SECTION 16020/CODES AND STANDARDS

1 GENERAL

1.1 All work under Division 16 shall be constructed in accordance with the codes and standards listed herein. The design has been based on the requirements of these codes and standards. While it is not the responsibility of the Contractor to verify that all work called for complies with these codes and standards, he shall be responsible for calling to the Engineer's attention any details on the Drawings and/or Specifications that are not in conformance with these or other codes and standards. Current issue of code applies unless specifically noted otherwise.

1.2 Comply with regulations and codes of suppliers of utilities.

1.3 Where no specific method or form of construction is called for in the Contract Documents, the Contractor shall comply with code requirements when carrying out such work.

1.4 Where code conflict exists, generally the most stringent requirement applies.

1.5 Codes or standards applying to a specific part of the work may be included in that section.

2 CODES

2.1 Florida Building Code - Building - 2007 with 2009 amendments

2.2 National Electrical Code (NFPA 70) - 2008

2.3 National Fire Alarm Code (NFPA 72) - 2002

2.4 Uniform Fire Code (NFPA 1) - 2006 Florida Edition

2.5 National Electrical Safety Code (NESC)

2.6 Life Safety Code (NFPA 101) - 2006 Florida Edition

3 STANDARDS

3.1 All electrical materials, installation and systems shall meet the requirements of the following standards, including the latest addenda and amendments:

3.1.1 American National Standard Institutes (ANSI)

3.1.2 Illuminating Engineering Society (IES).

3.1.3 Institute of Electrical and Electronics Engineers (IEEE).

3.1.4 National Electrical Manufacturer's Associations (NEMA).

3.1.5 National Fire Protection Association (NFPA).

3.1.6 Occupational Safety and Health Act (OSHA).

3.1.7 Underwriter's Laboratories, Inc. (UL).

END OF SECTION

SECTION 16030/ELECTRICAL RELATED WORK

1 DIVISION 1 - GENERAL REQUIREMENTS

1.1 All Division 1 Sections apply to all Division 16 Sections.

1.2 Coordinate for all cutting and patching. Contractor shall review all cutting and patching required prior to bidding and shall coordinate installation.

2 DIVISION 2 - SITEWORK

2.1 Specific requirements for excavation and backfill for underground conduit are contained in Section 16105.

2.2 The following is part of Division 16 work.

2.2.1 Underground electrical utilities.

3 DIVISION 3 - CONCRETE

3.1 Perform the following as part of Division 16 work, complying with the requirements of Division 3, Concrete.

3.1.1 Curbs, foundations and pads for electrical equipment.

3.1.2 Encasement of electrical work.

3.1.3 Underground structural concrete to accommodate electrical work.

3.1.4 Rough grouting in and around electrical work.

3.1.5 Patching concrete cut to accommodate electrical work.

4 DIVISION 4 - MASONRY

4.1 Refer to Division 4, Masonry for:

4.1.1 Patching openings to accommodate electrical work.

5 DIVISION 5 - METALS

5.1 Refer to Division 5, Metals for:

5.1.1 Supports for electrical work.

5.1.2 Framing openings for electrical equipment.

6 DIVISION 6 - WOOD

6.1 Refer to Division 6, Wood for:

6.1.1 Supports for electrical work.

6.1.2 Framing openings for electrical equipment.

7 DIVISION 7 - THERMAL & MOISTURE PROTECTION

7.1 Refer to Division 7, Thermal and Moisture Protection for:

7.1.1 Installation of all supports for electrical work.

7.1.2 Caulking and waterproofing of all wall and roof mounted electrical work.

7.2 Perform the following as part of Division 16 work, complying with Division 7 requirements.

7.2.1 Fire barrier penetration seals.

7.2.2 Caulking and related shielding around ducts and pipes for sound isolation and attenuation.

8 DIVISION 8 - DOORS AND WINDOWS

8.1 Refer to Division 8, Doors & Windows for:

8.1.1 Installation of all access doors for electrical work.

9 DIVISION 9 - FINISHES

9.1 Refer to Division 9, Finishes for:

9.1.1 Painting exposed conduit and equipment.

9.1.2 Painting structural metal and concrete for electrical work.

9.1.3 Painting access panels.

9.2 Colors shall be selected by the Architect for all painting of exposed electrical work unless specified herein.

9.3 Perform the following as part of Division 16 work.

9.3.1 Touch up painting of factory finishes.

10 DIVISION 15 - MECHANICAL

10.1 Mechanical Contractor shall furnish to Electrical Contractor all necessary nameplate data, equipment power requirements, wiring diagrams, etc., pertaining to the electrical phase of

mechanical installation, as well as all required motors, on/off switches, warning lights, relays, and control devices.

10.2 Contractor shall furnish and install all power wiring, starters and contactors, and make final electrical connections to motors, on/off switches, warning lights, relays, and control devices.

10.3 Disconnect switches for mechanical equipment shall be furnished and installed by the Contractor, unless specifically noted on the Drawings as being furnished as part of mechanical equipment.

10.4 Wiring for controls as indicated on the electrical drawings shall be furnished and installed by the electrical contractor. Control wiring and signal wiring between field installed controls, indicating devices and unit control panels as part of mechanical energy management system shall be provided by Division 15, complying with the requirements of Division 16 specifications.

11 DIVISION 17 - TELECOMMUNICATIONS

11.1 See "Contractor Coordination and Responsibilities Note" on the Drawings.

END OF SECTION

SECTION 16100/BASIC MATERIALS AND METHODS

1 GENERAL

1.1 Related Documents

1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.1.2 This Section is a Division-16 Basic Materials and Methods Section, and is part of each Division-16 Section making reference to or requiring products specified herein.

1.1.3 The requirements of these specifications also apply to Divisions 15, 17 and 18, unless clearly indicated within those Divisions.

1.2 Summary

1.2.1 This Section includes the following:

1.2.1.1 Raceways.

1.2.1.2 Building wire and connectors.

1.2.1.3 Supporting devices for electrical components.

1.2.1.4 Concrete equipment bases.

1.2.1.5 Cutting and patching for electrical construction.

1.2.1.6 Touchup painting.

1.3 Definitions

1.3.1 EMT: Electrical metallic tubing.

1.3.2 FMC: Flexible metal conduit.

1.3.3 RGS: Rigid galvanized steel conduit.

1.3.4 LFMC: Liquidtight flexible metal conduit.

1.3.5 RNC: Rigid nonmetallic conduit.

1.4 Quality Assurance

1.4.1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4.2 Comply with NFPA 70.

1.4.3 All materials and equipment specified herein shall be UL listed or approved according to the requirements of applicable NEC articles.

1.5 Coordination

1.5.1 Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1.5.2 Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

1.5.3 Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

1.5.4 Coordinate electrical service connections to components furnished by utility company.

1.5.5 Coordinate installation and connection of exterior underground utilities and services, including provision for electricity-metering components.

1.5.6 Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

1.5.7 Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."

1.6 Approval Submittals:

1.6.1 Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each product provided.

2 PRODUCTS

2.1 Manufacturers

2.1.1 Manufacturers: Subject to compliance with requirements, provide products by the following:

2.1.1.1 Allied Tube and Conduit;

2.1.1.2 Appleton Electric;

2.1.1.3 Belden Corporation;

2.1.1.4 Bridreport;

2.1.1.5 Ideal;

2.1.1.6 Erico;

2.1.1.7 W.H. Brady Co.;

2.1.1.8 Carlon;

2.1.1.9 Challenger, Crouse-Hinds Co.;

2.1.1.10 ETP;

2.1.1.11 Elcen Metal Products Co.;

2.1.1.12 General Cable Co.;

2.1.1.13 General Electric Co.;

2.1.1.14 Hoffman Engineering Co.;

2.1.1.15 Harvey Hubbell, Inc.;

2.1.1.16 Midland-Ross Corporation;

2.1.1.17 Okonite Co.;

2.1.1.18 0-Z/Gedney;

2.1.1.19 Quazite;

2.1.1.20 Raco, Inc.;

2.1.1.21 CDR;

2.1.1.22 Republic Steel Corporation;

2.1.1.23 3M;

2.1.1.24 Southwire;

2.1.1.25 Seton Nameplate;

2.1.1.26 Square D Co.;

2.1.1.27 Thomas and Betts;

2.1.1.28 Triangle PWC, Inc.;

2.1.1.29 Walker Parkersburg Textron;

2.1.1.30 Wiremold Co.,

2.1.1.31 Westinghouse Engine Div.

2.1.1.32 Wheatland

2.2 Raceways

2.2.1 EMT: ANSI C80.3, galvanized steel, protected inside and out. Maximum size of EMT shall be 4". Minimum size shall be ½" unless noted otherwise on the Drawings. EMT shall only be used with cables rated 600 volts or less and in indoor locations not subject to physical abuse.

2.2.2 FMC: galvanized steel protected inside and out.

2.2.3 RGS: galvanized steel, protected inside and out.

2.2.4 LFMC: galvanized steel protected inside and out with sunlight-resistant and mineral-oil-resistant plastic jacket.

2.2.5 RNC: NEMA TC 2, Schedule 40 PVC, with NEMA TC3 fittings.

2.2.6 Raceway Fittings

2.2.6.1 Specifically designed for the raceway type with which used.

2.2.6.2 RGS shall have threaded fittings, galvanized steel or threadless compression galvanized steel or threadless compression cadmium plated malleable iron. Fittings shall be rain tight/concrete tight.

2.2.6.3 RNC shall have polyvinyl chloride (PVC) fittings suited for the purpose and joined together by a method approved for the purpose. Schedule 80 conduit sections may be joined together with threaded fitting connectors.

2.2.6.4 EMT: Federal Specification W-F-408, except only material of steel or malleable iron is acceptable. Couplings and connectors shall be concrete and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 2" and smaller. Use set screw type couplings with four set screws each for conduit sizes over 2". Use set screws of casehardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding. Indent type connectors or couplings are prohibited. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.

2.2.6.5 FMC fittings shall be zinc plated steel or cadmium plated malleable iron screw type with insulated throat and angular wedge fitting between convolutions of conduit. Federal Specification W-F-406 and UL 5.

2.2.6.6 LFMC fittings shall be cadmium plated, malleable iron or steel with compression type steel ferrule and neoprene gasket sealing rings, with insulated throat.

2.2.6.7 Wireway fittings shall be steel with rust resistant undercoat and finish coat to match the wireway. The fittings shall be so designed that the sections can be electrically and mechanically fitted together to form a complete system. Dead ends shall be closed.

2.2.6.8 Couplings and Unions shall be galvanized steel, tapered thread standard conduit couplings for intermediate metal conduit and RGS. PVC couplings for rigid non-metallic conduit shall use

approved adhesive, and threaded couplings shall be used for schedule 80 conduit. Split couplings shall be galvanized steel. Unions shall be ground joint type galvanized steel.

2.2.7 Bushings

2.2.7.1 Shall be provided at the end of all conduits prior to pulling cables to protect the insulation of the conductor. Provide grounding bushings for metal raceways, boxes, and cabinets to insure that all metallic surfaces are effectively grounded. Metallic raceway may be bonded to cabinets, boxes and panelboards by double locknut and bushing to ensure the metallic parts are all effectively grounded. Bushings shall be one of the following types:

2.2.7.2 Zinc plated steel, threaded or threadless

2.2.7.3 Zinc plated steel of threaded or threadless, phenolic insulated with temperature rating of 105 degree C

2.2.7.4 Cadmium plated malleable iron, threaded or threadless

2.2.7.5 Cadmium plated malleable iron, threaded or threadless, phenolic insulated, with temperature rating of 105 degree C

2.2.7.6 Phenolic with temperature rating of 105 degree C

2.2.7.7 Zinc plated steel, or cadmium plated malleable iron; threaded or threadless; non-insulated or insulated with grounding connector or grounding lug

2.3 Metal Wireways

2.3.1 Material and Construction: Shall be sheet metal troughs with hinged or removable covers, rust resistant undercoat and gray finish coat. Sizes shall be as indicated on the Drawings or determined by the Contractor based on NEC requirements according to the number of conductors enclosed. Exterior units shall be weatherproof. Steel shall be minimum 14 gauge.

2.3.2 Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.3.3 Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

2.4 Surface Raceways

2.4.1 Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard coating.

2.4.1.1 Manufacturers: Walker Systems, Inc.; Wiremold Company (The).

2.4.2 Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.5 Cable Trays:

2.5.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.5.1.1 Cablofil Inc.

2.5.1.2 Cooper B-Line, Inc.

2.5.1.3 Flextray.

2.5.2 Cable Tray Material: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1 .

2.5.3 Basket Cable Trays: Minimum 12 inches wide and 4 inches deep. Wire mesh spacing shall not exceed 2 inches by 4 inches. Category 6 compliant.

2.5.3.1 Provide all necessary transitions at 90-degree angles, tees and change of cable tray size so that the cable tray is continuous. The drawings do not reflect these requirements due to the small scale. Transitions shall also be provided at all change of elevations.

2.5.3.2 Supports: Cable tray shall be supported by trapeze style hanging clips on threaded rods on both sides of the tray. Center supports are prohibited. Exception: cable tray in TRs which shall be supported by wall brackets.

2.5.3.3 Coordinate installation with other trades to avoid conflicts prior to installation. Install as required to transition around, above or below other trades work.

2.6 Boxes, Enclosures, and Cabinets

2.6.1 Sheet Metal Outlet and Device Boxes: Galvanized, NEMA OS 1. Boxes shall be 4"x 4" x 1-1/2" deep or larger (4" wide x 4" long x 2-1/8" deep or larger for telecommunications and CATV). Use only in recessed interior applications or non-finished interior applications.

2.6.2 Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Use in exterior applications and interior finished surface mounted applications.

2.6.3 Floor Boxes: Per details on drawings.

2.6.4 Small Sheet Metal Pull and Junction Boxes: NEMA OS 1. Use only in flush interior applications or non-finished interior applications.

2.6.5 Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover. Use in exterior applications and interior finished surface mounted applications.

2.6.6 Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

2.6.7 Metal Enclosures: Galvanized steel, finished inside and out with manufacturer's standard enamel.

2.6.8 Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable

front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.6.9 Exterior In-ground Junction Boxes: UL listed, polymer concrete construction, flared-wall, heavy duty cover (15,000 lbs over a 10" square), open bottom construction. Equivalent to Quazite "PG" style. Size as required or as indicated on the drawings, whichever is bigger.

2.7 Conductors

2.7.1 Conductors, No. 10 AWG and Smaller: 98% conductivity solid or stranded copper.

2.7.2 Conductors, Larger Than No. 10 AWG: 98% conductivity stranded copper.

2.7.3 Insulation: Dual rated THHN/THWN unless noted otherwise on the Drawings. Exception: Conductors for fire pumps and associated jockey pumps which shall be RHH 2 hour rated UL listed.

2.7.4 Low voltage Cables: Provide plenum rated where required.

2.7.5 Wire Connectors and Splices: Connectors for 600-volt conductors Size No. 18 to No. 6 AWG shall be pressure type, spring connectors. Use 600 volt splicer-reducer pressure connectors for copper conductors to 500 KCMIL. Use rectangular, solderless pressure connectors or split bolt-copper alloy connectors for copper conductors to 1000 KCMIL.

2.8 Supporting Devices

2.8.1 Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

2.8.2 Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

2.8.3 Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs.

2.8.3.1 Channel Thickness: Selected to suit structural loading.

2.8.3.2 Fittings and Accessories: Products of the same manufacturer as channel supports.

2.8.4 Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

2.8.5 Conduit Straps: All conduit shall be secured with two hole galvanized straps where the following conditions exist:

2.8.5.1 All exterior locations.

2.8.5.2 All interior locations other than mechanical and electrical rooms where the conduit is below 10'. Conduit concealed in wall finishes and ceilings may use single hole strap if allowed by NEC.

2.8.5.3 All other locations not listed above and approved by the NEC may use single hole galvanized straps.

2.8.5.4 Single hole or double hole straps may not be used on direct grade. All conduits on grade shall be mounted to galvanized strut and properly attached and anchored.

2.8.6 Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

2.8.7 Expansion Anchors: Carbon-steel wedge or sleeve type.

2.8.8 Toggle Bolts: All-steel springhead type.

2.9 Concrete Bases

2.9.1 Concrete Forms and Reinforcement Materials: Shall be provided for all floor mounted electrical equipment. Concrete bases and structural steel to support this Division's equipment and raceways, and not specifically shown on Structural or Architectural Drawings shall be furnished by the Contractor whose equipment or raceways is to be supported. Provide a raised reinforced 4" concrete base for all floor supported equipment. Equipment installed outdoors on concrete slabs shall be provided with a 4" raised concrete base. Pad shall exceed the equipment's footprint by 4" on all sides.

2.9.2 Concrete: 3000-psi (20.7-MPa), 28-day compressive strength.

2.10 Touchup Paint

2.10.1 For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

2.10.2 Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer..

2.11 Equipment Backboards

2.11.1 Equipment Backboards shall be exterior grade 3/4" plywood. Paint backboard with two coats of fire retardant gray paint on all six sides before mounting. Exposed side of plywood shall be smooth interior grade. A copper ground bus shall be supplied with each backboard. The ground bus shall terminate the #6 AWG ground wire provided from the electrical system. Locate equipment backboards where indicated on the Drawings. Install straight and plumb. Secure to structure using screws, toggle bolts or masonry anchors. DO NOT use plastic or wood plugs in masonry or concrete. Do not install combustible backboards in air handling space, plenums or where prohibited by the local governing authority.

3 EXECUTION

3.1 Electrical Equipment Installation

3.1.1 Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange

and install components and equipment to provide the maximum possible headroom.

3.1.2 Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated. Materials and equipment shall be installed in a neat and workmanlike manner according to the standards of the industry. Materials and equipment installed and not meeting the standards of the industry may be rejected and required to be removed and reinstalled by the Contractor at no additional cost to the Owner. Minor location changes from those indicated may be necessary so that work can conform with the building as constructed, to fit work of other trades or to comply with the rules of authorities having jurisdiction. Refer to structural drawings for framed openings for raceways, etc., in floors and roofs. Contractor shall be responsible for locating and providing proper dimensions for all required electrical openings.

3.1.3 Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

3.1.4 Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 Raceway Application

3.2.1 Outdoors

3.2.1.1 Use the following raceways for outdoor installations:

3.2.1.1.1 Exposed: RGS.

3.2.1.1.2 Concealed: RGS.

3.2.1.1.3 Underground: RGS. Feeders and branch circuit raceways installed below grade equal to and greater than 3/4" may be PVC, at the contractor's option. If PVC is used underground or below slab, elbows and risers through grade or slab shall be RGS, except as listed below in paragraph titled "Special PVC Requirements". All exposed raceways penetrating concrete slab shall be rigid metal conduit. Communication raceways shall be run overhead within the building except for connection to floor boxes. Any raceway not meeting this requirement shall be replaced at the contractor's expense. Additional construction time and compensation for the correction of the deficiency will not be allowed. RGS installed underground shall be painted with two coats of alkali and acid resistant paint such as bitumastic or equal. Coating shall not be diluted and shall completely cover conduit.

3.2.1.1.4 Connection to Vibrating Equipment: LFMC.

3.2.1.1.5 Provide sealing fittings, or properly seal the conduit system, to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant temperature rooms, air conditioned spaces, building exterior walls, roofs or similar spaces.

3.2.1.1.6 Boxes and Enclosures: NEMA 250, Type 3R or Type 4.

3.2.2 Indoors

3.2.2.1 Use the following raceways for indoor installations:

3.2.2.1.1 Exposed: RGS except EMT is acceptable in mechanical and electrical rooms above 6' AFF. Conduit may be exposed in equipment rooms, vertical chases, mechanical and electrical rooms, other similar spaces not normally habitable or exposed to public view, and where electrical drawings specifically note "exposed conduit."

3.2.2.1.2 Concealed: EMT.

3.2.2.1.3 Connection to Mechanical, Plumbing and Fire Protection Equipment: LFMC; exceptions: controls not mounted on equipment, which shall comply with 3.2.2.1 above; and small air handling units such as variable air volume units and air terminal units mounted above ceilings outside mechanical rooms, which shall be FMC.

3.2.2.1.4 Connection to Vibrating Equipment: FMC, except as listed in 3.2.2.1.3.

3.2.2.1.5 Damp or Wet Locations: RGS.

3.2.2.1.6 Boxes and Enclosures: NEMA 250, Type 1, unless otherwise indicated.

3.2.2.1.7 Do not use PVC coated flex conduit in plenums, including air streams inside air handler units. Use FMC instead.

3.2.3 Hazardous Locations

3.2.3.1 Use the following raceways for hazardous installations:

3.2.3.1.1 Raceways in hazardous areas shall be rigid metal conduit.

3.2.3.1.2 Install UL approved sealing fittings that prevent passage of explosive vapors, in hazardous areas equipped with explosive proof lighting fixtures, switches, and receptacles as required by the NEC.

3.3 Raceway Installation

3.3.1 General:

3.3.1.1 Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.

3.3.1.2 Install raceways and cables at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.

3.3.1.3 Conductors shall not be installed until conduit system is complete. Bending radius of insulated wire or cable shall not be less than the minimum recommended by wire or cable manufacturer. Maximum pulling tension of any wire or cable shall not exceed manufacturer's recommended values. Do not injure insulation while installing wire in conduits.

3.3.1.4 Use temporary raceway caps to prevent foreign matter from entering.

3.3.1.5 Provide an equipment grounding conductor which shall be separate from the electrical system neutral conductor. See corresponding specification section.

3.3.1.6 Make conduit bends and offsets so inside diameter is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

3.3.1.7 Use raceway and cable fittings compatible with raceways and cables and suitable for use and location.

3.3.1.8 Make bends in exposed parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for exposed parallel raceways.

3.3.1.9 Install pull wires in empty raceways. Use No.14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.

3.3.1.10 Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72-inch (1830-mm) LFMC. Install separate ground conductor across flexible connections.

3.3.1.11 Line voltage cables <600v: Provide colored insulation or phase tape at all terminations and pull through accessible junction box and cabinet locations.

3.3.1.12 Set floor boxes level and trim after installation to fit flush to finished floor surface.

3.3.2 Raceways in Concrete Slabs

3.3.2.1 Install raceways embedded in slabs in middle third of slab thickness where practical, and leave at least 1-inch (25-mm) concrete cover.

3.3.2.2 Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.

3.3.2.3 Space raceways laterally to prevent voids in concrete.

3.3.2.4 Install conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. Where conduit is at right angles to reinforcement, place conduit close to slab support.

3.3.2.5 Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit or rigid steel conduit before rising above floor.

3.3.3 Special PVC Requirements

3.3.3.1 Floor Penetrations: Rigid metallic conduit for all exposed conduits, regardless of size and concealed conduits greater than 1 ½". Schedule 40 PVC for conduits less than 1 ½" concealed in walls. All conduit concealed by floor mounted equipment may be schedule 40 PVC (if less than 1 ½") or rigid metallic conduit (if 1 ½" or greater).

3.3.3.2 Bends: Conduits less than 1 ½": Conduit elbows may be either rigid non-metallic or non-corrosive rigid metallic conduit. In circuit runs exceeding 50', all bends shall be non-corrosive rigid metallic conduit. Bends may be factory or field fabricated using manufacturer approved heat boxes. Field fabricated bends using blowtorch are not acceptable.

3.3.3.3 Conduits 1 ½" and larger: Conduit elbows shall be rigid non-corrosive metallic conduit only. Schedule 40 PVC elbows shall not be used.

3.3.3.4 Minimum Size: Minimum size of PVC conduit to be installed below slab shall be 3/4".

3.3.3.5 Jointing: Pipe and fittings shall be cement welded or threaded (only for Schedule 80 conduit) and made watertight. All joints shall be cleaned with solvent or sanded smooth prior to application of cement.

3.3.4 Raceway Methods for Voice, Data and CATV

3.3.4.1 Cable tray: A conduit shall be stubbed up above ceiling from each data outlet and each CATV outlet to the nearest cable tray. Each conduit shall serve one CO outlet only. Conduit shall be 1" trade size for data outlets and 1" trade size for CATV outlets. Conduit shall terminate at cable tray. Tray shall be provided with 6" clearance on all sides of tray.

3.3.4.2 Conduit bodies such as 'LB' fittings are not allowed.

3.3.4.3 Device boxes for voice/data/video shall be 4" wide x 4" long x 2-1/8" deep NEMA 1 galvanized steel with screw cover.

3.3.4.4 Provide pullboxes for each run of conduit at every 100 feet on center and at each end of conduit runs containing a total of two 90 deg bends or a combination of lesser bends totaling 180 deg (minimum requirements - provide whether specifically indicated on the drawings or not). Conduit runs containing more than two 90 deg bend without a pullbox are not acceptable. Factory conduit elbows and all other bends shall have a minimum radius of six times the internal conduit diameter. Conduit offsets and pullboxes required to suit field conditions and to conform to these requirements shall be provided at no additional cost to the owner. Do not terminate conduits at right angles to each other except as specifically indicated. Do not use junction boxes at changes of direction of raceway. Unless specifically shown on the drawings, pull boxes shall be sized per Table 6.6 of the BICSI TDMM 12th Edition.

3.3.5 Boxes

3.3.5.1 Attach boxes to concrete formwork, or to other surrounding building material. Provide additional junction and pull boxes where injury to insulation or deformation of wire would occur due to excessive pulling resistance. When several feeders pass through a common pull box, tag each feeder separately, indicating electrical characteristics and destination.

3.3.5.2 Boxes shall be accurately located. Consult Architectural plans for dimensions.

3.3.5.3 Mount boxes in the course nearest to the height specified when installed in finished block, brick or tile walls.

3.3.5.4 Boxes for use with raceway systems shall be minimum 1 ½ inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets shall be minimum 4 inches square, except 4-by-2 inch boxes may be used where only one raceway enters outlet.

3.3.5.5 Pull boxes shall be at least the minimum size required by NFPA 70 and of code-gauge galvanized sheet steel, or compatible with nonmetallic raceway systems, except where cast-metal boxes are required in locations specified herein. Furnish boxes with screw-fastened covers. Where several feeders pass through a common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.3.5.6 Extension rings shall not be used, except when required on device boxes in walls and ceilings where standard mud rings, tile rings, masonry rings, etc will not work with the specific device type (for example: some manufacturer's fire alarm system horn/strobe devices require extension rings in masonry walls). Any extension rings found not meeting this requirement shall be removed and replaced with appropriately sized boxes at the contractor's expense. The intent of this requirement is to have the contractor plan the raceway system out ahead of time. A well planned and designed raceway system shall have boxes sized appropriately without the need for extension rings.

3.3.5.7 Recessed Installation: Boxes and covers shall be installed so that the covers are flush with the finished surfaces. Boxes in masonry or tile construction shall have masonry boxes or boxes with square cut tile covers. Do not cut concrete block through its entirety in order to accommodate any type box. "Handy" boxes shall not be used.

3.3.5.8 Boxes in Partitions: Through type boxes are not permitted except where shown on electrical drawings. Recessed outlet boxes, cabinets, consoles, etc., when shown located back-to-back shall be provided with ½" fiberglass insulation between the boxes.

3.4 Wiring Methods for Power, Lighting, and Control Circuits

3.4.1 Feeders: Type THHN/THWN insulated conductors in raceway.

3.4.2 Underground Feeders and Branch Circuits: Type THWN insulated conductors in raceway.

3.4.3 Branch Circuits: Type THHN/THWN insulated conductors in raceway.

3.4.4 Remote-Control Signaling and Power-Limited Circuits: Type THHN/THWN insulated conductors in raceway for Classes 1, 2, and 3, unless otherwise indicated.

3.5 Wiring Installation

3.5.1 Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.5.2 Wire Pulling Lubrication: Shall be used when any wire is pulled by mechanical means. Wire and cable shall be carefully handled during installation. Soap flakes or vegetable soaps shall not be used for lubrication.

3.5.3 Install wiring at outlets with at least 12 inches (300 mm) of slack conductor at each outlet.

3.5.4 Connect outlet and component connections to wiring systems and to ground. Tighten electrical connectors and terminals, according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.5.5 Provide dedicated neutrals for all 120V.

3.5.6 Except for control wiring, the minimum size wire shall be No. 12 AWG. The following indicates the required minimum wire sizes for branch circuits to achieve <3% voltage drop at full load. The contractor shall verify all circuit lengths prior to pulling wire. Wires found to be smaller than those indicated below shall be removed and repulled (including increased conduit size and/or junction box sizes as required) with the correct wire at the contractor's expense. The distances indicated below are to be measured to the center of the load.

3.5.6.1 For all 120V lighting and receptacle circuits that are longer than 50' and less than 100', the minimum wire size shall be No. 10 AWG.

3.5.6.2 For all 120V lighting and receptacle circuits that are longer than 100' and less than 150', the minimum wire size shall be No. 8 AWG.

3.5.6.3 For all 120V lighting and receptacle circuits that are longer than 150' , the minimum wire size shall be No. 6 AWG.

3.6 Expansion Joints

3.6.1 Conduits 3" and larger, that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install couplings in accordance with the manufacturers' recommendations.

3.6.2 Provide conduits smaller than three inches with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 5" vertical drop midway between end. Flexible conduit shall have a green copper ground-bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for three inches and larger conduits are acceptable.

3.6.3 Expansion fittings shall be provided for raceways to compensate for thermal expansion and contraction in conduit runs 200 feet or greater and at building expansion joints. Bonding jumpers shall be provided for electrical continuity of the raceway system at the expansion fittings.

3.7 Electrical Supporting Device Application

3.7.1 Damp Locations and Outdoors: Hot-dip galvanized materials.

3.7.2 Dry Locations: Steel materials.

3.7.3 Support Clamps for PVC Raceways: Click-type clamp system.

3.7.4 Selection of Supports: Comply with manufacturer's written instructions.

3.7.5 Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb (90-kg) design load.

3.8 Support Installation

3.8.1 Install support devices to securely and permanently fasten and support electrical components.

3.8.2 Support no electrical work from piping, ductwork, etc. Where metal decking is used, provide supports independent of decking so that loads will not be transferred to decking. Drill through decking and secure supports to concrete slab.

3.8.3 Conduit through Slab Supports: Conduit supports for conduits routed from below grade up through concrete slabs shall be solid, metallic type. Metallic conduit shall not be used to support conduits through slab. After concrete slab has been poured and set, supports shall be cut flush with slab.

3.8.4 Vertical conduit inside building shall be supported at each floor level and at 10'0" intervals.

3.8.5 Support conduit within one foot of changes of direction, and within one foot of each enclosure to which it is connected.

3.8.6 Electrical devices in lay-in and gypsum board ceilings: Coordinate location of electrical outlets with architectural features of the building and with the equipment of other trades. Boxes or devices mounted between bar joists or "T" bars shall be supported from two bars or joists. Devices and associated boxes shall not be supported by the lay-in tiles or gypsum boards.

3.8.7 Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

3.8.8 Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

3.8.9 Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

3.8.10 Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

3.8.11 Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.

3.8.12 Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

3.8.13 Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

3.8.14 Simultaneously install vertical conductor supports with conductors.

3.8.15 Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.

3.8.16 Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

3.8.17 Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

3.8.18 Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

3.8.18.1 Wood: Fasten with wood screws or screw-type nails.

3.8.18.2 Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.

3.8.18.3 New Concrete: Concrete inserts with machine screws and bolts.

3.8.18.4 Existing Concrete: Expansion bolts.

3.8.18.5 Steel: Welded threaded studs or spring-tension clamps on steel.

3.8.18.6 Field Welding: Comply with AWS D1.1.

3.8.18.7 Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.

3.8.18.8 Light Steel: Sheet-metal screws.

3.8.18.9 Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

END OF SECTION

SECTION 16101/ELECTRICAL IDENTIFICATION

1 GENERAL

1.1 Related Documents

1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

1.2.1 This Section includes the following:

1.2.1.1 Identification for raceway.

1.2.1.2 Identification for conductors and communication and control cable.

1.2.1.3 Underground-line warning tape.

1.2.1.4 Warning labels and signs.

1.2.1.5 Instruction signs.

1.2.1.6 Equipment identification labels.

1.2.1.7 Miscellaneous identification products.

1.3 Quality Assurance

1.3.1 Comply with ANSI A13.1 and ANSI C2.

1.3.2 Comply with NFPA 70.

1.3.3 Comply with 29 CFR 1910.145.

1.4 Coordination

1.4.1 Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

1.4.2 Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

1.4.3 Coordinate installation of identifying devices with location of access panels and doors.

1.4.4 Install identifying devices before installing acoustical ceilings and similar concealment.

1.5 Approval Submittals:

1.5.1 Product Data: For each electrical identification product indicated.

1.5.2 Identification Schedule: An index of the nomenclature and color coding scheme of electrical equipment and system components used in identification signs, labels and colors.

2 PRODUCTS

2.1 Raceway Identification:

2.1.1 Paint: Semigloss acrylic-enamel.

2.1.2 Marker for circuit identification on box covers: Permanent, waterproof, black ink marker (exception : brown and black painted covers which shall use permanent, waterproof, white paint based marker).

2.2 Conductor and Cable Identification Materials:

2.2.1 Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

2.2.2 Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2.3 Write-On Tags: Polyester tag, 0.01 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

2.2.3.1 Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 Floor Marking Paint:

2.3.1 Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.

2.3.1.1 Primer: Interior concrete and masonry primer.

2.3.1.2 Finish Coats: Interior semigloss alkyd enamel.

2.4 Underground-line Warning Tape:

2.4.1 Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

2.4.1.1 Not less than 6 inches wide by 5.5 mils thick.

2.4.1.2 Compounded for permanent direct-burial service.

2.4.1.3 Embedded continuous metallic strip or core 3.5 mils thick.

2.4.1.4 Printed legend shall indicate type of underground line.

2.5 Warning Labels and Signs:

2.5.1 Comply with NFPA 70 and 29 CFR 1910.145.

2.5.2 Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

2.5.3 Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.

2.5.4 Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

2.5.5 Warning label and sign shall include, but are not limited to, the following legends:

2.5.6 Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.6 Instruction Signs:

2.6.1 Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

2.6.2 Engraved legend with black letters on white face.

2.6.3 Punched or drilled for mechanical fasteners.

2.6.4 Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 Equipment Identification Labels:

2.7.1 Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. White letters on a red background for Emergency and Optional Standby systems.

2.8 Miscellaneous Identification Products:

2.8.1 Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

2.8.2 Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

3 EXECUTION

3.1 Accessible Raceways More Than 600 V:

3.1.1 Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.

3.2 Accessible Raceways 600 V or Less, for Service, Feeder, and Branch Circuits:

3.2.1 Identify interior raceway systems with paint as follows:

3.2.1.1 Conduits: paint all couplings per the color coding below.

3.2.1.2 Junction Boxes:

3.2.1.2.1 Paint all junction and pull box covers per the color coding below.

3.2.1.2.2 For covers containing branch circuits: after painting the cover the appropriate color, hand write the panelboard/circuit number contained in the box (i.e. 2P1-15,17,19).

3.2.1.2.3 For covers containing feeder circuits: after painting the cover the appropriate color, hand write the feeding panel and load panel (i.e. 4D1 to 2P1A).

3.2.2 Coupling and box cover colors as follows:

3.2.2.1 120/208 Volt Systems: Black.

3.2.2.2 120/208 Volt System Junction Boxes containing Emergency Circuits: Paint box cover color of voltage and provide a red stripe.

3.2.2.3 Junction boxes containing optimal standby circuits: Paint box cover cooler of voltage and provide orange stripe.

3.3 Auxiliary Systems:

3.3.1 Identify interior raceway systems with paint as follows:

3.3.1.1 Conduits: paint all couplings per the color coding below.

3.3.1.2 Junction Boxes: Paint all junction and pull box covers per the color coding below.

3.3.2 Coupling and box cover colors as follows:

3.3.2.1 Fire Alarm System: Red.

3.3.2.2 Access Control & Security System: Yellow.

3.3.2.3 Telecommunication System: Blue.

3.3.2.4 Other Systems: Paint a unique color (do not use any of the above colors or green or white).

3.4 Conductors:

3.4.1 Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

3.4.2 Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3.4.3 Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

3.4.4 Power-Circuit Conductor Identification: For conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

3.4.5 Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.

3.4.6 Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

3.5 Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

3.6 Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

3.7 Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

3.7.1 Power transfer switches.

3.7.2 Controls with external control power connections.

3.8 Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

3.9 Instruction Signs:

3.9.1 Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

3.9.2 Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/3inch high letters for emergency instructions at equipment.

3.10 Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

3.11 Labeling Instructions:

3.11.1 Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a with 1/4-inch high letters on 1-inch high label.

3.11.2 Outdoor Equipment: Engraved, laminated acrylic or melamine label.

3.11.3 Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

3.11.4 Equipment to Be Labeled:

3.11.4.1 Panelboards, electrical cabinets, and enclosures.

3.11.4.2 Access doors and panels for concealed electrical items.

3.11.4.3 Electrical switchgear and switchboards.

3.11.4.4 Transformers.

3.11.4.5 Electrical substations.

3.11.4.6 Emergency system boxes and enclosures.

3.11.4.7 Motor-control centers.

3.11.4.8 Disconnect switches.

3.11.4.9 Enclosed circuit breakers.

3.11.4.10 Motor starters.

3.11.4.11 Push-button stations.

3.11.4.12 Power transfer equipment.

3.11.4.13 Contactors.

3.11.4.14 Remote-controlled switches, dimmer modules, and control devices.

3.11.4.15 Battery inverter units.

3.11.4.16 Power-generating units.

3.11.4.17 Voice and data cable terminal equipment.

3.11.4.18 Fire-alarm control panel and annunciators.

3.11.4.19 Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.

3.11.4.20 Monitoring and control equipment.

3.11.4.21 Uninterruptible power supply equipment.

3.11.4.22 Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.12 Installation:

3.12.1 Verify identity of each item before installing identification products.

3.12.2 Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

3.12.3 Apply identification devices to surfaces that require finish after completing finish work.

3.12.4 Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

3.12.5 Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

3.12.6 Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

3.12.7 Colors for 208/120-V Circuits:

3.12.7.1 Phase A: Black.

3.12.7.2 Phase B: Red.

3.12.7.3 Phase C: Blue.

3.12.7.4 Neutral: White.

3.12.7.5 Grounding Conductor: Green.

3.12.8 Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum

distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

3.12.9 Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 18" to 30" above the line and not less than 6" below grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

3.12.10 Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

3.12.11 Identification Schedule: Prior to Substantial Completion Inspection provide one framed and under glass 11" x 17" color copy of the approved Identification Schedule in each electrical room.

END OF SECTION

SECTION 16103 / GROUNDING AND BONDING

1 GENERAL

1.1 Related Documents

1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

1.2.1 This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 Approval Submittals

1.3.1 Product Data: For each type of product indicated.

1.3.2 Field Test Reports: Submit written test reports to include the following:

1.3.2.1 Test procedures used.

1.3.2.2 Test results that comply with requirements.

1.3.2.3 Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 Quality Assurance

1.4.1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4.1.1 Comply with UL 467.

1.5 Approval Submittals:

1.5.1 Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each type of product indicated.

1.6 Test Reports and Verification Submittals:

1.6.1 Provide ground system drawings per section 3 of this specification.

1.6.2 Perform the following field tests and inspections and prepare test reports:

1.6.2.1 Ground Resistance Test: See section 3 of this specification.

2 PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.1.1 Grounding Conductors, Cables, Connectors, and Rods:

2.1.1.1 Erico Inc.; Electrical Products Group.

2.1.1.2 Thermoweld, Inc.

2.2 Grounding Conductors

2.2.1 For insulated conductors, comply with Division 16 Section "Conductors and Cables."

2.2.2 Material: copper.

2.2.3 Equipment Grounding Conductors: Insulated with green-colored insulation.

2.2.4 Grounding Electrode Conductors: Stranded cable.

2.2.5 Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

2.2.5.1 Solid Conductors: ASTM B 3.

2.2.5.2 Assembly of Stranded Conductors: ASTM B 8.

2.2.5.3 Tinned Conductors: ASTM B 33.

2.2.6 Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators. (Harger HDGBI series)

2.3 Connector Products

2.3.1 Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

2.3.2 Bolted Connectors: Copper or bronze bolted-pressure-type connectors, or compression type. Do not use below grade.

2.3.3 Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions. For use in below grade applications.

2.4 Grounding Electrodes:

2.4.1 Ground Rods: Copper clad steel, sectional type, 3/4" x 10'

3 EXECUTION

3.1 Application

3.1.1 In raceways, use insulated equipment grounding conductors.

3.1.2 Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.

3.1.3 Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

3.1.4 Grounding Busbar: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

3.1.4.1 Use insulated spacer support from wall 6 inches above finished floor, unless otherwise indicated.

3.2 Equipment Grounding Conductors

3.2.1 Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

3.2.2 Install equipment grounding conductors in all feeders and circuits.

3.2.3 Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

3.2.3.1 Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4"x4"x12" grounding busbar.

3.2.3.2 Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.2.4 Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

3.3 Installation

3.3.1 Ground Rods:

3.3.1.1 At the main electrical service entrance, install rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

3.3.1.2 Drive ground rods until tops are 6 inches below finished floor or final grade, unless otherwise indicated.

3.3.1.3 Interconnect ground rods with grounding electrode conductors. Use exothermic welds, and as

otherwise indicated. Make connections without exposing steel or damaging copper coating.

3.3.2 Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

3.3.3 Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

3.3.4 Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

3.3.5 Building Foundation: The electrical service and remote buildings shall be tied to the building foundation. The rebar in the foundation shall be bonded electrically by metal wire. The rebar shall be turned up and extended through the slab by the equipment so the connection can be within sight and be inspected. The rebar shall be coated with protective paint where it penetrates the concrete slab.

3.3.6 Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

3.3.7 Gas Piping: Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

3.3.8 Building Steel: The electrical service, transformers and remote buildings shall be tied to building steel.

3.4 Connections

3.4.1 General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

3.4.1.1 Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.

3.4.1.2 Make connections with clean, bare metal at points of contact.

3.4.1.3 Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.4.2 Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that

are puffed up or that show convex surfaces indicating improper cleaning are not acceptable. Inspect molds prior to use and discard if deformed.

3.4.3 Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

3.4.4 Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

3.4.5 Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.4.6 Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

3.4.7 Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 Field Quality Control

3.5.1 Testing: Perform the following field quality-control testing: After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

3.5.1.1 Ground Resistance Test:

3.5.1.1.1 Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.

3.5.1.1.2 Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.5.1.1.2.1 Equipment Rated 500 kVA and Less: 10 ohms.

3.5.1.1.2.2 Equipment Rated 500 to 1000 kVA: 5 ohms.

3.5.1.1.2.3 Equipment Rated More Than 1000 kVA: 3 ohms.

3.5.1.1.2.4 Substations and Pad-Mounted Switching Equipment: 5 ohms.

3.5.1.1.2.5 Manhole Grounds: 10 ohms.

3.5.1.1.3 Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 16105/EXCAVATION AND BACKFILL

1 GENERAL

1.1 Related Documents

1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.1.2 Review all project Drawings to be aware of conditions affecting work herein.

2 PRODUCTS

2.1 Sand: Clean, hard, uncoated grains free from organic matter or other deleterious substances. Sand for backfill shall be of a grade equal to mortar sand, with 95% passing a No. 8 sieve, and not more than 8% passing a No. 100 sieve.

2.2 Gravel: Clean, well-graded hard stone or lime rock gravel, free from organic material. Size range to be from No. 4 screen retentions to 1".

2.3 Earth: Must be free of stones, wood, roots or rubbish.

2.4 Underground-line Warning Tape: See specifications Section 16101 / Electrical Identification.

3 EXECUTION

3.1 Ditching and Excavation: Shall be performed by hand wherever the possibility of encountering obstacles or any existing utility lines. The Contractor will be totally responsible to insure that no utility or service interruptions shall be caused and that no existing utilities or obstructions will prohibit installations of service under this Contract at proper grade and location. Where clear and unobstructed areas are to be excavated, appropriate machine excavation methods may be employed. Avoid use of machine excavations within the limits of the building lines except when machine weights and operation will not damage sub-surface structural components or piping.

3.2 Bedding: Excavate to bottom grade of raceway to be installed, and shape bed of undisturbed earth to contour of conduit for a width of at least 5% of the conduit diameter. If earth conditions necessitate excavation below raceway grade, bring the bed up to the proper elevation with clean, dry sand deposited in 6" layers and firmly tamped by mechanical means. If sub-cut exceeds 12" or if bed is of an unstable nature, a 6" minimum layer of rock will be required before sand bedding begins.

3.3 Placing: Conduit shall be carefully handled into place in the excavation. Avoid knocking loose soil from the banks of the trench into the conduit bed. Coated conduit shall have special handling slings to prevent damage to the coating. All holidays in the conduit coating shall be touched in before beginning back filling.

3.4 Backfilling: Deposit earth or sand carefully in 6" layers, maintaining adequate side support. Compact fill in 6" layers, using mechanical means up to the top elevation of the conduit and 12"

layers to finish grade.

3.5 Identification: Provide identifying metalized plastic warning tape above conduit. Replace surface to the original condition, i.e., sodding, sprigging, and fine grading.

3.6 Excavation shall be maintained in satisfactory condition during the progress of the work. Sub-surface structures shall be constructed in adequately sized excavations and dewatering equipment shall be installed and properly maintained. Shoring shall be employed in the event of unstable soil conditions, and in all cases to protect materials and personnel from injury.

3.7 Conduits to be installed below the footings or foundations shall be installed prior to the installation of the footings. All soil shall be compacted to meet the structural requirements for the footings. If it is not possible to install the conduit prior to pouring of the footings, it shall be necessary for the contractor to provide a bridge footing to span the excavation plus 2 feet on either side of the excavation. The footing modifications shall be approved prior to installation by the Structural Engineer.

END OF SECTION

SECTION 16107/SERVICE ENTRANCE METHODS AND MATERIALS - UNDERGROUND

1 GENERAL

1.1 Related Documents

1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.1.2 Division-16 Basic Electrical Materials and Methods Sections apply to work of this Section.

1.1.3 Review all project drawings to be aware of conditions affecting work herein.

2 PRODUCTS

2.1 Materials for this section are specified in the Section "Basic Materials and Methods."

3 EXECUTION

3.1 Installation shall comply with the requirements of the Utilities Company and the applicable paragraphs in Article "3.0 EXECUTION" of the Section "Basic Materials and Methods."

3.2 Comply with NEC 70 - Underground Services.

3.3 Comply with the Section "Excavation and Backfill."

3.4 The electrical contractor shall provide the raceways and service conductors from the reinforced concrete transformer pad to the service equipment as indicated on the Drawings.

3.5 The Electrical Contractor shall provide the raceways from the transformer pad to the meter cabinet. Minimum conduit size is 1".

3.6 Raceways shall be schedule 40 PVC or bitumastic coated rigid metal conduit for straight lengths and bitumastic coated rigid metal conduit for any bends of 45 or 90 degrees.

3.7 The 45 or 90-degree bends shall have a minimum radius of 36 inches.

3.8 Rigid metal conduit shall receive two undiluted coats of bitumastic free from holidays and pinholes.

3.9 The Electrical Contractor shall provide 200# test poly cord in each spare raceway.

END OF SECTION

SECTION 16112/FUSES 600 VOLTS AND BELOW

1 GENERAL

1.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Sections, apply to work of this Section.

1.2 Division-16 Basic Electrical Materials and Methods Sections apply to work of this Section.

1.3 Approval Submittals:

1.3.1 Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each type of product indicated.

2 PRODUCTS

2.1 Acceptable Producers: Buss, Farraz Shamut, Littlefuse, Siemens.

2.2 General: Products listed herein are common to various Divisions and Specification Sections for this project and as shown on this project's Drawings.

2.3 All fuses furnished shall be by the same producer.

2.4 Voltage Rating:

2.4.1 Provide 600 volt fuses for 277/480 volt systems.

2.4.2 Provide 250 volt fuses for 120, 208 and 240 volt systems.

2.5 Ampere Ratings: Ampere ratings of fuses shall be as indicated on the Drawings.

2.6 Interrupting Ratings: Interrupting ratings of fuses shall be as indicated on the Drawings.

2.7 Current Limitation: Current limiting fuses shall be provided where indicated by C/L on the Drawings.

2.8 Rejection Fuse Clips: Provide fuse with rejection feature for switches required to have the rejection feature as indicated on the Drawings.

2.9 Class of Fuses: Provide fuses of Class J, K, L or R.

3 EXECUTION

3.1 Coordinate fuse type and ampacity with fuse holder.

3.2 Provide 10% spare fusing with a minimum of three sets spare (including new fusing for each of the three phases) of the amount installed, based on the different voltages, amperage ratings, and types of fusing installed. Spare fusing shall be provided within weatherproof containers for long-

term storage (such as in ammo cans). Spray paint container with the wording "Spare Fuses" on the side.

END OF SECTION

SECTION 16120/ENCLOSED SWITCHES AND CIRCUIT BREAKERS O

1 GENERAL

1.1 Related Documents

1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 Summary

1.2.1 This Section includes the following individually mounted, enclosed switches and circuit breakers:

1.2.1.1 Fusible switches.

1.2.1.2 Nonfusible switches.

1.2.1.3 Molded-case circuit breakers.

1.2.1.4 Enclosures.

1.3 Definitions

1.3.1 GFCI: Ground-fault circuit interrupter.

1.3.2 HD: Heavy duty.

1.3.3 RMS: Root mean square.

1.3.4 SPDT: Single pole, double throw.

1.4 Quality Assurance

1.4.1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4.2 Comply with NFPA 70.

1.4.3 All products shall be UL listed.

1.4.4 Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.5 Project Conditions

1.5.1 Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1.5.1.1 Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

1.5.1.2 Altitude: Not exceeding 6600 feet (2010 m).

1.6 Coordination

1.6.1 Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.7 Approval Submittals:

1.7.1 Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1.7.1.1 Enclosure types and details for types other than NEMA 250, Type 1.

1.7.1.2 Time-current curves, including selectable ranges for each type of circuit breaker.

1.7.1.3 Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.7.1.4 Current and voltage ratings.

1.7.1.5 Short-circuit current rating.

1.7.1.6 Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components. O

1.8 O&M Data Submittals:

1.8.1 Submit manufacturer's maintenance data including parts lists. Include these data, a copy of approval submittals (product data & shop drawings) in O&M manual.

2 PRODUCTS

2.1 Manufacturers

2.1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.1.1.1 Square D Co.

2.1.1.2 Eaton Corp.; Cutler-Hammer Products.

2.1.1.3 General Electric Co.; Electrical Distribution & Control Division.