>Indoor</td>
<td>Wet, subject to hose-directed water</td>
<td>NEMA 4</td>
</tr>
<tr>
<td>Outdoor</td>
<td>Subject to falling rain, sleet, and external ice formation</td>
<td>NEMA 3R</td>
</tr>
</tbody>
</table>
### Enclosures

#### Indoor or Outdoor
- Subject to corrosion, windblown dust and rain, splashing water and hose-directed water

#### NEMA 4X

B. Enclosures shall have the following properties:

   a. Type 1: Steel.
   b. Type 4: Steel with gasket door, rain tight.
   c. Type 4X: Stainless steel, (polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas).
   d. Type 12: Steel with gasketed door, dust-tight.

C. Finish: Exterior, manufacturer's standard gray enamel finish; interior, white enamel finish.

D. Covers: Continuous hinge, held closed by flush latch operable by hasp and staple for padlock. Where required for NEMA ratings, gaskets shall be neoprene rubber.

E. Interior Panel for Mounting Terminal Blocks or Electrical Components: 14 gauge steel, white enamel finish.

F. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

G. Forced Ventilation: Where indicated, provide 115V single-phase fan motor, filtered with air plenum, finger guard, and stainless steel grille. Washable aluminum filter, accessible for cleaning from outside the enclosure; 20,000-hour continuous operation without lubrication or service. Provide matching exhaust grille assembly. Mount fan in lower side corner, exhaust grille in opposite upper side corner.

#### 2.2 CONTACTORS

A. Acceptable Manufacturers

1. General Electric Company
2. Square D Company
3. **SPEC-WRITER** - (coordinate for other manufacturers as approved by campus and engineer)
4. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

B. Contactors: NEMA ICS 2; electrically held or mechanically held as indicated on Drawings. Two-wire control for electrically held contactors and three-wire control for mechanically held contactors.
C. Enclosure: NEMA 1 unless indicated otherwise on Drawings.

D. Control Transformer: Provide when indicated on Drawings and size for the application. Minimum capacity shall be 100 VA. Provide primary and secondary fuse protection.

E. Coil operating voltage; 110 volts, 60 Hz or as per drawings.

F. Size: NEMA ICS 2; size as indicated on Drawings.

G. Contacts: As indicated on Drawings; 600 Volts, 60 Hz.

H. Provide solderless pressure wire terminals on bus terminals suitable for mounting in panelboard as indicated on Drawings.

2.3 CONTROL RELAYS

A. Acceptable Manufacturers

1. General Electric Type CR120A

2. Cutler-Hammer Type M-300

3. Square D Company

4. Allen-Bradley

5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

B. Provide magnetic control relays, NEMA Class A: A300 (300 volts, 10 amps continuous, 7,200 VA make, 720 VA break), industrial control type with field-convertible contacts, and meeting the requirements of NEMA ICS 2.

C. Where time delay relays are specified or required, unless otherwise noted, provide magnetic control relays with a solid-state timer attachment adjustable from 0.2 to 60 seconds (minimum) or with range as indicated. Provide as field convertible from ON delay to OFF delay and vice versa.

D. Where latching (mechanically held) relays or motor thermal detector relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts.

2.4 PUSH BUTTONS AND SELECTOR SWITCHES

A. Acceptable Manufacturers

1. Allen-Bradley

2. Square D

3. Cutler Hammer

4. Seimens

5. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.
B. For non-hazardous, indoor, dry locations, including control panels, and individual stations, provide heavy duty, NEMA 13, oil tight type pushbuttons, indicating lights, selector switches, and stations for these devices.

C. For nonhazardous, outdoor, or normally wet locations, or where otherwise indicated, provide heavy duty corrosion resistant, NEMA 4, watertight type pushbuttons, indicating lights, or selector switches mounted in NEMA 4 watertight enclosures. Provide special gasketing required to make complete station watertight.

D. For hazardous locations, provide control station listed by UL for Class I, Divisions 01 and 02, Groups C and D; Class II, Division 01 and 02, Groups E, F, and G. Specific type shall be in accordance with area classification as indicated on the Drawings.

E. For corrosive locations, provide nonmetallic components and enclosures meeting NEMA Type 4X.

F. Provide devices meeting the requirements of NEMA ICS 2, and having individual, extra large nameplates indicating their specific function. Provide push-button stations with laminated plastic nameplates indicating the drive they control. Provide contacts with NEMA designation rating A600. Install provisions for locking pushbuttons and selector switches in the OFF position wherever lockout provisions are indicated. Nameplates shall be as specified in Section 16195.

G. Utilize selector switches having standard operating levers. All indicating lights shall be LED type, push-to-test type. Provide ON or START pushbuttons colored black. Provide OFF or STOP pushbuttons colored red.

2.5 TERMINAL BLOCKS AND ACCESSORIES

A. Signal And Control Terminals

1. Acceptable Manufacturers
   a. Phoenix Contact
   b. Buchanan
   c. Weidmüller
   d. Entrelec
   e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 23 00 00 and Division 01 for substitution requirement.

2. Signal and Control Terminals: Modular construction type, DIN 46 277/3 channel mounted; screw clamp compression connectors, rated 300 volts. Minimum terminal width of 0.24 inch, capable of holding two No. 12 or two No. 14 AWG conductors in each connector. Terminal identification numbers shall be thermoset characters (black) on a white background. Provide 25 percent spare terminals.

B. Power Terminals

1. Acceptable Manufacturers
   a. Buchanan
   b. Ilsco
c. Square D Company

d. Burndy

e. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00 and Division 01 for substitution requirement.

2. Power Terminals: Unit construction type, closed back type, with tubular pressure screw connectors, rated 600 volts, size as required. Provide 25 percent spare terminals.

2.6 PENETRATION SEALING SYSTEMS (FIRE STOPS)

A. Provide penetration sealing where conduit, cable tray, etc. pass through rated walls, ceilings, and floors. See the other Division Sections on Fire Stopping and Joint Sealants for sealing requirements and systems.

2.7 UL LISTING

A. All equipment and materials shall be new and conform to the requirements of this Section. All equipment and materials shall be UL listed, and shall bear their label whenever standards have been established and level service is regularly furnished. All equipment and materials shall be of the best grade of their respective kind for the purpose.

B. OSHA recognized National Testing Laboratories providing equivalent testing, labeling and listing services as UL will be considered for approval, where appropriate for the equipment, system or function.

PART 3 - EXECUTION

3.1 FABRICATION - CONTROL ENCLOSURES AND CABINETS

A. Shop assembles enclosures and cabinets housing terminal blocks or electrical components in accordance with NEMA ICS 6.

3.2 INSTALLATION - ENCLOSURES AND CABINETS

A. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to dry wall is not permitted.

B. Provide accessory feet for freestanding equipment enclosures.

C. Install trim plumb.

3.3 ERECTION OF EQUIPMENT

A. Manufacturer's Installation Instructions: Where furnished or called for by the manufacturer, equipment manufacturer's installation instructions shall be considered a part of this specification and fully complied with.

B. Where the Contractor damages the finishing coat of paint in existing or completed areas, he shall refinish with matching paint.

C. Mounting Heights: Individual safety switches and buttons and devices shall normally be installed at the following mounting heights, when not specified on the Drawings.
1. Safety Switches: 6 feet 0 inches (to top).
2. Pushbuttons: 4 feet 0 inches (to center).
3. Control Panels: 6 feet 0 inches (to top).

D. Mounting: Equipment and control devices shall be supported independent of conduit connections. Panels or cabinets shall be mounted on metal frame supports independently of equipment. Control devices and metal enclosures shall be bolted or welded to steel channel or steel plate. All electrical equipment and devices not covered by the above, such as miscellaneous switches, thermostats, duct switches, temperature switches, floats, photoelectrical devices, and similar electrical devices shall be located and set as suitable for the application. Where control panels are provided as part of the equipment racks mounted on the floor, provisions shall be made to support conduits and flexible connections to control panels.

3.4 COORDINATION

A. Exact location of all electrical equipment, devices and fixtures shall be determined in field by contractor and verified as needed by Engineer's field representative prior to installation.

B. Contractor is responsible for coordinating electrical work across all trades.

C. Information represented in electronic files is representative and diagrammatic in nature. Contractor is responsible for coordinating all trades and for maintaining up to date electronic files for coordination and record keeping purposes.

END OF SECTION 26 05 00
SECTION 26 05 19  CABLE, WIRE AND CONNECTORS, 600 VOLT

PART 1  GENERAL

1.01  WORK INCLUDED

A. Building wire:
   1. Power distribution circuitry.
   2. Control system circuitry.
   3. Lighting circuitry.
   4. Appliance and equipment circuitry.
   5. Motor-branch circuitry.
   6. Outdoors lighting and power.
   7. Other systems circuitry as designated.

B. Cable.

C. Wiring connections and terminations.

D. Electrical/control portion of HVAC work covered by Division 23 pertaining 600 volt cable, wire and connectors shall follow the requirement set forth by this specification.

1.02  REFERENCES


C. Where application of National Electrical Code, trade association standards or publications appears to be in conflict with the requirements of this Section, the Architect/Engineer shall be asked for an interpretation.

1.03  SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

B. Submit manufacturer's literature and specification data sheets for each item of cable, wire and connectors.

C. Qualification of cable and wire manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years’ experience.

1.04  DELIVERY, STORAGE AND HANDLING

A. Provide factory-wrapped waterproof flexible barrier material for covering wire and cable wood reels, where applicable; and weather resistant fiberboard containers for factory packaging of cable, wire and connectors, to protect against physical damage in transit. Damaged cable, wire or connectors shall be removed from project site.

B. Store cable, wire and connectors in a clean, dry indoor space in their factory-furnished coverings, which provides protection against the weather.

PART 2  PRODUCTS
2.01 GENERAL REQUIREMENTS

A. Generally, cable, wire and connectors shall be of manufacturer's standard materials, as indicated by published product information.

B. Provide factory-fabricated wire of the size, rating, material and type as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. The minimum size wire to be used for power or lighting circuits shall be #12 copper with insulation as noted below. Minimum size for control shall be #14 copper.

C. The conductors of wires and cables shall be of copper (tinned where specified), and have conductivity in accordance with the standardization rules of the IEEE. The conductor and each strand shall be round and free of kinks and defects.

D. Grounding conductors, where insulated, shall be colored solid green or identified with green color as required by the NEC. Conductors intended as a neutral shall be colored solid white, or identified as required by the NEC. All motor or equipment power wiring shall be colored according to Section 26 05 53, Electrical Identification.

E. All cable specified for use in tray shall be multiconductor and shall have an outer jacket of flame-retardant, moisture and sunlight resistant polyvinyl chloride (PVC) and shall be UL and NEC approved type for tray installation.

F. All low voltage power and control cable installed in open cable tray above ceilings used for return air shall be plenum rated. Where tray cable is not available in size and type required, conductors shall be installed in conduit.

G. Use compression lugs for all wiring terminations, except on breakers or terminal strips in panel boards.

H. Provide factory applied color coded insulation unless otherwise approved per section 26 05 53 Electrical Identification, Part 2.1C.

2.02 BUILDING WIRE

A. WC 70/ICEA S-95-658-1999, Non-shielded 0-2kV Cables

B. Feeders and Branch Circuits-All sizes: 98% conductivity copper, soft-drawn, 600-volt insulation, THHN/THWN-2 Use XHHW-2 conductors where installed in conduit underground.

SPEC WRITER NOTE – CHOOSE ONE OPTION FROM BELOW

1. [No. 12 AWG and smaller: Provide solid conductor]
   No. 10 and larger: Provide stranded conductor]

2. [Provide stranded conductor for all sizes.]

2.03 REMOTE CONTROL AND SIGNAL CABLE

A. 600 Volt Insulation Control Cable for Class 1 Remote Control and Signal Circuits, Type TC:

1. Individual Conductors: 14 AWG, stranded copper, XHHW insulation. Rated 90°C dry, 75°C wet, color-coded per ICEA Method 1 plus one green equipment grounding conductor.

2. Assembly: Bundle wrapped with cable tape and covered with an overall PVC jacket. Cable shall pass IEEE-1202 vertical tray ribbon-burner flame test (210,000 BTU) VW-1.
B. Instrumentation Cable:
   1. 300 Volt Instrumentation Cable, Multiple Pairs, Overall Shield, Type PLTC:
      a. Individual Conductors: 18 AWG, stranded, tinned copper, flame retardant
         polyethylene or PVC insulated, rated 105°C, black and white numerically
         printed and coded pairs.
      b. Assembly: Individual twisted pairs having a 100 percent coverage
         aluminum-polyester shield and 20 AWG stranded tinned copper drain wire. Conductor bundle shall be shielded with 100 percent coverage overall aluminum-polyester shield complete with 20 AWG drain wire. All group shields completely isolated from each other. Bundle wrapped with cable tape and covered with an overall flame retardant PVC jacket. Cable shall pass IEEE-383 vertical tray flame test (70,000 BTU) UL1581.

C. Life Safety Systems Cable:
   1. All life safety system wiring shall be installed in dedicated conduit or raceway with adequate separation/shielding from all other systems.
   2. Life safety systems wiring shall be as specified in the Section 28 31 00 - Fire Alarm and Smoke Detection Systems.

D. Security/Access Control/CCTV Cable:
   1. All security/access control wiring shall be installed in dedicated conduits.
   2. Security/access control wiring shall be rated and as specified below:

<table>
<thead>
<tr>
<th>Circuit Type</th>
<th>No. of Conductors</th>
<th>Conductor Specifications</th>
<th>Cable Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mA Current Loop</td>
<td>2</td>
<td>18-gauge, stranded copper</td>
<td>2 cables, 1 twisted pair each required</td>
</tr>
<tr>
<td>Card Reader Coaxial</td>
<td>--</td>
<td>18-gauge, solid copper, center conductor</td>
<td>Schlage Model No. SE9284PL or Anicom 5910PL</td>
</tr>
<tr>
<td>Contact Circuits</td>
<td>2</td>
<td>18-gauge, stranded copper</td>
<td>Nonshielded, twisted</td>
</tr>
<tr>
<td>CCTV Coaxial</td>
<td>--</td>
<td>--</td>
<td>Belden 89259 plenum rated, or approved equal</td>
</tr>
</tbody>
</table>

   3. All security/access control power circuit wiring shall comply with paragraph 2.2. Building Wire of this Section.

E. Plenum Cable for Class 3 Remote Control and Signal Circuits: 98% conductivity copper conductor, 300-volt insulation, rated 60-degree C, UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.04 WIRING CONNECTIONS AND TERMINATIONS

A. Provide factory-fabricated, metal connectors of the size, rating, material, type and class as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. Select from only following types, classes, kinds and styles.
   1. Type:
      a. Solderless pressure connectors.
      b. Crimp.
      c. Threaded.
      d. Insulated spring wire connectors with plastic caps for 10 AWG and smaller.
   2. Class: Insulated.
   3. Material: Copper (for CU to CU connection).
   4. Style:
a. Insulated terminals. Use ring-terminal for control wiring. Use flange (fork)
spade compression terminal for termination of stranded conductors at
wiring devices, including ground connection.
b. Split bolt-parallel connector.
c. Pigtail connector.
d. Pre-insulated multi-tap connector.

PART 3 EXECUTION

3.01 INSPECTION

A. Installer must examine the areas and conditions under which cable, wire and connectors
are to be installed and notify the Contractor in writing of conditions detrimental to the proper
and timely completion of the work. Inspect wire and cable for physical damage. Do not
proceed with the work until unsatisfactory conditions have been corrected.

3.02 GENERAL WIRING METHODS

A. Install electrical cable, wire and connectors as indicated, in accordance with the
manufacturer's written instructions, the applicable requirements of NEC and the National
Electrical Contractors Association's "Standard of Installation", and as required to ensure
that products serve the intended functions.

B. Coordinate cable and wire installation work with electrical raceway and equipment
installation work, as necessary for proper interface. Do not install the conductors until
raceway system is complete and properly cleaned.

C. Cables shall be selected on the basis of their purpose and UL listing. Generally, use Types
THWN-2 and THHN-2 in building interiors and other dry locations. Outdoors and under-
ground in raceways, use Type XHHW-2. Conductors subject to abrasion, such as in
lighting poles, shall be Type XHHW-2.

D. No conductor smaller than No. 12 wire shall be used for lighting purposes. In the case of
"home runs" over 50' in length (100' for 277 volt) no conductor smaller than a No. 10 wire
shall be used. The sizing of all wire except remote control wire shall be accomplished in
the case of both feeder and branch circuits by conforming to the following provisions.
Separate neutral conductors shall be provided for each phase of the same size for
120V/277V single-phase application for heavy electrical loads, computer loads, loads fed
from isolated transformers, lab equipment, clinic equipment, dedicated circuits, unless
noted otherwise on drawings. Voltage drop on feeders and branch circuits shall not exceed
NEC requirement.

E. Include a separate neutral conductor with each phase conductor for all 120V and 277V
circuits. Sharing of neutrals is not permitted. Provide a maximum number of 3 phase
conductors in one conduit.

F. Remote control wires shall be no smaller than No. 14 conductors. Control wires shall be
run in separate conduits. Departures from the sizes so determined shall be made only in
those cases in which the National Electrical Code requires the use of larger conductors.
The sizes as determined from these tables shall be regarded as the acceptable minimum
under all other circumstances. In no case, however, shall there be a voltage drop greater
than that specified in any feeder or branch circuit. The Contractor may, if he deems it
necessary or advisable, use larger sized conductors than those shown. Under no
circumstances, however, shall the Contractor use any conductors sized in a manner which
does not conform to the above mentioned tables without having first secured the written approval of the Owner's duly authorized Representative.

G. Install exposed wire and cable, parallel and perpendicular to surface or exposed structural members and follow the surface contours, where possible.

H. Splice branch circuits only in accessible junction or outlet boxes. Control cable shall never be spliced except the final connection to field devices. Where terminations of cables that are installed under this Section are to be made by others, provide pigtail of adequate length for neat, trained and bundles connections, minimum 5 feet at each location, unless noted otherwise on drawings.

I. Wiring Within an Enclosure: Contractor shall bundle ac and dc wiring separately within an enclosure. The Contractor shall utilize panel wire-ways when they are provided. Where wireways are not provided the Contractor shall neatly tag, bundle wires and secure to sub-panel at a minimum of every three inches with T&B Type TC5355 heavy duty mounting bases.

J. Do not band any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors.

3.03 WIRING INSTALLATION IN RACEWAYS

A. Wire and cable shall be pulled into clean dry conduit. Do not exceed manufacturer's recommended values for maximum pulling tension.

B. Pull conductors together where more than one is being installed in a raceway.

C. Use UL listed pulling compound or lubricant, when necessary; compound must not deteriorate conductor and insulation.

D. Do not use a pulling means, including fish tape, cable or rope, which can damage the raceway.

E. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

F. Place an equal number of conductors for each phase of a circuit in same raceway.
   1. Contractor can combine circuits in a common conduit as long as derating of the conductors' ampacity and other NEC factors accounted for. The dedicated neutral conductor must be included as a current carrying conductor for all dedicated single phase circuits.

G. Provide separate conduit or raceway for line and load conductors of motor starters, safety disconnect switches, and similar devices. Those devices shall not share the same raceway.

H. All conduits shall contain a green grounding conductor. Conduit, wireways, or boxes shall not be used as the equipment grounding conductor.

3.04 CABLE INSTALLATION

A. Provide protection for exposed cables where subject to damage during construction. Do not install cable before the completion of raceway system.
B. Cable above ceilings shall be in conduit or raceways. Cables, conduits and raceways shall not be laid on ceiling tiles or strapped to ceiling wire.

C. Use suitable cable fittings and connectors.

D. It shall be the Contractor’s responsibility to accurately measure all cable runs before the cable is cut. The Contractor shall furnish all tools and equipment, have sufficient properly trained personnel and shall exercise necessary care to ensure that the cable is not damaged during installation. Cable found to be damaged before installation shall not be installed. Cable damage during installation shall be removed and replaced. Repairs to cables can only be done with written permission from the Owner’s Representative and only under special circumstances.

E. Care shall be exercised with cables entering or leaving cable trays that all cable bend radii shall not be less than the recommended minimum and that cables are not left to rest unprotected on any sharp edge or corner.

F. PVC jacketed cable shall not be installed or worked in any way at temperatures below 32°F, unless cable has been previously stored in a heated area 48 hours prior to being pulled and transported to a heated pulling area.

G. Each cable entering an enclosure shall have its conductors bundled together and identified with the cable number. All groups of conductors within an enclosure shall be shaped and formed to provide a neat appearance to facilitate future additions or rework. All control conductors shall be numbered and shall be labeled at each termination with this number, using markers designed for the application.

H. Multi-Conductor Cable Installation: Power and 120V control cable shall be installed in the same tray. When cables leave trays, they shall be protected between the trays and the cable terminal points by drawing them through conduits. Do not route 600V cables (power cable and 120V control cable) in the same conduit or cable tray as low voltage cables (less than 50V, communications, security systems, or control conductors). Do not route security systems, or control cables through communications rooms. Fire alarm cable shall be routed in a separate conduit only.

I. Instrument Cable: Instrument cable shall, when conduit installation is required be installed in rigid steel conduit. They shall not be spliced at any point. The shields and drain wires of shielded signal cables shall be grounded only at one point as indicated on the Drawings.

3.05 WIRING CONNECTIONS AND TERMINATIONS

A. Install splices, taps and terminations, which have equivalent-or-better mechanical strength and insulation as the conductor. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

B. Keep conductor splices and taps accessible and to a minimum, and in junction boxes only. Control circuit conductors shall terminate at terminal blocks only. Splices below grade shall only be in handholes or manholes and shall be made watertight with epoxy resin type splicing kits similar to Scotchcast.

C. Use splice, tap and termination connectors, which are compatible with the conductor material.

D. Thoroughly clean wires before installing lugs and connectors.
E. Terminate spare conductors with electrical tape and label as spare.

F. Power and Lighting Circuits: Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps on lighting and receptacle circuits.

G. Use split bolt connectors for copper wire splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.

H. Connections for all wire sizes in motor terminal boxes where the motor leads are furnished with crimped-on lugs shall be made by installing ring type compression terminals on the motor branch circuit ends and then bolting the proper pairs of lugs together. First one layer of No. 33 scotch tape reversed (sticky side out), then a layer of rubber tape, then two layers of No. 33 half-lapped.

I. Identify conductors per Section 26 05 53 - Electrical Identification.

3.06 FIELD QUALITY CONTROL

A. Torque test conductor connections and terminations to manufacturer's recommended values.

B. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

C. Conductors in vertical conduits or raceways shall be supported in the manner set forth in the appropriate section of the latest revision of the National Electrical Code. Lighting fixtures shall not be used for raceways for circuits other than parallel wiring of fixtures.

D. Conductors may be run in parallel on sizes 1/0 to 500 MCM inclusive provided all paralleled conductors are the same size, length, and type of insulation. Except as otherwise shown on drawings, no more than three conductors may be run in parallel, and they shall be so arranged and terminated as to insure equal division of the total current between all conductors involved. Where parallel connection is contemplated, approval of the Owner's Representative must be obtained before installation is made.

3.07 TESTING AND ACCEPTANCE

A. Before final acceptance, the Contractor shall make voltage, insulation, and load tests, necessary to demonstrate to the Owner's Representative the satisfactory installation and proper performance of all circuits.

B. Test feeder conductors clear of faults. Insulation-resistance test shall be conducted per NETA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems. Test results below 50 megohms shall be cause for rejection of the wiring installation. Replace and retest all such rejected conductor.

C. At the completion of this project, the Contractor shall provide for the Owner 3 complete and finally corrected sets of working drawings. These sets of working drawings shall be new, unused and in good condition, and shall include the nature, destination, path, size and type of wire and all other characteristics for complete identification of each and every conduit and circuit.
END OF SECTION 26 5 19
SECTION 26 05 26 – GROUNDING

PART 1 - GENERAL

1.01 WORK INCLUDED
   A. Power system grounding.
   B. Electrical equipment and raceway grounding and bonding.

1.02 RELATED WORK
   A. Section 26 41 00 - Lightning Protection. Systems
   B. Division 27, Communications.
   C. Division 28, Electronic Safety and Security.

1.03 REFERENCES
   A. NFPA 70 – National Electrical Code
   B. ANSI/UL 467 – Electrical Grounding and Bonding Equipment
   C. ANSI/IEEE STD 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems
   D. IEEE 81 – Guide for Measuring Earth Receptivity, Ground Impedance and Earth Surface Potential of a ground System
   E. IEEE 1100 – Recommended Practice for Powering and Grounding Sensitive Electronic Equipment
   F. ANSI/TIA/EIA 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications

1.04 SYSTEM DESCRIPTION
   A. Ground the electrical service system neutral at service entrance equipment to grounding electrodes. Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operations. Concrete encased electrodes shall be connected as the most effective grounding electrodes. Provide a completely grounded system in accordance with Article 250 of the NEC.

   B. Ground each separately-derived system neutral to separate ground buses that are installed in nearest electrical rooms. Transformer, UPS systems, power conditioners, inverters, or other power supplies are separately derived systems. Standby or emergency generators are separately derived systems if the neutral is bonded to the generator frame and if there is no direct connection of the generator neutral conductor to the service neutral conductor.
C. Provide communications system grounding conductor connected to separate electrode (ground bus) that is installed in each IT room.

D. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, cable trays, auxiliary gutters, meter fittings, boxes, cable armor, cable sheath, ground bus in electrical rooms and IT rooms, metal frame of the building or structure, ground ring, lightning down lead conductor, grounding conductor in raceways and cables, receptacle ground connectors, and metal underground water pipe.

E. Bonding jumpers shall be installed around non-metal fittings or insulating joints to ensure electrical continuity. Bonding shall be provided where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed.

1.05 SUBMITTALS

A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

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

C. Shop Drawings.

1. Provide detailed plans prepared to 1/8-inch scale with 1/8-inch text which indicate the work to be performed. Details of component mounting and connections shall be included on separate detail drawings. Manufacturer’s catalog numbers and generic identification shall be indicated for components shown on the Drawings.

2. Shop drawings shall include locations of conductors, roof penetrations, floor penetrations, etc., Contractor shall coordinate locations of conductors in walls and penetrations with the appropriate trades. Failure to coordinate these requirements shall not relieve this Contractor from properly completing this work. The Contractor shall employ the proper trades to provide the chases in walls and roof and floor penetrations required to install the conductors if not coordinated before the floors, walls and roof are installed.

D. Coordinated Submittal.

1. Submit product data and shop drawings for grounding system and lightning protection system at the same time and as one package. Indicate common components and interconnections between grounding and lightning protection systems. Refer to Section 26 41 00 for Lightning Protection system.

2. Coordinate submittal for grounding system with electrical service to building and with electrical service equipment.

E. 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.

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

G. 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. Deliver one set of As-Built record drawings on CD-Rom or similar electronic
media acceptable to the Owner. Drawing files shall be in the editions of AutoCAD (.dwg) and Adobe Acrobat (.pdf) acceptable to the Owner.

PART 2 - PRODUCTS

2.01 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. Unless noted otherwise, 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.

2.02 CONDUCTORS

A. Materials. Provide grounding conductors fabricated from annealed copper with conductivity > 98 percent International Annealed Copper Standard (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.

2.03 MANUFACTURER

A. Copperweld.
B. Cadweld.
C. Burndy.
D. Harger.
PART 3 - EXECUTION

3.01 INSTALLATION

A. Install ground system as indicated, in accordance with the applicable requirements of the National Electrical Code and the National Electrical Contractors Association's "Standard of Installation".

B. Install grounding conductors continuous, without splice or connection, between equipment and grounding electrodes. Install test wells as required per drawings.

C. In feeder and branch circuits, provide a separate, insulated equipment grounding conductor. Terminate each end on a grounding lug, bus, or bushing.

D. Connect grounding electrode conductors to metal water pipe where metal pipe is available and accessible using suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.

E. Install fusion welded ground connectors where they are concealed or inaccessible.

F. Ground each outlet by the use of an approved grounding clip attached to the junction box in such a position to be readily inspected on removal of the cover plate; or by the use of an approved grounding yoke type receptacle.

G. No strap grounding clamps shall 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.

H. Install external ground wire on liquid tight flexible metal conduit with grounding bushings.

I. Conductor connections shall be made by means of solderless connectors such as serrated bolted clamps or split bolt and nut type connectors.

J. The neutral of each transformer shall be bonded to system ground at one point only. This point shall be ahead of the first secondary protective device.

K. Connect grounding conductors to ground rods at the upper end of the rod with the end of the rod and the connection points below finished grade. Below grade connection shall be exothermic-welded type connectors as manufactured by Cadweld, Thermoweld. In manhole, install ground rods with 4 to 6 inches above the floor with connections of grounding conductors fully visible and accessible.

3.02 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 service entrance equipment where permitted per NEC. 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. Separately Derived Systems: Ground the neutral of each separately derived system in accordance with NEC-250.

C. 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.

D. 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.

3.03 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. Install grounding electrodes around exterior perimeter of building, a minimum of 3 feet outside the foundation of the building or facility. Space grounding electrodes at a distance between electrodes of at least twice their driven depth. Bond ground rods together with the building ground ring (counterpoise). Install grounding electrode conductor in undisturbed earth, a minimum of 2 feet below excavated depth of building structural mat, crawlspace, or sub-grade.

D. Depth: Bury grounding electrode conductors below grade to comply with NEC 250. Minimum depth 30 inches unless noted otherwise.

E. Provide grounding electrode conductor pigtails at each ground rod for connection to building structural steel. Place PVC sleeves through foundation at column locations. Provide minimum 12 feet of excess pigtail above the building foundation or structural mat, prior to placement of concrete. Coil pigtail conductors and support above finished level of mat or foundation during concrete pour to prevent excess pigtail from being embedded or cemented in concrete.

F. Provide main grounding electrode conductor pigtails at two locations on opposite sides of building for connection to power system neutral. Size main grounding electrode conductors as indicated on Drawings, minimum 4/0 AWG green-insulated copper conductor with Class-B stranding where not otherwise indicated. Provide larger conductors where indicated on Drawings. Place PVC sleeves through foundation and structure. Provide a minimum of 12 feet of excess pigtail above the building foundation or structural mat, as finally installed. Coil and support main grounding electrode conductor pigtails above finished level of mat or foundation during concrete pour to prevent excess conductor from being embedded or cemented in concrete. Connect grounding electrode conductors to main ground bus-bar at main electrical room. Connect power system neutral to main ground bus-bar at main electrical room. Provide test well for main grounding electrode conductor at each connection to ground rod, with reversible compression-type clamp.

G. 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 unsplited 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.

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.

3.04 SUPPLEMENTAL GROUND

A. Supplementary Grounding Electrode: Where indicated on Drawings, provide supplementary grounding electrodes (ground rods) and bond to equipment grounding conductors per NEC-250. Where larger bonding jumpers and/or conductors are indicated on Drawings, provide the size shown.

3.05 EQUIPMENT GROUND

A. Electrical Rooms: Provide a ground bus in electrical rooms, and at other locations indicated on Drawings.

1. Mount busbar 8 feet above finished floor and a minimum of 1 inch from wall.

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 noncurrent-carrying metallic parts of electrical equipment and enclosures in the room, to the ground bus.

4. Bond grounding conductors to the bus as further indicated on Drawings.

3.06 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.
B. 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.

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

D. Manholes: Unless indicated otherwise on Drawings, provide a No. 1/0 AWG bare stranded copper ground bus in manholes. Mount bus 12 inches above floor using one-hole pipe straps 3'-0" on center. Connect bus to ground rod with a No. 1/0 AWG conductor. Bond metallic components and electrical grounding conductors to the bus using lugs or clamps.

E. Underground Duct Bank: Provide bare copper grounding conductor embedded in concrete of underground duct bank for communications, utility and power systems. Bond conductor to ground lug or ground bus at each end of duct bank and within manholes.

3.07 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.

C. 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.

D. Resistance shall not exceed 5 ohm.

E. 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.

F. Test isolated power systems per NFPA 99.

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

3.08 CONFLICTS

A. In the event a conflict exists between this specification and the referenced standards, most restrictive is to be followed. Identify any necessary variances required to be made in order to obtain a UL Master label for the lightning protection system.

END OF SECTION
SECTION 26 05 29 – SECURING AND SUPPORTING METHODS

PART 1 - GENERAL

1.01 WORK INCLUDED
   A. Raceway, cable tray, and equipment supports
   B. Fastening hardware
   C. Coordinate location of concrete equipment pads

1.02 QUALITY ASSURANCE
   A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry. Support systems shall be sized adequately to support an additional 25% for future loads.

1.03 COORDINATION
   A. Coordinate with other trades where conduit and cable tray supports are in the same location as piping, ductwork, and work of other trades and where supports are furnished and installed under other Divisions. Supporting from the work or supports of other Contractors shall not be allowed except by express, written permission of the Owner.

1.04 SUBMITTALS
   A. Provide submittals in accordance with Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

PART 2 - PRODUCTS

2.01 MATERIAL
   A. Support Channel:
      1. All non-corrosive locations: Hot-dip galvanized steel.
      2. Corrosive locations: Nonmetallic fiberglass.
   B. Hardware:
      1. All non-corrosive locations: Hot-dip galvanized steel.
      2. Corrosive locations: Stainless steel threaded rod, attachments and fasteners shall be used with fiberglass supports.
   C. Threaded Rod: used for rack support from structure above; 3/8-inch minimum diameter.

PART 3 - EXECUTION

3.01 INSTALLATION
   A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using precast insert system, expansion anchors, or beam clamps. Do not use spring steel clips and clamps. Provide necessary calculations to select proper support materials for electrical equipment, raceway, and cable tray supports. Provide cable tray supports for cable tray filled to 125 percent capacity per NEC.
   B. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer’s written instructions and with recognized industry practices to insure supporting devices comply
with requirements. Comply with requirements of NEC for installation of supporting devices. Install supports with spacing in compliance with NEC requirements.

C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors in solid masonry walls; or concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

D. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.

E. Do not use powder actuated anchors without written permission from the Engineer.

F. Do not drill structural steel members without written permission from the Structural Engineer.

G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

H. Bridge studs top and bottom with channels to support recessed mounted cabinets and panelboards in stud walls.

I. Install surface mounted cabinets and panelboards with a minimum of four anchors. Provide strut channel supports to stand cabinet 1-5/8 inches off wall. Utilize “Post Bases” where support channel is attached to structural floor.

J. Provide extra care in supporting PVC conduit to protect it from potential damage.

K. Use fiberglass for nonmetallic raceway systems supports in areas subject to corrosives.

L. All supports in contact with floor using stanchion type support shall be solidly bolted to the permanent structural floor.

M. Conduit supports shall have at a minimum, the bottom support member constructed of double strut. This horizontal member shall be double-nutted, and the supporting all-thread rod shall be trimmed to one inch below lowest nut.

N. Conduit entering/exiting cable tray shall be attached to the tray rail by means of support channel bolted to the rail and standard manufacturer's accessories. Conduit shall only enter/exit tray horizontally supported within three feet of the tray, and extended into the tray two inches. Conduit shall be terminated with a grounding bushing, and bonded to the tray ground wire. (The attachment to the tray shall not be considered a support.)

O. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

P. Install freestanding electrical equipment on 4-inch concrete pads. Pad shall be a minimum four inches larger than equipment. No crevices shall be left around the pads. Equipment includes but not limited to the following:

1. Motor Control Centers
2. Floor mounted VFDs
3. Floor mounted transformers
4. Switchboards
5. Automatic Transfer Switches, where floor mounted
6. Metal enclosed switchgear

3.02 TOUCH-UP

A. Touch-up all scratches on securing and supporting system, and paint the ends of channel after cutting with an approved zinc chromate or 90 percent zinc paint.

END OF SECTION
SECTION 26 05 33 – RACEWAYS, CONDUITS AND BOXES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Raceways:
   1. Surface metal raceways.
   2. Multi-outlet assemblies.
   3. Wireways.
   4. Indoor service poles.

B. Conduit:
   1. Rigid metal conduit and fittings. (RGS)
   2. Intermediate metal conduit and fittings. (IMC)
   3. Electrical metallic tubing and fittings. (EMT)
   4. Flexible metal conduit and fittings.
   5. Liquid-tight flexible metal conduit and fittings.
   6. Non-metallic conduit and fittings. (underground use only)
   7. PVC coated rigid steel conduit.

C. Boxes:
   1. Wall and ceiling outlet boxes.
   2. Pull and junction boxes.

D. Electrical/control portion of HVAC work covered by Division 23 pertaining raceway, conduit and boxes shall follow the requirement set forth by this specification.

1.2 REFERENCES

A. NFPA 70 – National Electrical Code
B. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
C. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated
D. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies
E. EMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing
F. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
H. ANSI/NEMA TC 2 – Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
I. ANSI/UL 1 – Flexible Metal Conduit
J. ANSI/UL 5 – Surface Metal Raceways and Fittings
K. ANSI/UL 360 – Liquid-tight Flexible Steel Conduit
L. ANSI/UL 467 – Electrical Grounding and Bonding Equipment
M. ANSI/UL 651 – Schedule 40 and 80 Rigid PVC Conduit (underground use only)
N. ANSI/UL 797 – Electrical Metal Tubing
O. ANSI/UL 870 – Wireways, Auxiliary Gutters and Fittings
P. NEMA RN 1 – Polyvinyl Chloride (PVC) Externally Coated galvanized Rigid Steel Conduit and Intermediate Metal Conduit
Q. UL 6 – Rigid Metal Conduit
R. ANSI/UL 5C – Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits

1.3 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Section 013100, Submittal Procedures.
B. Provide product data cutsheets and catalog information consisting of a complete list of equipment and materials, which will be used for the project, including manufacturer's descriptive and technical literature, catalog cuts and installation instructions.
C. 2D Shop drawings indicating:
   1. 2D Scaled floorplan drawings indicating routing, quantity, size and bottom of conduit/conduit support and pull boxes.
D. Sealing/fire stopping materials and details.
E. Surface Mounted Raceways
   1. Product data
   2. Scaled shop drawings indicating:
      a. Wiring and connectivity of devices in raceway system
      b. Wire fill of prewired or maximum wire fill of system wired in field.
      c. Rough in requirements including quantity and locations of field connections
      d. Manufacturer installation details and requirements

1.4 STORAGE AND HANDLING

A. Handle materials carefully to avoid damage, breaking, denting and scoring. Damaged equipment or materials shall not be installed.
B. Store materials in a clean dry space and protected from the weather.

PART 2 - PRODUCTS

2.1 SURFACE METAL RACEWAY
A. Surface metal raceway shall be factory pre-assembled galvanized steel complete including bases, removable covers, receptacles, end plates, elbows, connectors and fittings, to exact length to match the length of the cabinets, casework, utility chases, and shelving as indicated on laboratory and furniture shop drawings, and work bench details, as applicable.

B. Size shall be as shown on the Drawings. The length shown on electrical drawings is diagrammatic only and is not accurate for fabrication of raceway Sections. Refer to shop drawings, architectural plans, elevations, and details.

C. Finish shall be ANSI-61 gray enamel.

D. Covers shall be field removable by use of a standard screwdriver, without marring the extrusion or cover finish. Raceway with two covers must allow each cover to be removed separately without access into the compartment(s) enclosed by the other cover.

E. Provide a permanent, integral, grounded metallic dividing barrier to isolate the wiring compartments in the multi-outlet raceway system per drawing as applicable. Provide divider with fittings that maintain the separation of the raceway wiring compartments.

F. Provide device brackets for mounting standard single-gang or two-gang devices within the raceway system. Devices shall have the capacity of mounting flush or in conjunction with device faceplates.

G. Provide receptacles for the respective power systems as indicated on the drawings. Refer to Section 26 27 26 Wiring Devices for device specifications.

2.2 MULTI-OUTLET ASSEMBLY

A. Multi-outlet assembly shall be two-piece sheet metal channel with fitted, removable cover suitable for use as a multi-outlet assembly.

B. Size shall be as indicated on the Drawings.

C. Provide receptacles mounted as shown on Drawings.

D. Finish shall be ANSI-61 gray enamel.

E. Provide couplings, elbows, outlet and device boxes, and connectors designed for use with multi-outlet system.

2.3 WIREWAYS

A. Wireways shall be of steel construction general purpose for indoor spaces and rain tight for outdoor applications with knockouts.

B. Size shall be as indicated on Drawings.

C. Cover shall be hinged or screw applied as indicated on Drawings. Rain tight wireways shall be provided with full gasketing.

D. Fittings shall be so constructed to continue the "lay-in" feature through the entire installation.

E. Provide all sheet metal parts with a rust inhibiting phosphatizing primer coating and finished in gray enamel. All hardware shall be cadmium plated to prevent corrosion.

2.4 CONDUIT AND FITTINGS

A. Conduit and fittings for all electrical systems on this project shall include the following:
1. Service entrance
2. Electrical power and lighting feeders
3. Electrical power and lighting circuits
4. Telephone systems
5. Control systems (other than HVAC)
6. Fire alarm and signaling systems
7. CCTV rough-in system
8. Clock and bell system
9. Computer system rough-in
10. Sound system rough-in
11. Building Management System
12. Other electrical systems

B. For each electrical wireway system indicated, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, other components and accessories as needed to form a complete system of the same type indicated.

C. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, unless grounding bushings are required by N.E.C. Article 250. Grounding bushings shall have insulated throats.

D. Rigid and intermediate metal conduit shall be hot-dipped galvanized. Fittings shall be threaded type. Expansion fittings shall be OZ Type DX or equivalent.

E. Electrical metallic tubing shall be galvanized. Fittings shall be all steel compression type. Expansion fittings shall be OZ Type TX or equivalent.

F. Flexible metal conduit and fittings shall be zinc-coated steel

G. Liquid-tight flexible conduit and fittings shall consist of single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel with liquid-tight covering of flexible polyvinyl chloride (PVC). It shall be furnished with a sealing O-ring where entering an enclosure subject to moisture. Where O-Rings are used, ground type bushings shall be used in the box or enclosure.

H. Nonmetallic conduit and fittings shall be suitable for temperature rating of conductor but not less than 90°C. Nonmetallic conduit and fittings shall be molded of high impact PVC compound having noncombustible, nonmagnetic, non-corrosive and chemical resistant properties and shall be of the same manufacturer. Where located outdoors and above ground, the conduit and fittings shall be UV resistant. Solvent cement shall be of the same manufacturer as the conduit and shall be of the brush-on type. Spray solvents are prohibited. PVC coated metallic fittings shall not be permitted for PVC conduit connections.

I. Crimp or set-screw type fittings are not acceptable.
J. Minimum conduit size shall be 3/4 inch, except 1/2 inch flexible metallic conduit may be used as fixture whips.

K. PVC coated rigid steel conduit shall be externally coated with a 40 mil PVC coating and internal phenolic coating over a galvanized surface.

L. Rigid and IMC sealing fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.

2.5 WALL AND CEILING OUTLET BOXES

A. Galvanized steel interior outlet wiring boxes of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.

1. Outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

2. Provide multi-gang outlets of single box design. Sectional boxes are not acceptable. Provide outlet boxes of sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NEC, and not less than 1 1/2 inch deep unless shallower boxes are required by structural conditions and are approved by the A/E.

B. Provide deep type cast metal weatherproof exterior outlet wiring boxes of the type, shape and size, including depth of box, with threaded conduit ends, cast metal face plate with spring-hinged waterproof cap suitably configured for each application, including face plate gasket and fasteners. Provide PVC type outlet boxes only in corrosive areas rated as NEMA 13X.

C. Outlet boxes in poured concrete shall be plenum type without any holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.

D. Provide 4-inch octagonal ceiling outlet boxes.

2.6 PULL AND JUNCTION BOXES

A. Boxes shall be galvanized sheet metal conforming to ANSI/NEMA OS 1 with screw-on cover and welded seams, stainless steel nuts, bolts, screws and washers.

B. Boxes larger than 12 inches in any dimension shall be panelboard code gauze galvanized steel with hinged cover.

C. Boxes shall be sized in accordance with NEC.

D. Provide cast-in-place, pre-cast concrete or die-molded fiberglass handholes/pull boxes as per design for underground installations. Cast-in-place and pre-cast boxes shall be provided with reinforcing bars with material compressive strength no less than 11,000 psi, and shall be approved by Owner/Structural Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION - CONDUIT
A. Install products as indicated, in accordance with the applicable requirements of NEC, NEMA and the National Electrical Contractors Association's "Standard of Installation".

B. Cut conduit square using a saw or pipe cutter. De-burr cut ends. Joints in steel conduit must be painted with T&B Kopr shield and drawn up tight. Threads for rigid metal conduit and IMC shall be deep and clean. Running threads shall not be used. Wipe plastic conduit clean and dry before joining. Apply full, even coat of cement with brush to entire area that will be inserted into fitting. Let joint cure for 20 minutes minimum. Spray type of cement is not acceptable. Install raceway and conduit system from point of origin in outlets shown, complete with support assemblies including all necessary hangers, beam clamps, hanger rods, turnbuckles, bracing, rolls, clips angles, through bolts, brackets, saddles, nuts, bolts, washers, offsets, pull boxes, junction boxes and fittings to ensure a complete functional raceway system. Where vertical drops of conduit are made to equipment in open space, the vertical conduit shall be rigidly supported from racks supported on the floor.

C. Install rigid wall hot-dipped galvanized steel conduit or hot-dipped galvanized intermediate metal conduit for service entrance; feeders; wall or floor penetrations; mechanical rooms, electrical rooms and exposed locations where there is a high potential subject to physical damage; exposed outdoor locations; wet or damp locations; or any location as per design drawing. The following exceptions permitted:

1. EMT
   a. In sizes up to and including 2 inch, may be used inside dry locations where not subject to mechanical damage. EMT may be used in air-conditioned spaces, such as accessible ceilings, dry wall partitions and exposed where 6 feet above the floor. EMT may not be used outside, in concrete, underground, in under floor spaces, in masonry walls, in locations likely to be damp, in electrical rooms subject to mechanical damage due to future installation, or exposed within 6 feet of the floor. EMT shall not be used for medium voltage circuits.
   b. Where used for feeder circuits, lighting branch circuits, equipment branch circuits, receptacle branch circuits and motor branch circuits EMT shall also contain a NEC grounding conductor.
   c. All conduits shall be concealed in walls or ceilings unless otherwise noted.

2. Rigid Non-Metallic
   a. PVC shall only be used where shown on the drawings.
   b. Install PVC schedule 80 conduit where direct buried in earth.

3. Liquid-tight
   a. Install liquid-tight flexible metal conduit for connections to rotating, vibrating, moving or movable equipment, including dry-type transformers. Maximum length shall be 6 feet, minimum of 2 feet.
   b. Not permitted for use in plenum spaces unless UL listed for plenum use.

4. Flexible Metal Conduit
   a. Install standard flexible metal conduit (not liquid-tight), which shall be only used for lighting fixture whips or motor vibrations, with internal ground wire. Install flexible conduit connection such that vibrations are not transmitted to adjoining conduit or building structure. Maximum length shall be 6 feet minimum of 3 feet; minimum size shall be 3/4; and minimum size shall be ½ inch for lay-in light fixture whips.
D. Install conduits parallel and supported on Unistrut, or equal, trapezes and anchored with split ring hangers, conduit straps or other devices specifically designed for the purpose. No raceways or boxes shall be supported using wire. Arrange conduit to maintain headroom and present a neat appearance. Conduit routes shall follow the contour of the surface it is routed on. Route exposed conduit and tray above accessible ceilings parallel and perpendicular to walls and adjacent piping. Maintain 12-inch clearance between conduit and heat sources, such as flues, steam pipes, and heating appliances. Wire ties or “wrap lock” are not permitted to support or secure conduit system. Fasten conduit with the following material:

1. Wood screws on wood
2. Toggle bolts on hollow masonry
3. Bolts and expansion anchors in concrete or brick
4. Machine screws, threaded rods and clamps on steel
5. Conduit clips on steel joists.
6. 4 inch x 4 inch penta-treated pine installed in pitch pans on roof, spaced at intervals not to exceed 5 feet.

E. Fittings shall be approved for grounding purposes or shall be jumpered with a copper grounding conductors of appropriate ampacity. Leave termination of such jumpers exposed.

F. Install expansion fittings in metal and PVC conduit as follows:

1. Conduit Crossing Building Expansion Joints:
   a. EMT all sizes
   b. IMC all sizes
   c. RMC all sizes
   d. PVC all sizes
2. Conduits entering environmental rooms and other locations subject to thermal expansion are to be installed as required by NEC.
3. Unless expansion fitting has an integral bonding braid, as in Crouse-Hinds Type XC, a green insulated grounding conductor shall be pulled in the conduit. Both ends of this green grounding conductors shall be accessible for inspection.

G. Install conduit concealed in walls, partitions and above ceilings. Install conduit exposed in ceiling area (at structure) of boiler rooms, mechanical rooms and in other similar rooms where ceilings are not called for.

H. Install conduit type as shown on plans, concealed in slab when finished areas below do not have ceiling, or where shown on plans. A written approval shall be obtained from Owner/Structural Engineer prior to construction for all such installations. Conduits embedded in structural slabs shall be installed in the middle of the slab below the top and above the bottom reinforcing steel. Maintain a minimum concrete coverage of one inch (1”) except where penetration is made. Conduit shall emerge from slab vertically, with no bend radius unless concealed in walls.

I. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.
J. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture if cable or wire are not installed immediate after conduit run. Tape covering conduit ends is not acceptable.

K. Provide 200 lb. nylon cord full length in empty conduit.

L. Where conduit penetrates fire-rated walls and floors, provide pipe sleeve two sizes larger than conduit; pack void around conduit with oakum and fill ends of sleeve with fire-resistive compound or provide mechanical fire-stop fittings with UL listed fire-rating or seal opening around conduit with UL listed foamed silicone elastomer compound equal to fire-rating of floor or wall.

M. Install no more than the equivalent of three 90-degree bends between boxes. Where four 90 degree bends are required, prior approval by the Engineer is required. Use conduit bodies to make sharp changes in direction, as around beams. Conduit bodies shall be readily accessible and sized for the cables installed. Running or rolling offsets are not approved. Use factory long radius elbows for bends in conduit larger than 2-inch size. All parallel bends shall be concentric.

N. Pull string shall be provided full length in conduit designated for future use.

O. WET OR DAMP LOCATIONS
   1. Unless otherwise shown, use conduits of rigid steel.
      a. Use galvanized rigid steel or intermediate metal conduit to run all electrical raceway systems where exposed to weather; in damp or wet locations; where subject to physical damage; and where cast in concrete walls or floor slabs which have waterproof membranes and where cast in masonry walls. Use threaded type couplings and fittings. Split type couplings and fittings are not acceptable.
   2. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, building exterior walls, roofs, or similar spaces; service entrance locations from exterior below grade applications to conditioned spaces.

P. HAZARDOUS LOCATIONS
   1. Use rigid steel conduit only, notwithstanding requirements otherwise specified in this or other sections of these specifications.
   2. Install UL approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

3.2 INSTALLATION - SURFACE METAL RACEWAY AND MULTI-OUTLET
   A. Use flathead screws to fasten channel to surfaces. Mount plumb and level.
   B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings on multi-outlet assembly.
   C. Maintain grounding continuity between raceway components to provide a continuous grounding path in accordance with the requirement of NEC.

3.3 INSTALLATION - WIREWAYS
   A. Bolt wireways to steel channels fastened to the wall or in self-supporting structure. Install level.
   B. Gasket each joint in oil-tight wireway.
C. Mount rain tight wireway for exterior installation in horizontal position only.

3.4 INSTALLATION - BOXES

A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.

C. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of outlets prior to rough-in.

D. Locate and install boxes to allow access, minimum 12 inches above ceiling except where space dimensions do not allow.

E. Do not install boxes back-to-back in walls. Provide minimum 6-inch separation. Provide minimum 24-inch separation in acoustic-rated walls. If boxes are connected together, install flexible connection between the two and pack openings with fiberglass.

F. Secure boxes rigidly to the substrate upon which they are being mounted, or solidly imbed boxes in concrete or masonry. Do not support junction boxes from the raceway systems. Boxes shall not be permitted to move laterally. Boxes shall be secured between two studs. Boxes connected to one stud are not permitted.

G. Provide knockout plugs for unused openings.

H. Use multiple-gang boxes where more than one device is mounted together. Do not use sectional boxes. Provide listed barriers to separate wiring of different voltage systems.

I. Install boxes in walls without damaging wall insulation.

J. Outlet boxes in plaster partitions shall be "shallow-type" set flush in wall so there is at least 5/8 inch plaster covering back of box.

K. Outlet boxes for switch shall not be used as junction boxes.

L. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.

M. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

N. Outlet boxes supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures, not from acoustic ceilings. Lighting fixture outlets shall be coordinated with mechanical and architectural equipment and elements to eliminate conflicts and provide a workable neat installation.

O. Set floor boxes level and flush with finish flooring material.

P. Prove tamper resistance receptacles in child care areas, psychiatric, medical facilities and elsewhere as required by NFPA standards or as indicated on the drawings.

3.5 WALL AND FLOOR PENETRATIONS:
A. Core drilling shall be approved in writing by the Structural Engineer prior to execution. Avoid anchor bolt on structural column by installing “column hugging” type of support channel for electrical installation. PVC shall not be used for wall and floor penetration.

B. Wall penetrations for cable tray or under floor raceway shall be sealed in accordance with the appropriate Fire-Stopping and Joint Sealers Specification Section.

C. Provide a 3 1/2 inch curb around block outs through concrete floors. Fire-stop per Architectural specification.

D. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket. Coordinate roof penetration locations and methods with the roofing contractor.

END OF SECTION
SECTION 26 05 53 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED
   A. Nameplates, engraving and tape labels
   B. Wire and cable markers or color coding
   C. Conduit color coding and labeling

1.2 REFERENCES
   A. NFPA 70 – National Electrical Code

1.3 SUBMITTALS
   A. Provide submittals in accordance with and in addition to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirements.
      1. Furnish nameplate identification schedules listing equipment type and nameplate data with letter sizes and nameplate material.

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.
   B. Underground Warning Tape
      1. Manufactured polyethylene material and unaffected by acids and alkaline.
      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.
   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 wire or cables are not acceptable.

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

E. Tape Labels: Embossed or laminate 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. White letters on black background for normal power.
   2. White letters on red background for emergency/standby power.
   3. White letters on orange background for UPS power.

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

G. Spare Conduits Labels: Label spare conduits at both source and termination along with entry into every pull box/enclosure. Label conduit with black permanent marker with identifier “SPARE-XX-YY” Where XX represent the source equipment name or id and YY represents the termination location i.e. room number or equipment id.

PART 3 - EXECUTION

3.1 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 screws or rivets. Use of adhesives shall be per Owner’s approval. Secure nameplate to outside face of flush mounted panelboard doors in finished locations.

3.2 WIRE IDENTIFICATION

A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits. Label control wire with number as indicated on schematic and interconnection diagrams or equipment manufacturer’s shop drawings for control wiring.

B. Conductors for power circuits to be identified per the following schedule.

C. [NOTE TO SPEC WRITER: EDIT THE FOLLOWING DESCRIPTIVE SPECIFICATIONS FOR ANY CONFLICTS WITH THE EXISTING COLOR CODING OR CAMPUS STANDARD.]

<table>
<thead>
<tr>
<th>System Voltage</th>
<th>480/277V</th>
<th>208/120V</th>
<th>240/120V High Leg</th>
<th>Medium Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A</td>
<td>Brown</td>
<td>Black</td>
<td>Black</td>
<td>One White Band</td>
</tr>
<tr>
<td>Phase B</td>
<td>Purple</td>
<td>Red</td>
<td>Orange</td>
<td>Two White Bands</td>
</tr>
<tr>
<td>Phase C</td>
<td>Yellow</td>
<td>Blue</td>
<td>Blue</td>
<td>Three White Bands</td>
</tr>
<tr>
<td>Neutral</td>
<td>Gray</td>
<td>White</td>
<td>White</td>
<td>N/A</td>
</tr>
<tr>
<td>Grounding IG</td>
<td>Green</td>
<td>Green w/Yellow</td>
<td>Green w/Yellow</td>
<td>Green</td>
</tr>
</tbody>
</table>
3.3 NAMEPLATE ENGRAVING SCHEDULE

A. Provide nameplates of minimum letter height as scheduled below. Nameplates shall be same as equipment names indicated on the Drawings.

B. 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.

C. 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.

D. Automatic Transfer Switches: 3/8-inch; white letters and red background; identify equipment designation 1/4-inch; identify voltage rating, normal source, standby source and load served including location.

E. Panelboards: 3/8-inch; identify equipment designation. 1/4 -inch; identify source, voltage and bus rating.

3.4 ENCLOSURE COLOR CODING

A. 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>Ethernet Backbone</td>
<td>Blue</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>Brown</td>
</tr>
<tr>
<td>FCMS</td>
<td>Green</td>
</tr>
<tr>
<td>Emergency Power</td>
<td>Red</td>
</tr>
<tr>
<td>Security**</td>
<td>White</td>
</tr>
<tr>
<td>Fire Alarm</td>
<td>Yellow</td>
</tr>
<tr>
<td>Clock</td>
<td>Fluorescent Violet</td>
</tr>
<tr>
<td>U.P.S.</td>
<td>Fluorescent Pink</td>
</tr>
</tbody>
</table>

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

END OF SECTION 26 05 19
SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE AND ARC FLASH STUDY

PART 1   GENERAL

1.01 SUMMARY

A. Provide a complete short-circuit and protective device coordination study for the normal and emergency/standby power electrical distribution systems.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the latest edition of NFPA 70E - Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in the latest edition of NFPA70E, Annex D. The arc flash study shall encompass all normal and emergency/standby power electrical distribution systems with the exception, of any equipment as described in paragraph 2.04C.

1.02 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 as 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. Details of the incident energy and flash protection boundary calculations.
   7. Recommendations for system improvements, where needed.
   8. One-line diagram.

C. Arc flash labels shall be provided for all equipment described in paragraph 2.04.

1.03 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.

C. The National Fire Protection Association (NFPA)
   1. NFPA 70 - National Electrical Code.

1.04 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis 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.

1.05 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be performed using the latest revision of EDSA, SKM Systems Analysis Power Tools or ETAP, unless approved otherwise.

PART 2 PRODUCTS

2.01 DATA COLLECTION

A. The Contractor shall be responsible for collecting all data for the studies as directed by the Engineer of Record.

2.02 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. 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.

B. 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.

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

2.03 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.

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 and above) 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 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.

D. EMERGENCY ELECTRICAL SYSTEM:
   1. The emergency distribution system shall be fully selectively coordinated. System will be coordinated from main service entrance through the largest branch circuit device. Selective coordination must be provided for the system throughout the entirety of both the normal and emergency branches.

2.04 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584-2002 equations that are presented in NFPA 70E, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all added electrical equipment.

D. Minimum working distances shall be based upon the calculated arc flash boundary considering incident energy of 1.2 cal/cm2.

E. The results of the short circuit calculations (fault values) and protective device coordination study (device clearing times) shall be utilized for use by the arc flash program. Ground
overcurrent relays should not be taken into consideration when determining the clearing
time when performing incident energy calculations

F. The short-circuit calculations and the corresponding incident energy calculations for
multiple system scenarios must be compared and the greatest incident energy must be
uniquely reported for each equipment location. Calculations must be performed to
represent the maximum and minimum contributions of fault current magnitude for all normal
and emergency operating conditions. The minimum calculation will assume that the utility
contribution is at a minimum and will assume a minimum motor contribution (all motors off).
Conversely, the maximum calculation will assume a maximum contribution from the utility
and will assume the maximum amount of motors to be operating.

G. The incident energy calculations must consider the accumulation of energy over time when
performing arc flash calculations on buses with multiple sources. Iterative calculations must
take into account the changing current contributions, as the sources are interrupted or
decremented with time. Fault contribution from motors and generators should be
decremented as follows:
1. Fault contribution from induction motors should not be considered beyond 5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to
match the actual decrement of each as closely as possible.

H. For all equipment locations with a separately enclosed main device (where there is
adequate separation between the line side terminals of the main protective device and the
work location), calculations for incident energy and flash protection boundary shall include
both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as
required per above), the line side and load side contributions must be included in the fault
calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the
immediate protective device upstream of the calculation location and the calculation should
utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on the actual overcurrent protective device clearing
time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002
section B.1.2. Where it is not physically possible to move outside of the flash protection
boundary in less than 2 seconds during an arc flash event, a maximum clearing time based
on the specific location shall be utilized.

2.05 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 and 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.

D. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc flash boundary.
5. Working distance.
6. Incident energy.
8. Recommendations for arc flash energy reduction.
PART 3 EXECUTION

3.01 FIELD ADJUSTMENT

A. Submit report to engineer for review. Based upon the Engineer and Utility Provider’s review, incorporate comments and required adjustments into final round of adjustments at all devices.

B. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by, or under the direction of the engineering service division of the equipment manufacturer.

C. Making minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies to be coordinated with Engineer of Record and equipment manufacturer.

3.02 ARC FLASH WARNING LABELS

A. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:
   1. Location designation.
   2. Nominal voltage.
   3. Flash protection boundary.
   5. Incident energy.
   7. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.

E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings. See page 6 for example of arc flash label.
   1. For each 480V and 208V panelboard, one arc flash label shall be provided.
   2. For each motor control center, one arc flash label shall be provided for each section.
   3. For each low voltage switchboard, one arc flash label shall be provided for each section.
   4. For each low and medium voltage switchgear, one flash label shall be provided for each breaker.
   5. For medium voltage switches one arc flash label shall be provided

F. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.03 ARC FLASH TRAINING

A. The contractor of the Arc Flash Hazard Analysis shall train the owner’s qualified electrical personnel of the potential arc flash hazards associated with working on energized
equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent.

## DANGER

Bus Electrical Shock and Arc Flash Hazard

### Appropriate PPE Required

<table>
<thead>
<tr>
<th>Danger</th>
<th>Max PPE Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>360.6</td>
<td>Cal/cm^2 Flash Hazard at 17.9 inches</td>
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<tr>
<td>52.4</td>
<td>kA Bolted Fault Current</td>
</tr>
<tr>
<td>863.8</td>
<td>inches Flash Hazard Boundary</td>
</tr>
</tbody>
</table>

| 00       | Glove Class ✓                  |
| ✓        | Suit Hood ✓                    |
| ✓        | Non-melting Flame Resistant Hair/Beard Nets |

- **Required ✓**
- **Not Required ∅**
- **Not Allowed X**

Arc Flash boundary at energy < 1.2 cal/cm^2

480.0 Volts Shock Hazard when cover is removed

Shock Distances (inches) - Limited = 120.0, Restricted = 12.0, Prohibited = 1.0

Thu Jul 07 11:22:25 2011  Equipment Name: MAIN SWGR1

END OF SECTION
SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes commissioning process requirements for Electrical systems, assemblies, and equipment.

B. This project will have selected building systems commissioned. The equipment and systems to be commissioned are specified in “SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS”.

1.2 RELATED SECTIONS

A. SECTION 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

B. SECTION 22 08 00 – COMMISSIONING OF PLUMBING SYSTEMS

C. SECTION 23 08 00 – COMMISSIONING OF HVAC SYSTEMS

D. SECTION 28 08 00 – COMMISSIONING OF FIRE ALARM SYSTEMS

1.3 DEFINITIONS

A. Refer to section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

1.4 SUBMITTALS

A. Certificate Of Readiness, signed by the Contractor, certifying that systems, assemblies, equipment, components, and associated controls are ready for testing.

B. Manufacturer’s completed start-up reports for equipment and systems.

1.5 CONTRACTOR’S RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for details of Electrical contractor’s responsibilities related to commissioning.

B. Attend commissioning meetings.

C. Provide information requested by the CxA for functional testing and for final commissioning documentation.

D. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
E. Functional testing of systems will be carried out solely by Electrical contractor’s personnel, under the direction of CxA. Provide experienced personnel, familiar with the systems being installed under this project.

1.6 CxA’S RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS.

B. CxA will direct commissioning testing.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in Division 26 Sections. Provide submittals, test data, inspector record, and certification to the CxA.

B. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Electrical systems.

C. Perform commissioning tests at the direction of the CxA.

D. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

E. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

F. Tests will be performed using design conditions whenever possible.

3.2 SYSTEM START-UP

A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies, and has so certified.

3.3 TESTING PREPARATION

A. Certify that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that Electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
C. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

D. Inspect and verify the position of each device and interlock identified on checklists.

E. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.

### 3.4 FUNCTIONAL TESTING

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of commissioning of Electrical systems.

B. Provide measuring instruments and logging devices to record test data as directed by the CxA.

### 3.5 DEFERRED TESTING

A. Initial commissioning will be done as soon as contract work is completed, though building may not be at full occupancy and equipment may not be at full loading.

B. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods. If testing cannot be carried out under these conditions to adequately verify system performance, testing will be deferred until such time as conditions are more satisfactory.

1. Contractor is to provide services of personnel and participate in deferred or seasonal testing process in the same manner as he would in non-seasonal testing.
2. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

### 3.6 RE-TESTING

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for detailed requirements of re-testing of Electrical systems.

### 3.7 SYSTEMS TO BE COMMISSIONED

A. Reference Project Specification Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS for list of Electrical systems to be commissioned.

**END OF SECTION**
SECTION 26 24 16 – PANELBOARDS – DISTRIBUTION AND BRANCH CIRCUIT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. This Section specifies the requirements for all panelboards including electronic grade panelboards.

1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. NEMA AB 1 – Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.

2. NEMA AB 3 – Molded Case Circuit Breaker and Their Application

3. NEMA PB 1 - Panelboards.

4. NEMA PB 1.1 – General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.


6. W-C-375B – Circuit Breakers, Molded Case; Branch Circuit and Service.


8. Underwriters Laboratories UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.

9. UL 67 – Panelboards.


1.04 SUBMITTALS

A. Product Data:
1. Submit manufacturer’s product data for panelboards and circuit breakers including but not limited to:
   1) Lug types
   2) Wire range for submitted lugs
   3) Accessories

B. Record Documents:
   1. Submit dimensioned Drawings showing size, circuit breaker and equipment arrangement and ratings, including but not limited to, voltage, single or three phase, main bus ampacity, circuit breaker short circuit ampere rating, trip type, cable entry arrangement (top or bottom), neutral bus rating, temperature rating of circuit breakers.
   2. Equipment arrangement must include panelboard schedules. Panelboard schedules must be identical to the schedules in the project documents unless there is a technical reason for a deviation. Reasons for any deviation shall be included in the Submittal.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver panelboards in factory-fabricated water-resistant wrapping.

B. Handle panelboards carefully to avoid damage to material components, enclosure and finish.

C. Store in a clean, dry space and protected from the weather.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Square D Company

B. Cutler Hammer/Eaton

C. General Electric Company

D. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in 26 00 00, and Division 01 for substitution requirement.

2.02 PANELBOARD CONSTRUCTION

A. General: Provide flush or surface mounted, or surface mounted dead front circuit breaker type distribution or branch circuit panelboards with electrical ratings and configurations, as indicated on the drawings and schedules. Load center types of panelboards are not acceptable.

B. Enclosure:
   1. Enclosure shall be proper NEMA type as shown on the drawings.
   2. NEMA 1
      a. Back box shall be galvanized steel for flush mounted branch circuit panelboards. Back box shall have gray enamel electro-deposited finish over cleaned phosphatized steel for all other type panelboards.
b. Provide cabinet front with full-height hinged door. Cabinet front shall be cleaned and finished with ANSI 49 or ANSI 61 gray enamel over a rust-inhibiting phosphatized coating. One door over the interior and an additional hinged dead front cover over interior and wireway (door-in-door). Full-height front cover hinged to box with concealed trim clamps. Provide flush door locks.

C. Where power monitors or metering are specified on the Drawings, the manufacturer shall cut the doors for field mounting of the unit.

D. NEMA 3R, 3S and 12 enclosures and doors shall have gray enamel electro-deposited finish over cleaned phosphatized steel.
   1. Doors shall be gasketed and equipped with tumbler type vault lock and two trunk latches where required by UL standard. Interior trim shall consist of four pieces, each covering one gutter top, bottom and both sides.

E. Doors shall be gasketed and equipped with tumbler type vault lock and two trunk latches where required by UL standard. Interior trim shall consist of four pieces, each covering one gutter top, bottom and both sides.

F. Construct cabinet in accordance with UL 50. Use not less than 16-guage galvanized sheet steel, with all cut edge galvanized. Provide a minimum 4-inch gutter wiring space on each side. Provide large gutter where required to accommodate the size and quantity of conductors to be terminated in the panel, and where required by code.
   1. Exterior and interior steel surfaces shall be cleaned and finished with gray enamel over rust inhibiting phosphatized coating. Color shall be ANSI 61 gray.
   2. Doors shall be equipped with flush-type combination catch and key lock. All locks shall be keyed alike.
   3. Branch circuit panelboards shall be 5 ¾ inches deep.
   4. A directory holder with heavy plastic plate, metal frame, and index card shall be mounted inside of each door.
   5. Reinforce enclosure and securely support bus bars and overcurrent devices to prevent vibration and breakage in handling.
   6. Rating: Minimum integrated short-circuit rating, voltage and current rating as shown on drawings.
   7. Labeling:
      A. The Contractor shall furnish and install engraved, laminated plastic nameplates on the trim per Section 26 05 53., ELECTRICAL IDENTIFICATION
      b. Provide arc flash labeling per NFPA 70E and Section 26 05 73.

G. Bus:
   1. Provide panelboards with rounded edge phase, neutral and ground buses, rated full capacity as scheduled on drawings. Buses shall be full-length copper and braced for the maximum available fault current as shown on drawings. Neutral bus shall be 200% rated for those panels feeding non-linear loads as determined by the Engineer of Record.
   2. Phase bussing shall be stacked front-to-back, A-B-C.
H. The neutral and ground bus bars shall have termination locations for each of the individual feeders and the lugs sized appropriately. In addition, space shall be provided to terminate the neutrals and grounds in two feeders equal to the largest size circuit breaker that can be installed in the panelboard.

I. The ground bus shall be mounted in the panelboard, opposite the incoming line and neutral lugs and shall be accessible to allow easy installation of bolts, nuts and lock washers used to attach ground lugs. The neutral and ground buses in branch circuit panelboards shall have spaces to terminate 42 neutral and 42 ground wires or the same number as the number of spaces provided in the panelboard, whichever is greater.

J. Where isolated ground buses are specified or indicated, provide copper grounding bus bars mounted in the panelboard on insulated standoffs to ensure isolation from equipment ground potential. Isolated ground buses shall be drilled and tapped as appropriate for connection of the individual isolated grounding conductors.

K. All lugs for phase, neutral, and ground buses shall be tin-plated copper.

L. Lugs shall be rated for CU.

M. Panelboard shall be rated SE where required for Service Entrance duty.

N. Panelboard boxes (cans) shall be galvanized steel with all cut edges galvanized.

O. Provide panelboards with factory installed knockouts.

A. Provide compression connectors where conductors terminate directly to bus. (MLO panels).

2.03 SWITCHING AND OVERCURRENT PROTECTIVE DEVICES

A. Provide molded case circuit breakers with manufacturer's standard construction, bolt on type, with integral inverse time delay thermal and instantaneous magnetic trip in each pole. Circuit breakers shall be constructed using glass reinforced polyester insulating material providing superior dielectric strength. Provide circuit breakers UL listed as Type HACR for air-conditioning equipment branch circuits.

B. Circuit breakers shall have an over center, trip-free, toggle operating mechanism that will provide a quick-make, quick-break contact action.

C. Provide handle padlock attachments on circuit breakers where indicated on drawings. Device shall be capable of accepting a single padlock. All circuit breakers shall be capable of being individually padlocked in the off position.

D. The circuit breakers shall be connected to the bus by means of solidly bolted connection. In multi-pole breakers, the phase connections on the bussing shall be made simultaneously without additional connectors or jumpers. Multi-pole breakers shall be two or three pole as specified. Handle ties are not permitted. The circuit breaker shall have common tripping for all poles.

E. All circuit breakers shall be provided with visible ON and OFF indications.

F. Provide GFCI and AFCI circuit breakers as indicated on drawing and per NEC requirement.

G. Heat Maintenance. Circuit breakers serving heat maintenance system for plumbing hot water piping, fire protection, or similar systems shall be single-pole or 2-pole as indicated on drawings, GFCI-type with ground fault trip for protection of equipment.
H. Provide handle ties as required to comply with NEC requirement for common disconnect of multi-wire branch circuits.

I. Breaker voltage and trip rating shall be per drawings. Breaker faceplate shall indicate UL certificate standards with applicable voltage systems and corresponding short current rating as per drawings.

J. Molded Case Circuit Breakers:
   1. Breakers 400 ampere frame and less shall be manufacturer’s standard industrial construction, bolt-on type, integral inverse time delay thermal and instantaneous magnetic trip. Breakers 225 ampere through 400 ampere shall have continuously adjustable magnetic pick-ups of approximately five to ten times trip rating.
   2. Breakers 600 ampere frame and above shall be equipped with solid-state trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip.

K. Current Limiting Molded Case Circuit Breakers:
   1. Breakers 100 ampere frame shall be inverse time delay thermal and instantaneous magnetic trip.
   2. Breakers 250 ampere and 400 ampere frame shall be solid-state trip with built-in current transformers, solid-state trip unit and flux transfer shunt trip.
   3. Current limiting breakers shall protect downstream molded case breakers. Submit manufacturer's test data proving the protection, from both peak currents and I²T energy of downstream devices.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards in accordance with manufacturer’s written instructions and the applicable requirements of the NEC, NEMA, ANSI and the National Electrical Contractors Association’s "Standard of Installation".

B. Install panelboards flush- or surface-mounted, as indicated on drawings and schedules. Anchor enclosure firmly to cross members in walls and structural surfaces, ensuring that they are permanently and mechanically secured. Direct attachment to drywall is not permitted. Freestanding distribution panelboards shall be installed on metal racks structurally capable for the equipment or on a concrete housekeeping pad with anchors per manufacturer’s recommendation.

C. Mounting height:
   1. Distribution Panelboards: As per Drawings, but such that highest operating handle is no greater than 79 inches above finished floor.
   2. Branch Circuit Panelboards: As per Drawings, but such that highest operating handle is no greater than 79 inches above finished floor.
   3. Where panelboards occur in groups, the tops shall be aligned if it can be done without exceeding items 1 and 2 above.

D. Install panelboards plumb. Adjust trim to cover all openings. Seal all conduit openings and cap all open knockout holes.
E. Provide blank plates for unused open spaces in panelboards. Keep the front door closed after work to protect from damage, dirt, and debris at all times.

F. Install identification nameplates in accordance with Section 26 05 53, Electrical Identification.

G. In addition to conduits serving circuits indicated on plans and schedules, stub [3] [5] empty one-inch conduits out of each recessed panelboard to an accessible location above ceiling. Extend conduit stub a minimum of 8 inches into accessible location and cap to prevent trash from entering conduit.

3.02 FIELD QUALITY CONTROL

A. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers and lugs.

B. Provide testing and start-up as indicated in Section 26 08 00 – Commissioning of Electrical Systems.

3.03 PANELBOARD SCHEDULE

A. The Contractor shall provide engraved, laminated plastic nameplates for circuit identification as indicated on the Drawings for panelboards.

B. The Contractor shall fill the index directory inside the front door of branch circuit panelboards identifying each circuit as shown on Panel Schedule drawings. Where changes are made, the schedule shall reflect the changes. At the end of the job, these schedules shall reflect as-built record conditions.

C. Each panelboard schedule shall include the following information:

1. Panelboard No.: Panelboard identification name/number as assigned on drawings.

2. Room No.: Room number in which panelboard is located.

3. Served From: Number of transformer or distribution panel that feeds panelboard.

4. Date Published: Date panelboard information was published.

5. Circuit Number: Each circuit number identified.

6. Description: Identify circuits by equipment served and by room numbers, where room numbers exist. Indicate equipment name (e.g., printer, VAV box, security cameras) if applicable, or device type (e.g., Receptacle, I.G. Receptacle, Floor Box, Furniture, SPD). Circuits serving more than one room shall indicate only the room in which the homerun commences.

7. Indicate spares and spaces with light, erasable pencil marking.

D. Provide electronic copy to Owner’s representative of all panelboard schedules as part of the closeout documentation.

END OF SECTION 26 24 16
SECTION 26 27 26 – WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY
A. This Section specifies the requirements for wiring devices, including wall switches, receptacles, device plate covers, wall dimmers, and occupancy sensors.

1.3 REFERENCE STANDARDS
A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
   1. NEMA WD 1 - General-Purpose Wiring Devices.
   2. NEMA WD 2 - Semiconductor Dimmers for Incandescent Lamps.
   3. NEMA WD 5 - Specific-Purpose Wiring Devices.
   4. Americans with Disabilities Act (ADA).
   5. ANSI/UL 20 - General Use Snap Switches.
   6. ANSI/UL 498 - Attachment Plugs and Receptacles.
   7. ANSI/UL 943 - Ground Fault Circuit Interrupters.
   10. Americans with Disabilities Act (ADA).

1.4 SUBMITTALS
A. Product Data:
1. Submit manufacturer's product data for all wiring devices and device plates.

2. Occupancy Sensor Shop Drawings
   a. Shop drawings indicating occupancy sensor type, quantity, coverage, field of view and location and quantity of power packs. Shop drawings shall be provided on 1/8" scale drawing with device types clearly identified by use of a legend.
   b. Shop drawings shall clearly identify the locations and specification of any auxiliary contacts.
   c. Shop drawings shall include sequence of operations for all occupancy sensors types and installations.

3. Submit shop drawings on 1/8" scale drawings for the following systems:
   a. Surface mounted raceway systems as identified in the drawings.
   b. Poke-throughs and floor-boxes.
      1) Clearly indicate model number, finish and trim of floor-boxes and poke throughs.
      2) Poke throughs and floor-boxes shall be dimensioned for coordination of rough in.

PART 2 - PRODUCTS

2.1 GENERAL
   A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
   B. Provide factory fabricated wiring devices in the type and electrical rating for the service indicated. Where type and grade are not indicated provide proper selection to correspond with branch circuit wiring and overcurrent protection.
   C. Attachment of wires to devices shall be by screw pressure under the head of binding screws. Arrangements depending on spring pressure or tension are not acceptable. All binding screws shall be brass or bronze.

2.2 WALL SWITCHES
   A. Type: Specification grade, quiet type, back and side wired switches as specified herein. Switch terminal screws shall be designed to accommodate No. 10 AWG solid conductor.
   B. Rating: 20 amperes, 120/277 volts.
   D. Finished Areas. Wall switches shall be toggle-style switches. Select device plates of same color, and match with receptacle, phone and data outlet device plate style. Coordinate with Architect and Owner for room finish.
   E. Manufacturers: Provide devices in the color as specified herein.

<table>
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<th>Type</th>
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<th>Leviton</th>
<th>Hubbell</th>
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E&C Engineers & Consultants  26 27 26 - 2
E&C No. 3782.00
S2  PS20AC2  AH1222  1222-2  HBL1222
S3  PS20AC3  AH1223  1223-2  HBL1223
S4  PS20AC4  AH1224  1224-2  HBL1224

1. Provide color designation for designated use.

2. Pilot light type shall be equipped with red toggle handle (glow when on), 20 amperes and 120/277 volt AC with number of poles as required.

3. Key operated switches shall be 20 amperes and 120/277 volt AC with number of poles as required. Key locks alike. Furnish keys compatible with key switch, quantity as directed by Owner, minimum of ten copies.

4. Switches for lighting circuits and motor loads under 1/3 hp shall be AC general use snap switch with toggle handle, 20 amperes and 120/277 volt AC with number of poles as required.

5. A listed manual switch having a horsepower rating not less than the rating of the motor, a thermal overload element suitable for the motor served, and marked "Suitable as Motor Disconnect", shall be permitted to serve as the disconnect means for stationary motors of 1/4 horsepower or less.

6. Use horsepower rated switches, with thermal overload element, approved for motor control or disconnect service when controlling or disconnecting motor loads in excess of 1/4 hp. Horsepower rated switches shall be 30 ampere minimum, with number of poles as required.

7. EPO. Illuminated Emergency-Power-Off (EPO) switch shall be provided with button guard equal to Allen-Bradley #800T-QA10R or accepted substitution.

8. Switch terminal screws or connectors shall be designed to accommodate up to No. 10 AWG solid conductor.

2.3 RECEPTACLES

A. Commercial Grade devices shall be provided throughout unless otherwise identified on the drawings.

B. Rating: Scheduled on Drawings.


D. Provide devices in the color as specified herein.

<table>
<thead>
<tr>
<th>NEMA Configuration</th>
<th>Pass &amp; Seymour</th>
<th>Cooper</th>
<th>Leviton</th>
<th>Hubbell</th>
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<tr>
<td>5-20R (Duplex)</td>
<td>8300</td>
<td>8300</td>
<td>8300</td>
<td>HBL8300</td>
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<td>5-20R (Single)</td>
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<td>2095-HG</td>
<td>VGFH20_</td>
<td>N7899-HF</td>
<td>GFR8300H</td>
</tr>
</tbody>
</table>

1. Provide color designation for designated use.

E. Provide corrosion resistant devices where installed in wet locations and damp locations and other areas as required per NEC.

F. Heavy Duty Locking-Blade Receptacles. NEMA WD 5. Locking-blade receptacles shall be heavy duty specification grade.
G. Ground Fault Circuit Interrupter (GFCI). GFCI receptacles shall be rated 20 amperes, 125 volt with integral ground fault current interrupter.

1. End of Life. GFCI receptacles shall include End-of-Life protection, such that when the GFCI device is incapable of passing the internal self-test function, and can therefore no longer provide ground fault protection, the GFCI receptacle will either render itself incapable of delivering power, or indicate by visual or audible means that the device must be replaced.

2. Reverse Line-Load Mis-wire. GFCI receptacles shall include reverse line-line protection, such that the GFCI device will deny power to the receptacle face if it is mis-wired with the connections to the line and load terminals reversed.


4. Do not use feed through feature.

5. GFCI receptacles are required throughout the building within 6 feet of sinks, including lab areas.

6. Each GFCI device shall control only one receptacle.

7. Where receptacle is installed in damp or wet locations provide weather resistant type GFCI receptacles.

H. Specific-use receptacles shall have volts, amps, poles, and NEMA configuration as noted on Drawings.

I. Weatherproof Receptacles. Receptacles specified or indicated as "weatherproof" shall be mounted in a cast steel box with gasketed, weatherproof device plate as specified. Provide weatherproof, gasketed device covers suitable for continuous connection of cord-and-plug devices. See paragraph 2.5E, this Section.

2.4 DEVICE PLATES

A. Laboratories and Patient Care Areas: Use 302 stainless steel.

B. Coordinate final selection of devices connected to normal power with architect.

C. Exposed Boxes in Dry Interior Spaces:

1. Manufacture plates of heavy cadmium-plated sheet steel.

2. Edges of plates must be flush with edges of boxes.

D. Other Areas:

1. Use weatherproof device plates.

2. Provide cast plates with gasketed spring door covers for protection of device.

E. For outlets and switches, provide labeled nameplates listing power source and circuit number. Example: P10 for panel "P" circuit "10". Label to be tape type black letters on white for normal power and red on white for all generator/emergency circuits.

F. Covers for outlets outdoors shall be weatherproof while in use and meet the requirements of latest NEC.
2.5 DEVICE COLOR
A. All switches shall be white except as follows: Red switches shall be used on all equipment and circuits connected to emergency power.
B. Normal power receptacles shall be white and receptacles connected to the emergency electrical circuits shall be red.

PART 3 - EXECUTION
3.1 DELIVERY, STORAGE AND HANDLING
A. Deliver wiring devices individually wrapped in factory-fabricated containers.
B. Handle wiring devices carefully to avoid breaking, scoring, and damage to material components, enclosure and finish. Damaged products shall be rejected and not be installed on this project.
C. Store wiring devices in a clean, dry space, elevated above grade, and protected from weather, dirt, sunlight, and moisture.

3.2 INSPECTION
A. Examine the areas and conditions under which wiring devices are to be installed and notify the Owner and the Architect/Engineer in writing of conditions detrimental to the proper and timely completion of the work. Include a written plan for correction of deficiencies and conditions noted. Inspect devices for physical damage. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.3 DEVICE COORDINATION
A. Where items of equipment are provided under other Sections, by other Divisions, or by the Owner, provide a compatible receptacle and device plate for the cap or plug, and cord of the equipment.

3.4 GENERAL
A. Install wiring devices in accordance with applicable requirements of the NEC, NEMA, ANSI, and the product manufacturer recommendations.
B. Taps, Splices and Connections. Make grounding (earth) conductor approximately 2 inches longer than the ungrounded (phase) conductors at both ends. Refer to Section 26 05 26, Grounding and Bonding.
C. Termination. Stranded conductors for branch circuit wiring to snap switches and receptacles shall terminate at the wiring device with an insulated tin-plated copper spade compression terminal. Select a spade terminal compatible with the wiring devices supplied so that device screw terminals can be torqued to the wiring device manufacturer's recommendations. Refer to Section 26 05 19, Insulated Conductors.
D. Where more than one device occurs in one outlet box, such that the voltage between adjacent devices would exceed 300 volts, provide a barrier for isolation to comply with the requirements of NEC Article 404.8(B).
E. Location. The approximate location of switches, power outlets, floor boxes, etc., is indicated on the Drawings. These Drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the general building Drawings and by actual measurements during construction of the building before rough in, subject to the approval of the Constructor Inspector and the Owner's Representative.
3.5 **COORDINATION.** COORDINATE LOCATION, MOUNTING HEIGHT, AND ORIENTATION OF WIRING DEVICES WITH ADJACENT OUTLETS FOR OTHER SYSTEMS SUCH AS HVAC CONTROL, VOICE/DATA, SECURITY, FIRE ALARM, ETC.  **PREPARATION**

A. Contractor must examine the areas and conditions under which wiring devices are to be installed and notify the Owner’s Project Manager in writing of conditions detrimental to the proper and timely completion of the Work.

B. Inspect devices for physical damage.

C. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.6 **INSTALLATION**

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Wall switch and receptacle ground wiring shall terminate at the wiring device with an insulated tin-plated copper spade compression terminal. Select a spade terminal compatible with the wiring devices supplied so that device screw terminals can be torqued to the wiring device manufacturer’s recommendations.

D. Wall receptacles shall be installed with the ground pinhole in the up position, unless instructed otherwise by the Owner. Where installed horizontally, the ground pinhole shall be installed at the left side.

E. The approximate location of switches and receptacles are indicated on the Drawings. These Drawings, however, may not give complete and accurate information in regard to locations of such items. Determine exact locations by reference to the architectural Drawings and by actual measurements during construction of the building before rough-in, subject to the approval of the Owner’s Project Manager.

F. Install wall switches 48 inches above finished floor, OFF position down.

G. Install wall dimmers 48 inches above floor; derate ganged dimmers as instructed by manufacturer; do not use common neutral.

H. Where wainscot is near the 48 inch level, install device in the wall below the top edge of the wainscot and as near the 48 inch level as possible to provide the most pleasing appearance. Do not partially install devices in the wainscot and partially in the wall.

I. Where shown the strike side of doors, install switches and dimmers not less than 2 inches and not more than 12 inches from door trim, but in all cases as close to the 2 inch setback as possible.

J. Verify all doors swings before rough-in and locate switches and dimmers on strike side of door wherever possible.

K. Position the center of convenience, telephone, computer and TV outlets 18 inches above floor or 8 inches above countertops unless otherwise noted. Coordinate with equipment and architectural Drawings. Install outlets vertically on walls and horizontally above countertops.

L. Install specific-use receptacles at heights shown on Drawings.

M. Install poke through devices per manufacturer requirements, including but not limited to:
1. UL requirements for maximum density in structural bays and minimum spacing between poke through devices.

2. Final installation for all devices shall be ADA compliant.

3. Properly seal poke through devices where installed above non-conditioned spaces to minimize the passage of unconditioned air into the space through the poke through device.

4. Device gangs not used by electrical, A/V and telecom shall remain blocked off for future use.

5. Properly clean the inside of the poke through device.

6. Properly label the devices installed within the poke through device.

N. Install occupancy sensors per manufacturer requirements.

O. Coordinate with owner representative and Engineer of Record for programming of sensors with regards to line of sight and programmed delay.

3.7 DEVICE PLATES

A. Type. Provide device plates for each outlet of the type required for service and device involved. Plates shall be provided for telecom and A/V per those documents.

B. Ganged Devices. Mount ganged devices under a single, one-piece device plate.

C. Workmanship. Install devices and device plates level, plumb, and parallel to adjacent surfaces or trim. Devices shall be flush with the finished trim cover plates. Device plates shall be tight to surfaces over which they are installed.

D. Patching. Where cover plates do not completely conceal the rough openings for the devices, it shall be the responsibility of the Contractor to patch, paint, etc. around the opening to the satisfaction of the Owner’s Representative.

E. Engraving. Engrave plates with 1/8-inch-high black letters, if designated for engraving.

F. Labels. Where switches controlling devices that are out of sight, or where three or more switches are gang mounted, provide plates with labels to identify items being controlled, or areas being lighted. Refer to Section 26 05 53 for Electrical Identification requirements.

END OF SECTION
SECTION 26 36 23 – AUTOMATIC TRANSFER AND BYPASS ISOLATION SWITCHES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The Section specifies furnishing and installation of automatic transfer switches to automatically transfer between the normal and emergency power sources with integral bypass/isolation.

1.02 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for automatic transfer.

1. Section 26 00 00 - Basic Electrical Requirements
2. Section 26 05 33 – Raceways, Conduit, and Boxes
3. Section 26 05 19 – Cable Wire and Connectors 600V
4. Section 26 05 53 – Electrical Identification
5. Section 26 05 26 – Grounding
6. Section 26 05 73 - Overcurrent Protective Device and Arc Flash Study

1.03 REFERENCE STANDARDS

A. The materials and installation shall conform to the minimum requirements and latest revisions of the following codes, standards and regulations wherein they apply:

1. IEEE C37.2 – Electrical Power System Device Function Numbers and Contact Designations
2. NEMA ICS 1 – General Requirements for Industrial Control and Systems
3. NEMA ICS 6 – Industrial Control and System Enclosure
4. NEMA ICS 10, Part 1 – Electromagnetic AC Transfer Switch Equipment
5. NFPA 70 – National Electrical Code
6. UL 1008 – Transfer Switch Equipment
7. NFPA 110 – Standard for Emergency and Standby Power Systems
8. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems

1.04 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00, Basic Electrical Requirements, and Division 01 for submittal requirement.

1. Descriptive product literature, to include, but not limited to:
   a. Rated current, voltage and frequency
   b. Number of poles
c. Symmetrical rms amperes withstand current at rated voltage

d. Physical dimensions, to include drawout clearances and working clearances

e. NEMA enclosure type

f. Itemized list of accessories

g. UL 1008 3-cycle close and withstand rating

2. Plan, elevation, side, and front view arrangement drawings, including overall dimension, weights, clearances for installation, drawout of removable components, and working clearances, as well as mounting or anchoring requirements and conduit entrance locations.

3. Schematic diagram (show wiring and only those components which are part of switch).

4. Provide wire diagram prior to shipping. Show all factory wiring on wiring diagram and clearly indicate all wiring and connections to remote devices which are to be made in the field.

1.05 PRODUCT DELIVERY AND STORAGE

A. Deliver unit to the project site, protected from the weather and damage due to shipping and handling. Cover all piping connections.

B. Store unit in a clean and dry space and protected from weather.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. ASCO

B. Russelectric

C. Cummins

D. Cutler-Hammer

E. Other manufacturers equal in design and function will be considered upon A/E approval following substitution procedure in Section 26 00 00 and Division 01 for substitution requirement.

2.02 RATINGS

A. The transfer switches shall have voltage rating, current rating and interrupting ratings as shown on Drawings.

B. The transfer switches shall be 100 percent equipment rated for continuous duty as shown on the Drawings and shall conform to the applicable requirements of UL 1008 for emergency system total load. The automatic transfer switches shall be fully rated to protect all types of loads, inductive and resistive, from loss of continuity of power without de-rating.

C. All pilot devices and relays shall be of the industrial type with self-cleaning contacts and rated 10 amperes.
2.03 CONSTRUCTION

A. The transfer switches shall consist of completely enclosed contact assemblies and a separate control logic panel. The transfer switch shall be open-transition. The contact assemblies shall be operated by a non-fused motor operator or stored energy mechanism and be energized only momentarily during transfer, providing inherently double throw switching action. Control power for all transfer operations shall be derived from the line side of the source to which the load is being transferred.

B. Transfer switches shall be capable of being operated manually under full load conditions. Manual operation shall be accomplished via a permanently affixed manual operator or integrally mounted pushbutton operators located on the face of the transfer switch assemblies. Removable manual operating handles and handles which move in the event that electrical operations should suddenly become energized while performing a manual transfer operation are not acceptable. The manual operator shall provide the same contact-to-contact transfer time as provided under normal automatic operation to prevent possible flashovers from switching the main contacts slowly. In addition, provisions shall be made to allow disengagement of the electrical operator during manual operation.

C. Each transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation. Main contacts shall be mechanically locked in position in both normal and emergency positions. A neutral position shall not be possible under normal electrical operation unless a delayed transition accessory is required for switching highly inductive loads. Each transfer switch shall have a manual neutral position for load circuit maintenance. A transfer switch position indicator shall be visible from the front of the switch to show which source the transfer switch is connected.

D. All three-phase four-wire transfer switches used on system with ground fault equipment shall be true four-pole switched neutral type with fully rated and connected to a common shaft. The fourth (neutral) pole contacts shall be identical construction as, and operate simultaneously with, the main power contacts. Add-on or overlapping neutral contacts are not acceptable.

E. Where shown on the Drawings, transfer switches applied as service entrance switches shall be provided with overcurrent trip units and a service entrance label. An external key-operated selector switch shall be provided to disconnect the power supplies. Indicators shall be provided to show the availability of each source as well as breakers in a tripped or disconnected position. Provide a neutral disconnect link for three-pole solid neutral switches, and a neutral-to-ground main bonding jumper for all switches to meet UL service entrance requirements. Ground fault protection shall be provided for all switches rated 1000 amperes or more in accordance with NEC Article 230.95.

2.04 MICROPROCESSOR-BASED CONTROLLER

A. A microprocessor-based controller shall be separately mounted from the power switching portion of the transfer switch. The two sections shall be connected by control cables with plug-in connectors. The control section shall be capable of being disconnected from the power section for maintenance purposes.

B. The controller shall be rated for an operation temperature range of -20 degree C to +70 degree C, and a storage temperature range of -30 degree C to +85 degree C. The microprocessor-based controller shall be capable of operating with control input power available within the range of 55 percent to 133 percent of nominal voltage indefinitely. Connection to any external battery or to the engine battery is not permissible. The controller shall not in any way be adversely affected by line voltage or frequency fluctuation during the course of transferring heavy electrical loads.
from one source to another. Adverse effects may include, but are not limited to, an unintended retransfer to the original source.

C. The controller shall be equipped with self-diagnostics, which performs periodic checks of the memory, input/output (I/O), and communication circuits, with a watchdog/power fail circuit.

D. The controller shall be accurate to within 1 percent of full-scale value for measured parameter. Voltage and current for all phases shall be sampled simultaneously to assure high accuracy in conditions of low power factor or large waveform distortions.

E. A digital readout shall display each option as it is functioning. Readouts shall display:
   1. Three phase voltage with 1 percent accuracy to display all three separate phase-to-phase voltage simultaneously, for both the normal and emergency source.
   2. Frequency with 1 percent accuracy to display frequency for both normal and emergency source.
   3. Availability of normal source and emergency source.

F. The following metered readings shall also be communicated by the Controller, via local display and serial communication.
   1. Current, per phase RMS and neutral
   2. Current unbalance %
   3. Voltage, phase-to-phase and phase-to-neutral
   4. Voltage unbalance %
   5. Real power (KW), per phase and 3-phase total
   6. Apparent power (KVA), per phase and 3-phase total
   7. Reactive power (KVAR), per phase and 3-phase total
   8. Power factor, per phase and 3-phase total
   9. Frequency
   10. Accumulated energy (KWH, KVAH, and KVARH)

G. When timers are functioning, the microprocessor shall display the timer counting down. All set points can be reprogrammed from the front of the switch when the switch is in the program mode. A test push button shall be included as part of the microprocessor.

H. The controller shall be capable of storing records in memory for access either locally or remotely for up to 100 events. The reports shall include date, time and a description of the event, and shall be maintained in a non-volatile memory. The controller shall be capable to

2.05 ACCESSORIES

A. The following logic and options shall be supplied:
1. The logic of the transfer switch shall function via a microprocessor-based controller. The set points shall be field adjustable without use of the special tools. The switch shall have a multi-tap voltage selection plug for ease of voltage adjustment in the field. LED lights shall be included on the exterior of the switch to show:
   a. Normal source available
   b. Emergency source available
   c. Normal source connected
   d. Emergency source connected
   e. Load energized
   f. Position indicators shall be visible from the front of the switch.

2. The switch shall include the following:
   a. Provide a time delay transfer from the normal power source to the emergency power source (0 seconds to 30 minutes). This option does not affect the engine start circuit.
   b. Provide a timer to override a momentary power outage or voltage fluctuation (0 seconds to 120 seconds).
   c. Provide a time delay transfer from the emergency power source to the normal power source (0 seconds to 30 minutes).
   d. Provided a timer to allow the generator to run unloaded after retransfer to the normal power source (0 seconds to 30 minutes).
   e. Provided single-phase under-voltage and under-frequency sensing on the emergency power source. Voltage shall be factory set at 90 percent pickup and 80 percent dropout. Frequency sensing shall be set at 58-hertz pickup and 56-hertz dropout.
   f. Provide a pilot light to indicate that the switch is in the normal position as an integral part of the microprocessor.
   g. Provide a pilot light to indicate that the switch is in emergency position as an integral part of the microprocessor.
   h. Provide a pilot light to indicate that the normal power is available as an integral part of the microprocessor.
   i. Provide a pilot light to indicate that the emergency power is available as an integral part of the microprocessor.
   j. Provide auxiliary relay contacts that are energized when the power is available on the normal source.
   k. Provide auxiliary relay contacts that are energized when the power is available on the emergency source.

B. The following features shall be provided:
1. Time delay normal to emergency, adjustable.
2. Time delay emergency to emergency, adjustable.
3. Green pilot light to indicate switch in normal position and red pilot light to indicate switch in emergency position.
4. White pilot lights marked “Normal Source” and “Emergency Source” to indicate that respective source voltages are available.
5. Tripped position indicating lights for both sources.
6. Relay auxiliary contacts (3 NO and 3 NC) to indicate transfer switch position and the availability of each sources.

C. When the alternate source is an engine generator, the following features shall also be provided:
1. Time delay engine start, adjustable.
2. Time delay engine cool off, adjustable.
3. Engine start contact.
4. Frequency/voltage relay for emergency source, frequency adjustable from 45 to 50 Hz and voltage fixed at 90 percent pickup, 70 percent dropout.
5. Four-position selector switch permitting four (4) modes of transfer switch operation: TEST (simulates normal power outage), AUTO (standard automatic operation), OFF (de-energizes control relays and opens the engine start circuit for maintenance purpose), ENGINE START (retains transfer switch in normal position and initiates a testing of the engine start circuit). Furnish white pilot light for OFF indication.

D. Provide engine generator exerciser (selectable load no-load transfer).

2.06 COMMUNICATIONS

A. Where shown on the Drawings, provided in the transfer switch a microprocessor-based unit capable of communicating phase and ground current, peak demand, present demand, energy consumption, contact status, and mode of trip. The transfer switch shall respond to open and close commands from a master control unit via a non-proprietary communication network.

B. Provide communications capability to monitor the normal and emergency switch position and normal and emergency source availability. Where shown on the Drawings, provided additional communications capability to bypass time delays during transfer or retransfer, and to initiate engine start for no-load or load testing of the transfer switch from a remote master computer.

2.07 DRAWOUT OPTION

A. Where shown on the Drawings, provide transfer switches with drawout mechanism to allow easy access for preventative maintenance, testing or inspection. The drawout mechanism shall provide visual indicators as to position the switch/breaker during the drawout operation.

2.08 BYPASS/ISOLATION SWITCH OPTION

A. Where shown on the Drawings, provided bypass/isolation switch to electrically bypass and isolate, without load interruption, each automatic transfer switch. Furnish an integral
bypass/isolation switch to provide a safe and convenient means for manually bypassing and isolating the automatic transfer switch, regardless of the condition or position of the ATS. The integral bypass/isolation switch shall also serve as an emergency back-up system in the event the automatic transfer switch should fail. In addition, the bypass/isolation switch shall be utilized to facilitate maintenance and repair of the automatic transfer switch.

B. Completely isolate the automatic transfer switch from the bypass/isolation switch by means of insulating barriers and separate access doors to positively prevent hazard to operating personnel while servicing the automatic transfer switch. The isolation portion of the bypass/isolation shall allow the automatic transfer switch to be disconnected from all sources of power and control without opening the enclosure door. Provide transfer switch with a true drawout configuration which does not require disconnection of any electrical or mechanical devices by personnel performing maintenance upon and/or operation of the switch. Provide the automatic transfer switch with rollers or casters to allow removal from enclosure by simply rolling out the unit.

C. The main contacts of the bypass/isolation switch shall be mechanically locked in both the normal bypass/isolation and emergency bypass/isolation positions without the use of hooks, latches, magnets, or springs and shall be silver-tungsten alloy, protected by arcing contacts with magnetic blowouts on each pole. The switching mechanism shall provide “quick-break”, “quick-make” operation of the contacts.

D. Positive sequencing of all contacts, with no possible intermediate position, shall be accomplished through the manual operations from a dead front location. Electrical testing during maintenance of the automatic transfer switch shall be possible in the bypass/isolation position.

E. The switch shall be fully manually operated and shall not be dependent upon electrical operators, relays, or interlocks for operation. The bypass/isolation switch shall be listed by Underwriters’ Laboratories Inc., Standard UL-1008 and meet the identical withstand ratings of its associated transfer switch.

F. Provide the bypass/isolation switch with mechanical interlocks to accomplish this separation of normal and emergency circuits, to prevent accidental connection of unsynchronized sources. Electrical interlocking, alone, will not be considered acceptable.

2.09 WIRING TERMINATIONS

A. Terminal blocks shall conform to NEMA ICS 4. Terminal facilities shall be arranged for entrance of external conductors from the top or bottom of the enclosure. The main transfer switch terminals shall be suitable for the termination of conductors shown on the plans.

2.10 SEQUENCE OF OPERATION

A. The transfer switch shall automatically transfer its load circuits to an emergency or alternate power supply upon failure of its normal or preferred source.

B. Upon loss of phase-to-phase voltage of the normal source to 80 percent of nominal, and after a time delay, adjustable from 0.5 to 15 seconds, to override momentary dips and/or outages, a 10-ampere, 30-Vdc contact shall close to initiate starting of the emergency or standby source power plant. Transfer to the alternate source shall take place immediately upon attainment of 90 percent of rated voltage and frequency of that source. For switches not involving engine generator sets as power plants, transfer shall occur after an adjustable time delay of 1 to 60 seconds to override momentary dips and outages.
C. When the normal source has been restored to 90 percent of rated voltage, and after a time delay, adjustable from 0 seconds to 30 minutes, the load shall be retransferred to the normal source.

D. A time delay, adjustable from 0 seconds to 30 minutes, shall delay shutdown of the emergency or standard power source after retransfer to allow the generator to run unloaded for cool-down, after which the generator shall be automatically shut down.

E. If the emergency or standby power should fail while carrying the load, transfer to the normal power supply shall be made instantaneously upon restoration of the normal source to satisfactory conditions.

2.11 ENCLOSURE AND FINISH

A. Each transfer switch shall be provided in enclosure suitable for locations as indicated on the drawings and as indicated on Drawings.

B. NEMA 1, 12 or 3R enclosure shall be painted with the manufacturer’s standard painting procedures to ensure suitability for environmental conditions as referenced in the planes. Color shall be light gray ANSI 61. NEMA 4 or 4X shall be stainless steel, non-painted.

PART 3 - EXECUTION

3.01 PRODUCT HANDLING AND VISUAL INSPECTION

A. Handle unit carefully to avoid damage to material components, enclosure and finish. Use only lifting and brackets provided for that purpose. Unit shall be inspected prior to installation for damage. Damaged units shall be rejected and not be installed on project.

3.02 FOUNDATION PAD

A. Install automatic transfer and bypass/isolation switch on a concrete housekeeping pad with manufacturer’s instruction and/or per Drawings.

B. Coordinate conduit stub-up locations with Structural Engineer prior to placing conduit and farms for foundation pad.

3.03 INSTALLATION

A. Install the automatic transfer and bypass/isolation switch as shown on the drawings. Installation shall follow manufacturer’s installation procedures and be in accordance with NEC.

B. Coordinate controller functions with packaged engine generator controls. Coordinate with metal clad medium voltage switchgear or low voltage metal-enclosed switchgear, which are designed for emergency power distribution. The entire system shall be demonstrated functional as a whole.

C. Coordinate interfaces with other life safety and/or building control systems as shown on Drawings.

3.04 TOUCHUP PAINTING

A. Restore any marred surfaces to factory finish.

3.05 FIELD TESTING

A. Test the switches with the packaged engine generator set in operating condition. Demonstrate to the Owner that the automatic transfer switches and bypass/isolation switches perform all required functions.
3.06 TRAINING

A. Provide on-site training for Owner’s designated personnel in the construction, operation, maintenance, troubleshooting and repair of the automatic transfer and bypass/isolation switch.

B. Formal training for the operation and maintenance shall be provided by factory trained and certified personnel.

C. The training shall consist of a minimum of 8-hour training sessions or per Owner’s direction.

D. The timing of the training shall coincide with the schedule for the manufacturer’s representative(s) to be on site for testing and start-up.

E. The specific training shall be provided at a location designated and provided by the Owner for a minimum of 10 personnel selected by the Owner.

F. A training program shall be submitted with material, instructor’s qualification, and proposed schedule, a minimum 60 days prior to the proposed training. The Owner reserves the right of approval of any training course, material, instructor and schedule.

G. The training program shall consist of, but not limited, instruction in the following subjects:

1. Review of the applicable one-line drawings, wiring diagrams, and schematic for the automatic transfer and bypass/isolation switch.

2. Review of the factory record shop drawings and placement of the various components.


4. Instruction in manufacturer’s published procedures for operation, maintenance, troubleshooting, and safety. Instruction shall include all modes of equipment operation and alignment.

5. Review of maintenance procedures for removal and placement of major components, and removal and replacement of renewable parts, as applicable.

6. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.

7. Provide binders to participants complete with copies of drawings and other course material covered.

H. A minimum of 12 bound copies of training material shall be provided at the time of training, with four additional copies submitted at the time of substantial completion included in the Owner’s manuals.

END OF SECTION
ELECTRICAL POWER PLAN - GROUND FLOOR

**General Notes:**
A. See floor for more general notes, symbols, and abbreviations.
B. Owner shall provide UPS as needed.

**Drawing Notes:**
1. Conduit from first floor above, run floor to structure and route as shown.
2. New emergency feed to ground floor workshop, run floor for more information.
3. New pull box for feeder, size shall be 6" X 6".
4. New takes car fuse and disconnect, run floor for more information.
5. New generator, run floor for more information.
6. Existing panel to be replaced with emergency and normal power, run floor for more information.
7. New circuit references to panel, run floor as shown.
8. All outlets circuited to panel, run floor as shown.
9. Junction box for extension connection to mechanical pump, run floor for more information.
10. Convert power feed to pump to plug, run floor for more information.
11. New generator, run floor as shown.
12. New motor, run floor as shown.

**Device Notes:**
1. UPS 1, APC # SYA8K16PXR, three (3) SYAXR9B9, and one (1) SYPD7, and one (1) GNMR circuit shown.
2. UPS 2, APC # SRT3000XLA, and ten (10) SRT96BP or equal for EM equipment.
3. UPS 3, APC # SRT3000XLA, and eight (8) SRT96BP or equal for EM equipment.

**General Notes:**
A. Owner shall provide UPS as needed.
B. Re: E0.00 for more general notes, symbols, and abbreviations.

**Scheduling Notes:**
1. New emergency feed to ground floor workshop, run floor for more information.
2. New generator, run floor for more information.
3. New pull box for feeder, size shall be 6" X 6".
4. New generator, run floor for more information.
5. Convert power feed to pump to plug. Plug motor into receptacle.
6. Convert 120V circuit and direct connect to duplex receptacle.
7. Junction box and direct connection to mechanical pump.
8. Junction box and direct connection to mechanical pump.
9. New generator, run floor as shown.
10. New generator, run floor as shown.

**Re-Circuiting Notes:**
1. All outlets circuited to panel, run floor as shown.
2. New generator, run floor as shown.
3. New generator, run floor as shown.
4. New generator, run floor as shown.
5. Exist panel to be backfed with emergency and normal power, run floor for more information.
6. New circuit references to panel, run floor as shown.
7. All outlets circuited to panel, run floor as shown.
8. Junction box for extension connection to mechanical pump, run floor for more information.
9. Convert power feed to pump to plug. Plug motor into receptacle.
10. Convert 120V circuit and direct connect to duplex receptacle.

**Device Notes:**
1. UPS 1, APC # SYA8K16PXR, three (3) SYAXR9B9, and one (1) SYPD7, and one (1) GNMR circuit shown.
2. UPS 2, APC # SRT3000XLA, and ten (10) SRT96BP or equal for EM equipment.
3. UPS 3, APC # SRT3000XLA, and eight (8) SRT96BP or equal for EM equipment.

**New FEEDER**
1. New feeder to ground floor EM equipment. Provide new L5-30R to plug on new panel, run floor as shown.
2. New generator, run floor as shown.
3. Convert power feed to pump to plug. Plug motor into receptacle.
4. New generator, run floor as shown.

**General Notes:**
1. See floor for more general notes, symbols, and abbreviations.
2. Owner shall provide UPS as needed.

**Scheduling Notes:**
1. New emergency feed to ground floor workshop, run floor for more information.
2. New generator, run floor for more information.
3. New pull box for feeder, size shall be 6" X 6".
4. New generator, run floor for more information.
5. New takes car fuse and disconnect, run floor for more information.
6. New generator, run floor for more information.
7. New generator, run floor as shown.
8. New generator, run floor as shown.
9. New generator, run floor as shown.
10. New generator, run floor as shown.

**Device Notes:**
1. UPS 1, APC # SYA8K16PXR, three (3) SYAXR9B9, and one (1) SYPD7, and one (1) GNMR circuit shown.
2. UPS 2, APC # SRT3000XLA, and ten (10) SRT96BP or equal for EM equipment.
3. UPS 3, APC # SRT3000XLA, and eight (8) SRT96BP or equal for EM equipment.

**Re-Circuiting Notes:**
1. All outlets circuited to panel, run floor as shown.
2. New generator, run floor as shown.
3. New generator, run floor as shown.
4. New generator, run floor as shown.
5. Exist panel to be backfed with emergency and normal power, run floor for more information.
6. New circuit references to panel, run floor as shown.
7. All outlets circuited to panel, run floor as shown.
8. Junction box for extension connection to mechanical pump, run floor for more information.
9. Convert power feed to pump to plug. Plug motor into receptacle.
10. Convert 120V circuit and direct connect to duplex receptacle.

**Device Notes:**
1. UPS 1, APC # SYA8K16PXR, three (3) SYAXR9B9, and one (1) SYPD7, and one (1) GNMR circuit shown.
2. UPS 2, APC # SRT3000XLA, and ten (10) SRT96BP or equal for EM equipment.
3. UPS 3, APC # SRT3000XLA, and eight (8) SRT96BP or equal for EM equipment.

**General Notes:**
1. See floor for more general notes, symbols, and abbreviations.
2. Owner shall provide UPS as needed.

**Scheduling Notes:**
1. New emergency feed to ground floor workshop, run floor for more information.
2. New generator, run floor for more information.
3. New pull box for feeder, size shall be 6" X 6".
4. New generator, run floor for more information.
5. New takes car fuse and disconnect, run floor for more information.
6. New generator, run floor for more information.
7. New generator, run floor as shown.
8. New generator, run floor as shown.
9. New generator, run floor as shown.
10. New generator, run floor as shown.

**Device Notes:**
1. UPS 1, APC # SYA8K16PXR, three (3) SYAXR9B9, and one (1) SYPD7, and one (1) GNMR circuit shown.
2. UPS 2, APC # SRT3000XLA, and ten (10) SRT96BP or equal for EM equipment.
3. UPS 3, APC # SRT3000XLA, and eight (8) SRT96BP or equal for EM equipment.

**Re-Circuiting Notes:**
1. All outlets circuited to panel, run floor as shown.
2. New generator, run floor as shown.
3. New generator, run floor as shown.
4. New generator, run floor as shown.
5. Exist panel to be backfed with emergency and normal power, run floor for more information.
6. New circuit references to panel, run floor as shown.
7. All outlets circuited to panel, run floor as shown.
8. Junction box for extension connection to mechanical pump, run floor for more information.
9. Convert power feed to pump to plug. Plug motor into receptacle.
10. Convert 120V circuit and direct connect to duplex receptacle.
01 Partial Electrical Riser Diagram

NOT TO SCALE

NOTES:

1. All text for NOTING ARE DRAFTING NOTES, TITLES AND LEGENDS.

COMPANY NOTES:

1. EXISTING #4 HOG. #6-8" C/F, READY TO REPLACE AND BE REWORKED.
2. EXISTING ELECTRICAL POWER DRAW TO REMAIN AND BE REWORKED.
3. MR. HERI IS THE ONLY APPROVED CONTRACTOR TO MAKE ANY CHANGES.
4. NOT A FULL REWORK/REPLACEMENT AUTOMATIC TRANSFER SWITCH.
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