

DIVISION 26 SPECIFICATION

26 0000	Electrical General Requirements
26 0519	Low-Voltage Electrical Power Conductors and Cables
26 0526	Grounding and Bonding for Electrical Systems
26 0529	Hangers and Supports for Electrical Systems
26 0533	Raceway and Boxes for Electrical Systems
26 0553	Identification for Electrical Systems
26 2400	Switchboards and Panelboards
26 2800	Low-Voltage Circuit Protective Devices

1 GENERAL

1.01 SUMMARY:

A. Section Includes:

1. Electrical systems required for this work includes labor, materials, equipment, and services necessary to complete installation of electrical work for building shell, core and one Tenant build out as shown on Drawings, specified herein or required for a complete operable facility and not specifically described in other Sections of these Specifications. Among the items required are:
 - a. Service and distribution equipment shown on Drawings.
 - b. Distribution level transient voltage suppression equipment.
 - c. Feeders to switchboards, distribution panels, HVAC equipment, Owner provided equipment and other equipment as detailed.
 - d. Branch circuit wiring from the distribution panels for lighting, receptacles, motors, signal systems and other detailed circuit wiring.
 - e. Wiring and power connections for motors installed for heating, cooling, and ventilation.

1.02 DEFINITIONS:

A. Following is a list of abbreviations generally used in Divisions 26, 27, 28, and 33:

1. AHJ Authority Having Jurisdiction.
2. ADA Americans With Disabilities Act.
3. ANSI American National Standards Institute.
4. APWA American Public Works Association.
5. ASTM American Society for Testing and Materials.
6. FCC Federal Communications Commission.
7. HVAC Heating-Ventilating and Air Conditioning.
8. IBC International Building Code.
9. IEEE Institute of Electrical and Electronic Engineers.
10. IEC International Electrotechnical Commission.
11. IETA International Electrical Testing Association.

- 12. IFC International Fire Code.
- 13. FM Factory Mutual.
- 14. NEMA National Electrical Manufacturer's Association
- 15. NFPA National Fire Protection Association.
- 16. NEC National Electric Code.
- 17. OSHA Occupational Safety and Health Administration.
- 18. UL Underwriters' Laboratories, Inc.

- B. Provide: To furnish and install, complete and ready for the intended use.
- C. Furnish: Supply and deliver to the project site, ready for unpacking, assembly, and installation.
- D. Install: Includes unloading, unpacking, assembling, erecting, installation, applying, finishing, protecting, cleaning and similar operations at the project site as required to complete items of work furnished by others.

1.03 ADDITIONAL REQUIREMENTS TO DIVISION 01:

- A. Operation and Maintenance Documentation: Provide copies of certificates of code authority acceptance, test data, product data, guarantees, warranties, and the like.
- B. Shop Drawings: When requested by individual Sections provide shop drawings, which include physical characteristics, electrical characteristics, device layout plans, wiring diagrams, and the like. Refer to individual Specification Sections for additional requirements for the shop drawings.
- C. Closeout Documentation: Submit electrical code authority certification of inspection. Include documentation of on-site electrical testing that was performed.
- D. Record Drawings:
 - 1. Show changes and deviations from the Drawings. Include written Addendum and change order items.
 - 2. Show exact routes of feeders 60 amp and larger, conduits for signal systems 2-inches in diameter and larger, and service entrance conduits.
 - 3. Show exact location of switchboards, distribution panelboards, safety disconnects, motor controllers, and the like.
 - 4. Make changes to Drawings in a neat, clean, and legible manner.
 - 5. Provide an 11 x 17 size Record Drawing of the one-line power diagram sealed in a plastic coating. Mount on the wall of the electric room.

1.04 QUALITY ASSURANCE:

- A. Conform to requirements of the NEC, latest adopted version with amendments by local AHJs.
- B. Conform to latest adopted version of the IBC with Oregon amendments.
- C. Obtain and pay for electrical permits, plan review, and inspections.
- D. Furnish products listed by UL or another testing firm acceptable to AHJ.
- E. Conform to requirements of the serving electric, and telephone utilities.

1.05 SEQUENCING AND SCHEDULING:

- A. For the proper execution of the work cooperate with other crafts and contracts as needed.
- B. To avoid installation conflicts, thoroughly examine the complete set of Contract Documents. Resolve conflicts with Architect prior to installation.
- C. Prior to installation of feeders to equipment requiring electrical connections, examine the manufacturer's shop drawings, wiring diagrams, product data, and installation instructions. Verify that the electrical characteristics detailed in the Contract Documents are consistent with the electrical characteristics of the actual equipment being installed. When inconsistencies occur request clarification from Architect.

2 PRODUCTS

2.01 MANUFACTURERS:

- A. Provide like items from one manufacturer, such as, luminaire types, switches, receptacles, breakers, panels, and the like.

2.02 MATERIALS:

- A. Provide new electrical materials of the type and quality detailed, listed by UL, bearing their label wherever standards have been established. Indicated brand names and catalog numbers are used to establish standards of performance and quality. The description of materials listed herein governs in the event that catalog numbers do not correspond to materials described herein.
- B. Provide material and equipment that is acceptable to AHJ as suitable for the use indicated. For example, provide wet labeled equipment in locations that are wet.
- C. Include special features, finishes, accessories, and other requirements as described in the Contract Documents regardless of the item's listed catalog number.
- D. Provide incidentals not specifically mentioned herein or noted on Drawings, but needed to complete the system or systems, in a safe and satisfactory working condition.

2.03 FIRESTOPPING:

- A. For additional requirements see Division 07, Firestopping section
- B. Foam Sealant: Foam sealant for use around conduit penetrations to prevent passage of smoke, fire, toxic gas or water. Maintain seal before, during and after fire. In and around conduit for thermal break at penetration of barrier between heated and unheated spaces. Chase Technology Corporation, Fire Foam, Thomas & Betts, or approved.

3 EXECUTION

3.01 EXAMINATION:

- A. Construction Documents:
 - 1. Drawings are diagrammatic with symbols representing electrical equipment, outlets, luminaires, and wiring.
 - 2. Electrical symbols indicating wiring and equipment shown in the Contract Documents are included in the Contract unless specifically noted otherwise.
 - 3. Examine the entire set of Drawings to avoid conflicts with other systems. Determine exact route and installation of electrical wiring and equipment with conditions of construction.
- B. Clarification:
 - 1. The Drawings govern in matters of quantity, the Specification in matters of quality. In event of conflict on Drawings or in the Specifications, the greater quantity and the higher quality apply.
 - 2. Should the Electrical Documents indicate a condition conflicting with the governing codes and regulations, refrain from installing that portion of the work until clarified by Architect.

3.02 INSTALLATION:

- A. Install electrical equipment complete as directed by manufacturer's installation instructions. Obtain installation instructions from manufacturer prior to rough-in of the electrical equipment, examine the instructions thoroughly. When requirements of the installation instructions conflict with the Contract Documents, request clarification from Architect prior to proceeding with the installation.
- B. Do not install electrical equipment in obvious passages, doorways, scuttles or crawl spaces which would impede or block the area passage's intended usage.
- C. Noise Control:
 - 1. Do not install outlet boxes back to back. Do not use straight through boxes.

2. Do not place contactors, transformers, starters and similar noise producing devices on walls, which are common to occupied spaces, unless specifically called for on Drawings. Where such devices must be mounted on walls common to occupied spaces, mount or isolate in such a manner as to effectively prevent the transmission of their inherent noise to the occupied space.
- D. Firestopping:
1. Coordinate with the Drawings the location of fire rated walls, ceilings, floors, and the like. When these assemblies are penetrated by electrical equipment, seal around the equipment with approved firestopping material. Maintain integrity of rated assemblies
 2. Install firestopping material complete as directed the manufacturer's installation instructions.
- 3.03 FIELD QUALITY CONTROL:
- A. Tests:
1. Conduct tests of equipment and systems to demonstrate compliance with requirements specified in Divisions 26, 27, 28, and 33. Refer to individual Specification Sections for required tests. Document tests and include in Closeout Documents.
 2. During site evaluations, by Architect or Engineer, provide an electrician with tools to remove and replace trims, covers, devices, and the like, so that a proper evaluation of the installation can be performed.
- 3.04 CLEANING:
- A. Remove dirt and debris caused by the execution of the electrical work.
 - B. Leave the entire electrical system installed under this Contract in clean, dust-free, and proper working order.
 - C. Vacuum clean interiors of electrical equipment enclosures.

END OF SECTION

1 GENERAL**1.01 SUMMARY:**

- A. Wires and cables.
- B. Connectors.
- C. Lugs and pads.
- D. MC cable.

1.02 SYSTEM DESCRIPTION:

- A. Provide wires, cables, connectors, lugs, and the like for a complete and operational electrical system.

1.03 SUBMITTALS:

- A. Provide product data for the following equipment:
 - 1. Wires.
 - 2. Cables.
 - 3. Connectors.
 - 4. Lugs.
- B. Provide the insulation cable testing report in the project closeout documentation, see Project Closeout Requirements in Division 01.

1.04 REGULATORY REQUIREMENTS:

- A. Conform to requirements of the NEC, latest adopted version with amendments by local AHJs.
- B. Furnish products listed by UL or another testing firm acceptable to AHJ.

2 PRODUCTS**2.01 MANUFACTURERS:**

- A. Wires and Cables: Carol, General Cable, Okonite, Rome, Southwire, or approved.
- B. Connectors: Stranded conductors by Anderson, Burndy, IlSCO, Thomas & Betts, or approved.

- C. Splices:
 - 1. Branch Circuit Splices: Ideal, Scotch-Lock, 3M, or approved.
 - 2. Feeder Splices: Compression barrel splice with two layers Scotch 23 and four layers of Scotch 33+ as vapor barrier.
- D. MC Cable: Alfex, AFC, Carol, or approved.

2.02 WIRES AND CABLES:

- A. Copper, 600 volts rated throughout. Conductors 14AWG to 10AWG, solid or stranded. Conductors 8AWG and larger, stranded.
- B. Phase color to be consistent at all feeder terminations; A-B-C, top to bottom, left to right, front to back.
- C. Color Code Conductors as Follows:

PHASE	208 VOLT WYE	240 VOLT DELTA	480 VOLT
A	Black	Black	Brown
B	Red	Orange (High Leg)	Orange
C	Blue	Blue	Yellow
Neutral	White	White	[Gray] [White w/ colored strip]
Ground	Green	Green	Green
Isolated Ground	Green w/yellow trace	N/A	N/A

- D. Conductors 3AWG and larger, minimum insulation rating of 75C.
- E. Insulation types THWN, THHN or XHHW. Minimum insulation rating, 90C, for branch circuits.
- F. MC Cable: High strength galvanized steel or aluminum flexible armor. Full length minimum size No. 12 copper ground wire, THHN 90C conductors, full length tape marker. Overall PVC or nylon cable tape. Short circuit throat insulators, mechanical compression termination. Manufacturers: Alfex, AFC, or Carol.
- G. Refer to communications, Division 27, for cable requirements.

2.03 CONNECTORS:

- A. Copper Pads: Drilled and tapped for multiple conductor terminals.
- B. Lugs: Indent/compression type for use with stranded branch circuit or control conductors.
- C. Solid Conductor Branch Circuits: Spring connectors, wire nuts, for conductors 18 through 8AWG.

2.04 LUGS AND PADS:

- A. Ampacity: Cross-sectional area of pad for multiple conductor terminations to match ampere rating of panelboard bus or equipment line terminals.

3 EXECUTION

3.01 INSTALLATION:

A. Wires and Cables:

1. Conductor Installation:

- a. Install conductors in raceways having adequate, code size cross-sectional area for wires indicated.
- b. Install conductors with care to avoid damage to insulation.
- c. Do not apply greater tension on conductors than recommended by manufacturer during installation.
- d. Use of pulling compounds is permitted. Clean residue from exposed conductors and raceway entrances after conductor installation. Do not use pulling compounds for installation of conductors connected to GFI circuit breakers or GFI receptacles.

2. Conductor Size and Quantity:

- a. Install no conductors smaller than 12AWG unless otherwise shown.
- b. Provide all required conductors for a fully operable system.

3. Provide dedicated neutrals (one neutral conductor for each phase conductor) in the following single phase circuits:

- a. Dimmer controlled circuits.
- b. Isolated ground circuits.
- c. Ground fault protected circuits where a GFI breaker is used in a panelboard.
- d. Other electronic equipment which producer a high level of harmonic distortion including but not limited to computers, printers, plotters, copy machines, fax machines, and the like.

4. MC cable allowed in the following locations only: In areas were there is an accessible ceiling. Do not use in areas where there is no accessible ceiling.

5. Conductors in Cabinets:
 - a. Cable and tree all wires in panels and cabinets for power and control. Use plastic ties in panels and cabinets.
 - b. Tie and bundle feeder conductors in wireways of panelboards.
 - c. Hold conductors away from sharp metal edges.
6. Connectors: Retighten mechanical type lugs and connectors for conductors to equipment prior to Substantial Completion.

3.02 FIELD QUALITY CONTROL:

A. Tests:

1. Test conductor insulation on feeders of [100] [???] amp and greater for conformity with 1000 volt megohmmeter. Use Insulated Cable Engineers Association testing procedures. Minimum insulation resistance acceptable is 1 megohm for systems 600 volts and below. In the condition that the insulation resistance is less than 1 megohm notify Architect.
2. Test Report: Prepare a typed tabular report indicating the testing instrument, the feeder tested, amperage rating of the feeder, insulation type, voltage, the approximate length of the feeder, conduit type, and the measured resistance of the megohmmeter test. Submit report with operating and maintenance manual.

END OF SECTION

1 GENERAL

1.01 SUMMARY:

- A. Grounding materials.
- B. Electric service grounding electrode.
- C. Feeder and branch circuit grounding.
- D. Raceway and enclosure grounding.
- E. Equipment grounding.
- F. Receptacle grounding.
- G. Related Sections:
 - 1. Section 26 0519, Low-Voltage Electrical Power Conductors and Cables.
 - 2. Section 26 0533, Raceway and Boxes for Electrical Systems.

1.02 SYSTEM DESCRIPTION:

- A. Provide grounding and bonding of electrical service, circuits, equipment, signal, and communications systems.
- B. Performance Requirements: Supplement the grounded neutral of the secondary distribution system with an equipment grounding system to properly safeguard the equipment and personnel. Install equipment grounding such that all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with electrical circuits operate continuously at ground potential and provide a low impedance path for possible ground fault currents.

1.03 SUBMITTALS:

- A. Provide Shop drawings and product data for the grounding material.
- B. Provide the following test reports for information:
 - 1. Grounding system test.

1.04 REGULATORY REQUIREMENTS:

- A. Conform to requirements of the NEC, latest adopted version with amendments by local AHJs.
- B. Furnish products listed by UL or another testing firm acceptable to AHJ.

1.05 SEQUENCING AND SCHEDULING:

- A. Building Ground Electrode: Coordinate placement of ground rods and grounding electrode conductor in base of building footing prior to placement of concrete. Coordinate bonding of rebar with rebar installer prior to rough-in.

2 PRODUCTS

2.01 MATERIALS:

- A. Grounding Connectors: Hydraulic compression tool applied connectors or exothermic welding process connectors or powder actuated compression tool applied connectors. Mechanical connectors are not acceptable. Manufacturers: Burndy Hyground Compression System, Erico/Cadweld, Amp Ampact Grounding System or approved.
- B. Pipe Grounding Clamp: Mechanical ground connector with cable parallel or perpendicular to pipe. Burndy GAR Series, O-Z Gedney, Thomas & Betts or approved.

3 EXECUTION

3.01 INSTALLATION:

- A. Concrete Encased Ground Electrode:
 - 1. From the service equipment ground bus install grounding electrode conductor to footing foundation rebar.
 - 2. Bond the grounding electrode conductor to two independent steel rebars. Minimum re-bar length, 20-feet.
 - 3. Protect grounding electrode conductor extension from footing/foundation to service equipment with rigid PVC conduit. Do not use metal conduit for grounding electrode conductor protection.
- B. Water Service Grounding: Bond building ground electrode and water service pipe to service ground bus. Connect to water pipe on utility side of isolating fittings or meters, bond across water meters.
- C. Raceways:
 - 1. Ground all metallic raceway systems. Bond to ground terminal with code size jumper except where code size or larger grounding conductor is included with circuit, use grounding bushing with lay-in lug.
 - 2. Connect all metal raceways, which terminate within an enclosure but without mechanical connection to the enclosure, by grounding bushings and ground wire to the grounding bus.
 - 3. Where equipment supply conductors are in flexible metallic conduit, install stranded copper equipment grounding conductor from outlet box to equipment frame.

4. Install equipment grounding conductor, code size minimum unless noted on Drawings, in all nonmetallic and metallic raceway systems.
- D. Feeders and Branch Conduits:
1. Install continuous insulated equipment copper ground conductors within the following circuits: feeders, circuits for computer systems and other circuits as indicated on Drawings.
 2. Where installed in a continuous solid metallic raceway system and larger sizes are not detailed, provide insulated equipment ground conductors for feeders and branch circuits sized in accordance with Table 250.122.
- E. Boxes, Cabinets, Enclosures and Panelboards:
1. Bond grounding conductors to enclosure with specified conductors and lugs. Install lugs only on thoroughly cleaned contact surfaces.
 2. Bond all sections of service equipment enclosure to service ground bus.
- F. Motors, Equipment and Appliances: Install code size equipment grounding conductor from outlet box to (motor) equipment frame or manufacturer's designated ground terminal.
- G. Receptacles: Connect ground terminal of receptacle to equipment ground system by No. 14 conductor bolted to outlet box except isolated grounds where noted. Self-grounding nature of receptacle devices does not eliminate the requirement for ground conductor bolted to outlet box.
- H. Separately Derived Systems: Ground each separately derived system per NEC 250.30.

END OF SECTION

1 GENERAL**1.01 SYSTEM DESCRIPTION**

- A. Safety factor of 4 required for every fastening device or support for electrical equipment installed. Support to withstand four times weight of equipment it supports.

1.02 SUPPORTING DEVICES

- A. Safety factor of 4 required for every fastening device or support for electrical equipment installed. Support to withstand four times weight of equipment it supports. Bracing to comply with Seismic Zone 3 requirements.

2 PRODUCTS**2.01 MATERIALS**

- A. Hangers: Kindorf B-905-2A channel, H-119-D washer, C105 strap, 3/8-inch rod with ceiling flange.
- B. Concrete Inserts: Kindorf D-255, cast in concrete for support fasteners for loads up to 800 lbs.
- C. Pipe Straps: Two-hole galvanized or malleable iron.

3 EXECUTION**3.01 INSTALLATION**

- A. Provide all electrical equipment supports.
- B. Verify mounting height of all luminaires or items prior to installation when heights are not detailed.
- C. Install vertical support members for equipment and luminaires, straight and parallel to building walls.
- D. Provide independent supports to structural member for electrical luminaires, materials, or equipment installed in or on ceiling, walls or in void spaces or over furred or suspended ceilings.
- E. Do not use other trade's fastening devices as supporting means for electrical equipment materials or fixtures.
- F. Do not use supports or fastening devices to support other than one particular item.
- G. Support conduits within 18-inches of outlets, boxes, panels, cabinets and deflections.

- H. Maximum distance between supports not to exceed 8-foot spacing.
- I. Securely suspend all junction boxes, pull boxes or other conduit terminating housings located above suspended ceiling from the floor above or roof structure to prevent sagging and swaying.
- J. Provide seismic bracing per UBC requirements.

END OF SECTION

1 GENERAL

1.01 SUMMARY:

- A. Section Includes:
 - 1. Raceways.
 - 2. Conduit fittings.
 - 3. Sleeves and chases.
 - 4. Surface metal raceways.
 - 5. Outlet boxes.
 - 6. Weatherproof outlet boxes.
 - 7. Junction and pull boxes.

1.02 SYSTEM DESCRIPTION:

- A. Raceways:
 - 1. Provide raceways, wires, cables, connector, boxes, devices, finish plates and the like for a complete and operational electrical system.
 - 2. Electrical Connections: Connect equipment, whether furnished by Owner or other Divisions of the Contract, electrically complete.
 - 3. Supporting Devices: Safety factor of 4 required for every fastening device or support for electrical equipment installed. Support to withstand four times weight of equipment it supports. Bracing to comply with Seismic Zone 3 requirements.
- B. Boxes:
 - 1. Outlet System: Provide electrical boxes and fittings as required for a complete installation. Include but not limited to outlet boxes, junction boxes, pull boxes, bushings, locknuts, and all other necessary components.
 - 2. Code Compliance: Comply with NEC as applicable to construction and installation of electrical boxes and fittings and size boxes according to NEC 370, except as noted otherwise.

1.03 SUBMITTALS:

- A. Provide Shop Drawings and Product Data for the Following Equipment:
 - 1. Raceways.
 - 2. Conduit fittings.
 - 3. Surface metal raceways.
 - 4. Outlet boxes.
 - 5. Weatherproof outlet boxes.
 - 6. Junction and pull boxes.

1.04 REGULATORY REQUIREMENTS:

- A. Conform to requirements of the NEC, latest adopted version with amendments by local AHJs.
- B. Furnish products listed by UL or another testing firm acceptable to AHJ.

1.05 SEQUENCING AND SCHEDULING:

- A. Raceway System is Defined as Consisting of: Conduit, tubing or duct and fittings including but not limited to connectors, couplings, offsets, elbows, bushings, expansion and deflection fittings and other components and accessories. Complete electrical raceway installation before starting the installation of conductors and cables.
- B. Finished Surfaces: Prevent cutting in connection with finished work. Make repairs in a manner approved by Architect.

2 PRODUCTS

2.01 MANUFACTURERS:

- A. Raceways: Allied Steel, Certainteed, Jones & Laughlin, Carlon, Kraloy, or approved.
- B. Conduit Fittings: 0-Z Gedney, Thomas & Betts, Crouse & Hinds, or approved.
- C. Surface Metal Raceway System: Square D, Wiremold, or approved, unless specifically noted on Drawings.
- D. Outlet Boxes: Bowers, Raco, or approved.
- E. Weatherproof Outlet Boxes: Bell, Red Dot, Carlon, or approved.
- F. Junction and Pull Boxes: Circle AW, Hoffman, or approved.
- G. Box Extension Adapter: Bell, Red Dot, Carlon, or approved.

H. Conduit Fittings: O-Z Gedney, Thomas & Betts, or approved.

2.02 CONDUITS:

- A. Galvanized Rigid Steel Conduit (GRC)
- B. Hot-dip galvanized after thread cutting.
- C. Manufacture in conformance with Federal Specification WWC-581 and ANSI C80.1.
- D. Uniform finish coat with chromate for added protection.
- E. Rigid Aluminum Conduit: Alloy 6063, threaded at each connection.
- F. Intermediate Metal Conduit (IMC)
- G. Hot-dip galvanized after thread cutting.
- H. Manufacture in conformance with Federal Specification WWC-581.
- I. Uniform finish coat with chromate for added protection.
- J. Electrical Metallic Tubing (EMT)
- K. Hot-dip galvanized and chromate coated.
- L. Manufacture in conformance with Federal Specification WWC-563 and ANSI C80.3.
- M. Flexible Conduit
- N. Reduced wall flexible steel conduit.
- O. Hot-dip galvanize steel strip prior to forming and joining.
- P. Manufacture in conformance with Federal Specification WWC-566.
- Q. Flexible Conduit, PVC Coated
- R. Hot-dip galvanize steel strip prior to forming and joining.
- S. PVC chemical resistant jacket extruded to core, up to 1-inch trade size.
- T. PVC chemical resistant jacket tubed over core, up to 4-inch trade size.
- U. PVC
- V. Class 40 heavy wall rigid PVC.
- W. Rated for use with 90C conductors.
- X. Manufacture in conformance with Federal Specification WC1094A and NEMA TC-2.

2.03 CONDUIT FITTINGS:

- A. Bushings:
 - 1. Insulated Type for Threaded Rigid, IMC Conduit or Raceway Connectors without Factory Installed Plastic Throat Conductor Protection: Thomas & Betts 1222 Series or O-Z Gedney B Series.
 - 2. Insulated Grounding Type for Threaded Rigid, IMC Conduit and Conduit Connectors: O-Z Gedney BLG Series.
- B. Raceway Connectors and EMT Couplings
- C. Steel conductor and coupling bodies, with zinc electroplate or hot-dip galvanizing.
- D. Connector locknuts are steel, with threading meeting ASTM tolerances. Locknuts are zinc electroplated or hot-dip galvanized.
- E. Connector throats (EMT, flexible conduit, metal clad cable and cordset connectors) have factory installed plastic inserts permanently installed. For normal cable or conductor exiting angles from the raceway (NEC bending radius), the cable jacket or conductor insulation bears only on the plastic throat insert.
- F. Steel gland, Tomic or Breagle connectors and couplings are recognized for this Contract as having acceptable raceway to fitting electrical conductance.
- G. Set screw connectors and couplings, without integral compression glands, are recognized for this Contract as not having acceptable raceway to fitting electrical conductance. A ground conductor sized per this Specification must be included and bonded within a raceway assembly utilizing this type connector or coupling.
- H. Expansion/Deflection Fittings
- I. EMT, O-Z Gedney Type TX.
- J. RMC, O-Z Gedney Type AX, DX and AXDX, Crouse & Hinds XD.

2.04 BOXES:

- A. Outlet Boxes
- B. Device Outlet: Installation of one or two devices at common location, minimum 4-inch square, minimum 1-1/2-inches deep. Single or 2-gang flush device raised covers. Raco Series 681 and 686.
- C. Multiple Devices: Three or more devices at common location. Install 1-piece gang boxes with 1-piece device cover. Install one device per gang.
- D. Masonry Boxes: Outlets in concrete, Raco Series 690.

- E. Construction: Provide 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.
- F. Accessories: Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, luminaire studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations.
- G. Weatherproof Outlet Boxes
- H. Construction: Provide corrosion-resistant cast metal weatherproof 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, blank plugs and corrosionproof fasteners. Weatherproof boxes to be constructed to have smooth sides, gray finish.

2.05 JUNCTION AND PULL BOXES:

- A. Construction: Provide galvanized sheet steel junction and pull boxes, with screw-on covers; of the type shape and size, to suit each respective location and installation; with welded seams and equipped with steel nuts, bolts, screws and washers.
- B. Location:
 - 1. Install junction boxes above accessible ceilings for drops into walls for receptacle outlets from overhead.
 - 2. Install junction boxes and pull boxes as required to facilitate the installation of conductors and limiting the accumulated angular sum of bends between boxes, cabinets, and appliances to 270 degrees.

2.06 BOX EXTENSION ADAPTER:

- A. Construction: Diecast aluminum.
- B. Location: Install over flush wall outlet boxes to permit flexible raceway extension from flush outlet to fixed or movable equipment. Bell 940 Series, Red Dot IHE4 Series.

2.07 CONDUIT FITTINGS:

- A. Requirements: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and plastic conduit bushings of the type and size to suit each respective use and installation.

3 EXECUTION

3.01 PREPARATION:

- A. Inserts, Anchors and Sleeves:
- B. Coordinate location of inserts and anchor bolts for electrical systems prior to pouring concrete.
- C. Coordinate location of sleeves for electrical systems prior to pouring concrete, with consideration for all other building systems.

3.02 INSTALLATION:

- A. Conduits
- B. Conduit Joints: Assemble conduits continuous and secure to boxes, panels, luminaires, and equipment with fittings to maintain continuity. Provide watertight joints where embedded in concrete, below grade or in damp locations. Seal PVC conduit joints with solvent cement and metal conduit with metal thread primer. All rigid conduit connections to be threaded, clean and tight (metal to metal). Threadless connections are not permitted for GRC and IMC.
 - 1. Conduit Placement
 - 2. Install continuous conduit and raceways for electrical power wiring [and signal systems wiring].
 - 3. Conceal all conduits. Exposed conduits are permitted only in the following areas:
 - a. Mechanical rooms, electrical rooms, or spaces where walls, ceilings and floors will not be covered with finished materials.
 - b. Existing walls that are concrete or block construction.
 - c. Where specifically noted on the Drawings.
 - d. Where exposed conduits are permitted install parallel or at right angles to building lines, tight to finished surfaces and neatly offset into boxes.
 - e. Do not install conduits or other electrical equipment in obvious passages, doorways, scuttles, or crawl spaces which would impede or block the area passage's intended usage.
 - f. Do not install conduits on surface of building exterior, across roof, on top of parapet walls, or across floors.

4. Below Grade Conduit and Cables: Place a minimum 3-inch cover of sand or clean earth fill around the cable or conduit on a leveled trench bottom. Lay conduit on a smooth level trench bottom, so that contact is made for its entire length. Remove water from trench before electrical conduit is installed.
 5. Maximum Bends: Install code sized pull boxes to restrict maximum bends in a run of conduit to 270 degrees.
 6. Conduit Terminations: Provide conduits shown on Drawings which terminate without box, panel, cabinet, or conduit fitting with not less than five full threads. Bushings and metal washer type sealer between bushing and conduit end.
 7. Flexible Conduit: Install 12-inch minimum slack loop on flexible metallic conduit and PVC coated flexible metallic conduit.
 8. Conduit Size: Size as indicated on Drawings. Where size is not indicated, provide conduit in minimum code permitted size for THW conductors of quantity shown. Minimum trade size 1/2-inch.
- C. Conduit Use Locations:
1. Underground: PVC.
 2. Cast-in-Place Concrete, Masonry, Damp Locations and Subject to Mechanical Damage: GRC or IMC.
 3. Dry, Protected: GRC, IMC, EMT.
 4. Sharp Bends and Elbows: GRC, EMT use factory elbows.
- D. Install pull wire or nylon cord in empty raceways provided for other systems. Secure wire or cord at each end.
- E. Elbows for Signal Cables: Use long radius factory ells where linking sections of raceway for installation of signal cable.
- F. Motors, recessed luminaires, and equipment connections subject to movement or vibration, use flexible metallic conduit.
- G. Motors and equipment connections subject to movement or vibration and subjected to any of the following conditions: exterior location, moist or humid atmosphere, water spray, oil or grease use PVC coated liquid tight flexible metallic conduit.
- H. Branch Circuits: Do not change the intent of the branch circuit or controls without approval. Homeruns for 20 amp branch circuits may be combined to a maximum of six conductors in a homerun. Apply derating factors as required by NEC 310. Increase conductor size as needed.
- I. Feeders: Do not combine or change feeder runs.

- J. Unless otherwise indicated, provide raceway systems for lighting, power and Class 1 remote-control and signaling circuits and Class 2 and 3 remote-control signaling and communication circuits.
- K. Condulets and Conduit Bodies: Condulets and conduit bodies are not allowed.
- L. Sleeves and Chases - Floor, Ceiling and Wall Penetrations: Provide necessary rigid conduit sleeves, openings, and chases where conduits or cables are required to pass through floors, ceiling, or walls.
- M. Boxes:
1. Location: Locate boxes and conduit bodies so as to ensure accessibility of electrical wiring.
 2. Round Boxes: Avoid using round boxes where conduit must enter through side of box, which would result in a difficult and insecure connection with a locknut or bushing on the rounded surface.
 3. Anchoring: Secure boxes rigidly to the substrate upon which they are being mounted, or solidly embed boxes in concrete or masonry.
 4. Special Application: Provide weatherproof outlets for locations exposed to weather or moisture.
 5. Knockout Closures: Provide knockout closures to cap unused knockout holes where blanks have been removed.
 6. Mount Center of Outlet Boxes, unless Otherwise Required by ADA, or Noted on Drawings, the Following Distances above the Floor:
 - a. Control Switches: 48-inches.
 - b. Receptacles: 18-inches.
 - c. Telecom Outlets: 18-inches.
 - d. Other Outlets: As indicated in other Sections of Specifications or as detailed on Drawings.
 7. Coordinate all electrical device locations (switches, receptacles, and the like) with Drawings to prevent mounting devices in mirrors, back splashes, behind cabinets, and the like.

END OF SECTION

1 GENERAL**1.01 SUMMARY:**

- A. Section Includes:
 - 1. Equipment identification labels.
 - 2. Conductor identification numbers.
 - 3. Branch circuit identification.

1.02 SYSTEM DESCRIPTION:

- A. Design Requirements
- B. Coordinate names, abbreviations and other designations with equipment specified in this or other Divisions of the Specification or identified on Drawings.
- C. Fasten labels to equipment in a secure and permanent manner.

1.03 REGULATORY REQUIREMENTS:

- A. Conform to requirements of the NEC, latest adopted version with amendments by local AHJs.
- B. Furnish products listed by UL or another testing firm acceptable to AHJ.

2 PRODUCTS**2.01 MANUFACTURERS:**

- A. Engraved Labels: Lamicoid or approved.
- B. Conductor Numbers: Brady or approved.

2.02 ENGRAVED LABELS:

- A. Melamine plastic laminate, white with black core, 1/16-inch thick.
- B. Letter and number font: Engravers standard letter style, minimum 3/16-inch high letters, all capitals.
- C. Drill or punch labels for mechanical fastening except where adhesive mounting is necessary because of substrate. Use self-tapping stainless steel screws.
- D. Dymo tape labels are not acceptable.

2.03 CONDUCTOR NUMBERS:

- A. Cable and conductor markers: Standard vinyl-cloth self-adhesive backing, wraparound type. Pre-printed black numbers on a yellow field.

2.04 BRANCH CIRCUIT SCHEDULES:

- A. Provide branch circuit identification schedules, typewritten, clearly filled out, to identify load connected to each circuit and location of load. Numbers to correspond to numbers assigned to each circuit breaker pole position.
- B. Provide two columns, odd numbers in left column, even numbers in right column, with 3-inch wide line for typing connected load information.

2.05 CIRCUIT BREAKER IDENTIFICATION:

- A. Provide permanent identification number in or on panelboard dead-front adjacent to each circuit breaker pole position. Square D adhesive approved, other adhesives by specific prior approval only.
- B. Horizontal centerline of engraved numbers to correspond with centerline of circuit breaker pole position.

3 EXECUTION

3.01 GRAPHICS:

- A. Coordinate names, abbreviations and designations used on Drawings with equipment labels.

3.02 CONDUCTOR IDENTIFICATION:

- A. Apply markers on each conductor for power, control, signaling and communications circuits where wires of more than one circuit are present.
- B. Match conductor identification used in panelboards, shop drawings, Contract Documents and similar previously established identification for work included in Divisions 26,27, and 33.

3.03 EQUIPMENT/SYSTEM IDENTIFICATION:

- A. Install an engraved label on each major unit of electrical equipment, including but not limited to the following items:
 - 1. Disconnect switches, identify item of equipment controlled.
 - 2. Relays.
 - 3. Contactors.
 - 4. Time switches.
 - 5. Override switches.
 - 6. Service disconnect and distribution switches, identify connected load.
 - 7. Branch circuit panelboards.

8. Central or master unit of each electrical system, including communication/signal systems, unless the unit incorporates its own self-explanatory identification.

3.04 APPLICATION:

- A. Install engraved labels on the inside of flush panels, visible when door is opened. Install label on outside of surface panel.
- B. Install signs at locations detailed or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment.
- C. Where signs are to be applied to surfaces, which require finish, install identification after completion of painting.

END OF SECTION

1 GENERAL**1.01 SUMMARY:****A. Section Includes:**

1. Switchboards.

B. Related Sections:

1. Section 26 0553, Identification for Electrical Systems.
2. Section 33 7173, Electrical Utility Services.
3. Section 26 0526, Grounding and Bonding for Electrical Systems.
4. Section 26 2800, Low-Voltage Circuit Protective Devices.

1.02 SYSTEM DESCRIPTION:

- A. Electrical Service System: 208Y/120 volts, 3-phase, 4 wire, wye connected system.

1.03 SUBMITTALS:**A. Provide Shop Drawings and Product Data for the Following Equipment:**

1. Switchboards.

- B. Provide the following operating, maintenance, and installation instructions from the manufacturer for project closeout, see Project Closeout Requirements in Division 01:

1. Switchboards.

1.04 REGULATORY REQUIREMENTS:

- A. Conform to requirements of the NEC, latest adopted version with amendments by local AHJs.
- B. Furnish products listed by UL or another testing firm acceptable to AHJ.
- C. Conform to requirement of the serving electric utility.

2 PRODUCTS**2.01 MANUFACTURERS:**

- A. Switchboards: General Electric, match to existing Switchboard.

2.02 MATERIALS:

- A. Standards: Comply with requirements of UL 67, NEMA PB1 and NEC 384 in construction of switchboards.
- B. Switchboards:
 - 1. Enclosures:
 - a. Free standing, dead front with front accessibility.
 - b. Framework constructed of formed, code gauge steel, rigidly welded and bolted together to support all cover plates, bussing and component devices during shipment and installation bolt steel base channels to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting.
 - c. Provide each section with individually removable top plate and open bottom to permit installation and termination of service and feeder raceways.
 - d. Removable Front Covers: Screw attached.
 - e. Provide removable hinge pins on all hinged doors.
 - f. Paint interior and exterior surfaces. Medium light gray finish applied by electro-deposition process over an iron phosphate pretreatment.
 - 2. Bussing:
 - a. Material: Extruded aluminum plated by ALTAN 70 or 80 process.
 - b. Bus supports, connections and joints bolted together with hex-head bolts and Belleville washers.
 - c. Ground Bus: Full length of switchboard, 50 percent of phase bus capacity.
 - d. Neutral Bus: 100 percent rated, full length of switchboard.
 - 3. Provide fully rated integrated equipment rating greater than the available fault current. Series rated switchboards are not acceptable. See Drawings for available fault current.
 - 4. Lugs: Compression type rated for both aluminum and copper conductors.
 - 5. Circuit Breakers:
 - a. Provide electronic, adjustable trip, circuit breakers rated 600A and larger.
 - b. Provide molded case thermal magnetic circuit breakers, less than 600A.

- c. Provide the units with provisions for padlocking in the "OFF" position.
- d. Operating handle position to clearly indicate device contact position, "ON" or "OFF".
- e. Provide circuit breakers rated for the available fault current and suitable for use as service equipment.

3 EXECUTION

3.01 INSTALLATION:

- A. General: Equipment arrangement in electrical room is based on one manufacturer. Coordinate space requirements with equipment supplier. Maintain Code required clearances and manufacturer's recommended clearances.
- B. Switchboards:
 - 1. Install switchboards as directed by manufacturer's installation instructions.
 - 2. Install equipment in conformance with workspace requirements of NEC 110.26.
 - 3. Locate equipment in rooms or spaces dedicated to such equipment, NEC 110.26(F). Coordinate with other Divisions of work.

3.02 CLEANING:

- A. Thoroughly clean the exterior and the interior of each switchboard and distribution panelboard in accordance with manufacturer's installation instructions.
- B. Vacuum construction dust, dirt and debris out of each switchboard and distribution panelboard.
- C. Where enclosure finish is damaged, touch up finish with matching paint in accordance with manufacturer's specifications and installation instructions.

END OF SECTION

1 GENERAL

1.01 SUMMARY:

- A. Section Includes:
 - 1. Toggle types disconnect switches.
 - 2. Manual motor starters.
 - 3. Safety switches.
 - 4. Fuses.
 - 5. Circuit breakers.
 - 6. Fuse cabinet.

1.02 SYSTEM DESCRIPTION:

- A. Provide disconnect switches as required by NEC for a complete and operational electrical system.

1.03 SUBMITTALS:

- A. Provide product data for toggle type disconnect switches, manual motor starters, and safety disconnect switches.
- B. Provide product data for project closeout, see Project Closeout Requirements in Division 1.
- C. Product Data:
 - 1. Provide instantaneous let-through current curves and average melting time current curves for fuses supplied to project.
 - 2. Provide product data and time/current trip curves for circuit breakers supplied to project.

1.04 REGULATORY REQUIREMENTS:

- A. Conform to requirements of the NEC, latest adopted version with amendments by local AHJs.
- B. Furnish products listed by UL or another testing firm acceptable to AHJ.

2 PRODUCTS

2.01 MANUFACTURERS:

- A. Toggle Type Disconnect Switches: Arrow-Hart, Bryant, Hubbell, Leviton, Pass & Seymour, Slater, or approved.
- B. Manual Motor Starters: Cutler-Hammer/Westinghouse, Siemens, Square D, or approved.
- C. Safety Switches: Cutler-Hammer/Westinghouse, General Electric, Siemens, Square D, or approved.
- D. Fuses: Bussmann Division, McGraw-Edison; Shawmut Division, Gould Electronic, Littelfuse, or approved.
- E. Circuit Breakers: Cutler-Hammer/Westinghouse, General Electric, Siemens, Square D, or approved.
- F. Fuse Cabinet: Bussmann, Circle AW, Gould-Shawmut, Littelfuse, Siemens, Square D, or approved.

2.02 TOGGLE TYPE DISCONNECT SWITCHES:

- A. Rating: 120 volts, 1-pole, 20 amp, 1 HP maximum.
- B. Enclosure: NEMA 1 indoors, NEMA 3R raintight outdoors.

2.03 MANUAL MOTOR STARTERS:

- A. Characteristics:
 - 1. Quick-make, quick-break.
 - 2. Thermal overload protection.
 - 3. Clearly label device for maximum voltage, current and horsepower.
 - 4. Square D, Class 2510.
- B. Enclosure: NEMA 1 indoors, NEMA 3R raintight outdoors.

2.04 SAFETY SWITCHES:

- A. Heavy duty, fused type, dual rated, quick-make, quick-break with fuse rejection feature for use with Class R fuses only, unless another fuse type is specifically noted.
- B. Enclosures NEMA 1 indoors, NEMA 3R raintight outdoors.
- C. Switches clearly marked for maximum voltage, current and horsepower.

- D. Equip enclosure with defeatable cover interlock.
- E. Switches rated for maximum available fault current.

2.05 COMBINATION STARTERS:

- A. Heavy duty, fused type, dual rated, quick-make, quick-break with fuse rejection feature for use with Class R fuses only, unless another fuse type is specifically noted.
- B. Enclosures NEMA 1 indoors, NEMA 3R raintight outdoors.
- C. Clearly mark switches for maximum voltage, current and horsepower.
- D. Provide coil voltage coordinated with control requirements.
- E. Provide thermal overload units sized to equipment nameplate rating.
- F. Provide one N.C. and one N.O. auxiliary contacts.
- G. Provide pre-wired hand/off/auto switch and start button.

2.06 FUSES:

- A. Characteristics: Dual element, time delay, current limiting, nonrenewable type, rejection feature.
- B. Combination Loads: Class RK1, 1/10 to 600 amp, UL Class L, above 600 amps.
- C. Motor Loads: UL Class RK5, 1/10 to 600 amp.
- D. Fuse pullers for complete range of fuses.

2.07 MOLDED CASE CIRCUIT BREAKERS:

- A. One, two or three-pole bolt on, single handle common trip, rated 15 to 800 amp, 250VAC as indicated on Drawings.
- B. Over center toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.
- C. Calibrate for operation in 40C ambient temperature.
- D. 15 to 100 Amp Breakers: Permanent trip unit containing individual thermal and magnetic trip elements in each pole.
- E. Greater than 100 Amp Breakers: Variable magnetic trip elements set by a single adjustment. Provide push-to-trip button on cover on breaker for mechanical tripping.
- F. Provide removable load lugs, UL listed for compression type lugs, copper conductors only.
- G. Provide all circuit breakers series rated and when series combination ratings are applied, identify all equipment enclosures as required by NEC 110-22.

3 EXECUTION

3.01 INSTALLATION:

- A. Provide disconnect switch at each motor location within 5-feet unless otherwise noted.
- B. Motors within sight of and not more than 20-feet from motor branch circuit device do not require a disconnect switch at the motor. Provide locking device on circuit protective device.
- C. Recessed fractional horsepower exhaust ceiling or wall fan units; no disconnect switch required at motor if unit is recessed, unless shown otherwise on Drawings.
- D. Switches disconnect all phase legs.
- E. Coordinate fuse ampere rating with installed equipment. Fuse ampere rating variance between original design information and installed equipment, size in accordance with Bussmann Fusetron 40C recommendations. Do not provide fuses of lower ampere rating than motor starter thermal units.
- F. Fuses: For each class and ampere rating of fuse installed, provide the following quantities of spares for quantity of fuses installed:
 - 1. 0 to 24: Provide 6 spare.
 - 2. 25 to 48: Provide 9 spare.
 - 3. 49 and Above: Provide 12 spare.
- G. Circuit Breakers:
 - 1. Provide circuit breakers, specified herein and on Drawings, for installation in panelboards, individual enclosures, or combination motor starters.
 - 2. Provide ground fault interrupter circuit breakers for equipment in damp or wet locations.
 - 3. Provide device on handle to lock breaker in "ON" position for breakers feeding time switches, night lights and similar circuits required to be continuously energized.

END OF SECTION