

SECTION 26 00 00.00 20

BASIC ELECTRICAL MATERIALS AND METHODS

07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 709 (2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code

IEEE C57.12.28 (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity

IEEE C57.12.29 (2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2003) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2007; AMD 1 2008) National Electrical Code - 2008 Edition

1.2 RELATED REQUIREMENTS

This section applies to certain sections of Division 11, EQUIPMENT, and Divisions 22 and 23, PLUMBING and HEATING VENTILATING AND AIR CONDITIONING. This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections. This section has been incorporated into, and thus, does not apply to, and is not referenced in the following sections.

Section 26 12 19.10 THREE-PHASE PAD MOUNTED TRANSFORMERS

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM

Section 26 51 00 INTERIOR LIGHTING

Section 26 56 00 EXTERIOR LIGHTING

Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM
Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION
Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT

1.3 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.
- b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.
- c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 13.8 kV primary, three phase, three wire, 60 Hz, and 480 volts secondary, three phase, four wire. Final connections to the power distribution system at the existing overhead lines shall be made by the Government.

1.5 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

1.5.1 Shop Drawings (SD-02)

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.5.2 Product Data (SD-03)

Submittal shall include performance and characteristic curves.

1.6 QUALITY ASSURANCE

1.6.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and

advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

1.6.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.8 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

- a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
- b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
- c. Safety precautions.
- d. The procedure in the event of equipment failure.
- e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For

operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.9 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.10 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

1.11 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

- a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPS0710D72 or approved equal.
- b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

1.12 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.13 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified

systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section.

PART 2 PRODUCTS

2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.2 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

-- End of Section --

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM

08/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.7 (2005) Requirements for Watthour Meter Sockets

ASTM INTERNATIONAL (ASTM)

ASTM B 1 (2001; R 2007) Standard Specification for Hard-Drawn Copper Wire

ASTM B 8 (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM D 709 (2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code

IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms

IEEE Std 81 (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1) Normal Measurements

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS (2003) Acceptance Testing Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2003) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA BU 1.1 (2005) General Instructions for Proper Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less

NEMA C12.1	(2008) Electric Meters; Code for Electricity Metering
NEMA C80.1	(2005) Standard for Electrical Rigid Steel Conduit (ERSC)
NEMA C80.3	(2005) Standard for Electrical Metallic Tubing (EMT)
NEMA C80.5	(2005) Standard for Electrical Rigid Aluminum Conduit (ERAC)
NEMA FU 1	(2002; R 2007) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2005) Standard for Industrial Control and Systems General Requirements
NEMA ICS 2	(2000; Errata 2002; R 2005; Errata 2006) Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
NEMA ICS 3	(2005) Standard for Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC
NEMA ICS 4	(2005) Industrial Control and Systems: Terminal Blocks
NEMA ICS 6	(1993; R 2006) Standard for Industrial Controls and Systems Enclosures
NEMA KS 1	(2001; R 2006) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA MG 1	(2007) Standard for Motors and Generators
NEMA MG 10	(2001; R 2007) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2007) Energy Management Guide for Selection and Use of Single Phase Motors
NEMA RN 1	(2005) Standard for Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(1992; R 1997) Standard for Dry-Type Transformers for General Applications

NEMA TC 14	(2002) Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
NEMA TC 2	(2003) Standard for Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
NEMA TC 3	(2004) Standard for Polyvinyl Chloride PVC Fittings for Use With Rigid PVC Conduit and Tubing
NEMA TP 1	(2002) Guide for Determining Energy Efficiency for Distribution Transformers
NEMA VE 1	(2002) Standard for Metallic Cable Tray Systems
NEMA WD 1	(1999; R 2005) Standard for General Requirements for Wiring Devices
NEMA WD 6	(2002; R 2008) Standard for Wiring Devices - Dimensional Requirements
NEMA Z535.4	(2007; Errata 2007) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2007; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 70E	(2008) Electrical Safety in the Workplace
NFPA 780	(2007) Standard for the Installation of Lightning Protection Systems

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA J-STD-607-A	(2002) Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
TIA/EIA-568-B.1	(2001 Addendums 2001, 2003, 2003, 2003, 2004, 2007) Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements
TIA/EIA-569-A	(1998; Addenda 2000, 2001) Commercial Building Standards for Telecommunications Pathways and Spaces

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.147	Control of Hazardous Energy (Lock Out/Tag Out)
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UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Rev thru Jul 2007) Standard for Flexible Metal Conduit
UL 1010	(2006) Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations
UL 1063	(2006) Standard for Safety Machine-Tools Wires and Cables
UL 1242	(2006; Rev thru Jul 2007) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 1449	(2006) Surge Protective Devices
UL 1561	(1999; Rev thru Sep 2005) Dry-Type General Purpose and Power Transformers
UL 1569	(1999; Rev thru Nov 2006) Metal-Clad Cables
UL 1660	(2004; Rev thru Jan 2005) Liquid-Tight Flexible Nonmetallic Conduit
UL 1699	(1999; Rev thru May 2003) Arc-Fault Circuit-Interrupters
UL 198M	(2003; Rev thru Oct 2007) Mine-Duty Fuses
UL 20	(2000 ; Rev thru Dec 2004) Standard for General-Use Snap Switches
UL 2043	(2008) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
UL 360	(2003; Rev thru Jul 2007) Liquid-Tight Flexible Steel Conduit
UL 4	(2004) Armored Cable
UL 44	(2005; Rev thru Nov 2005) Thermoset-Insulated Wires and Cables
UL 467	(2007) Standard for Grounding and Bonding Equipment
UL 486A-486B	(2003; Rev thru Aug 2006) Standard for Wire Connectors
UL 486C	(2004; Rev thru Aug 2006) Standard for Splicing Wire Connectors
UL 489	(2002; Rev thru Jun 2006) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

UL 498 (2001; Rev thru Nov 2007) Attachment Plugs and Receptacles

UL 5 (2004; Rev thru May 2007) Surface Metal Raceways and Fittings

UL 50 (2007) Standard for Enclosures for Electrical Equipment

UL 506 (2000; Rev thru May 2006) Standard for Specialty Transformers

UL 508 (1999; Rev thru Sep 2008) Standard for Industrial Control Equipment

UL 510 (2005; Rev thru Aug 2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape

UL 512 (1993; Rev thru Jan 2008) Fuseholders

UL 514A (2004; Rev thru Aug 2007) Standard for Metallic Outlet Boxes

UL 514B (2004; Rev thru Aug 2007) Standard for Conduit, Tubing and Cable Fittings

UL 514C (1996; Rev thru Jul 2008) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

UL 5A (2003; Rev thru Aug 2008) Nonmetallic Surface Raceways and Fittings

UL 6 (2007) Standard for Electrical Rigid Metal Conduit-Steel

UL 651 (2005; Rev thru May 2007) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings

UL 67 (1993; Rev thru Jul 2008) Standard for Panelboards

UL 674 (2003; Rev thru Oct 2007) Standard for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations

UL 698 (2006) Industrial Control Equipment for Hazardous (Classified) Locations

UL 6A (2000; Rev thru Jan 2004) Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel

UL 719 (2006; Rev thru Oct 2007) Nonmetallic-Sheathed Cables

UL 797	(2007) Standard for Electrical Metallic Tubing -- Steel
UL 817	(2001; Rev thru May 2007) Cord Sets and Power-Supply Cords
UL 83	(20086) Standard for Thermoplastic-Insulated Wires and Cables
UL 845	(2005; Rev thru Aug 2006) Standard for Motor Control Centers
UL 854	(2004; Rev thru Oct 2007) Service-Entrance Cables
UL 857	(2001; Rev thru Nov 2002) Busways
UL 869A	(2006) Reference Standard for Service Equipment
UL 870	(1995; Rev thru Jul 2003) Standard for Wireways, Auxiliary Gutters, and Associated Fittings
UL 877	(1993; Rev thru Nov 1999) Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL 886	(1994; Rev thru Nov 2005) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 943	(2006; Rev thru Feb 2008) Ground-Fault Circuit-Interrupters
UL 984	(1996; Rev thru Sept 2005) Hermetic Refrigerant Motor-Compressors

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval only. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Panelboards; G

Transformers; G

Cable trays; G

Wireways; G

Marking strips drawings; G

SD-03 Product Data

Receptacles; G

Circuit breakers; G

Switches; G

Transformers; G

Enclosed circuit breakers; G

Motor controllers; G

Manual motor starters; G

Metering; G

Telecommunications Grounding Busbar; G

Surge protective devices; G

Submittals shall include performance and characteristic curves.

SD-06 Test Reports

600-volt wiring test; G

Grounding system test; G

Transformer tests; G

Ground-fault receptacle test; G

SD-07 Certificates

Fuses; G

SD-09 Manufacturer's Field Reports

Transformer factory tests

SD-10 Operation and Maintenance Data

Electrical Systems, Data Package 5; G

Metering, Data Package 5; G

Submit operation and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein.

1.4 QUALITY ASSURANCE

1.4.1 Fuses

Submit coordination data as specified in paragraph, FUSES of this section.

1.4.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.5 MAINTENANCE

1.5.1 Electrical Systems

Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. This shall include:

- a. Single line diagram of the "as-built" building electrical system.
- b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).
- c. Manufacturers' operating and maintenance manuals on active

electrical equipment.

1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials, equipment, and devices shall, as a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70.

2.2 CONDUIT AND FITTINGS

Shall conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

NEMA C80.1, UL 6.

2.2.2 Rigid Nonmetallic Conduit

PVC Type EPC-40, and EPC-80 in accordance with NEMA TC 2, UL 651.

2.2.3 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only.

2.2.4 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, NEMA C80.3.

2.2.5 Plastic-Coated Rigid Steel and IMC Conduit

NEMA RN 1, Type 40 (40 mils thick).

2.2.6 Flexible Metal Conduit

UL 1.

2.2.6.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360.

2.2.7 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings shall be cadmium- or zinc-coated in accordance with UL 514B.

2.2.7.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.7.2 Fittings for EMT

Steel compression type.

2.2.8 Fittings for Rigid Nonmetallic Conduit

NEMA TC 3 for PVC, and UL 514B.

2.3 SURFACE RACEWAY

2.3.1 Surface Metal Raceway

UL 5, two-piece painted steel, totally enclosed, snap-cover type. Provide multiple outlet-type raceway with grounding-type receptacle where indicated. Receptacles shall be as specified herein and shall be spaced minimum of one every 24 inches.

2.4 CABLE TRAYS

NEMA VE 1. Cable trays shall form a wireway system, and shall be of nominal depth as indicated. Cable trays shall be constructed of aluminum. Trays shall include splice and end plates, dropouts, and miscellaneous hardware. Edges, fittings, and hardware shall be finished free from burrs and sharp edges. Fittings shall have not less than load-carrying ability of straight tray sections and shall have manufacturer's minimum standard radius. Radius of bends shall be 12 inches.

2.4.1 Ladder-Type Cable Trays

Provide size as indicated with maximum rung spacing of 9 inches.

2.4.2 Channel-Type Cable Trays

Provide size as indicated. Trays shall be one-piece construction having slots spaced not more than 4 1/2 inches on centers.

2.4.3 Cantilever

Cantilever-type, center-hung cable trays may be provided at the Contractor's option in lieu of other cable tray types specified.

2.5 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

2.5.1 Floor Outlet Boxes

Boxes shall be adjustable and concrete tight, and sized as required for power and telecommunications receptacles. Each box shall consist of cast-metal body with threaded openings for conduits, a recessed pocket for cord-and-plug access, and hinged cover with cord opening and floor tile insert. Telecommunications outlets shall consist of appropriate bezels and

plates with jacks as specified.

2.5.2 Outlet Boxes for Telecommunications System

Provide standard type 4 inches square by 2 1/8 inches deep. Depth of boxes shall be large enough to allow manufacturers' recommended conductor bend radii.

2.6 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 100 cubic inches, UL 50, hot-dip, zinc-coated, if sheet steel.

2.7 WIRES AND CABLES

Wires and cables shall meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.

2.7.1 Conductors

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and capacities shown are based on copper, unless indicated otherwise. Conductors indicated to be No. 6 AWG or smaller diameter shall be copper. Conductors indicated to be No. 4 AWG and larger diameter shall be either copper or aluminum, unless type of conductor material is specifically indicated, or specified, or required by equipment manufacturer.

2.7.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to satisfy manufacturer's requirements.

2.7.1.2 Aluminum Conductors

Aluminum conductors shall be AA-8000 series electrical grade aluminum alloy conductors. Type EC/1350 aluminum is not acceptable. Should Contractor choose to provide aluminum for conductors No. 4 AWG and larger diameter, Contractor shall be responsible for increasing conductor size to have same ampacity as copper size indicated; increasing conduit and pull box sizes to accommodate larger size aluminum conductors in accordance with NFPA 70; ensuring that pulling tension rating of aluminum conductor is sufficient; providing panelboards that are UL listed for use with aluminum, and so labeled; relocating equipment, modifying equipment terminations, resizing equipment; and resolving problems that are direct results of providing aluminum conductors in lieu of copper.

2.7.1.3 Minimum Conductor Sizes

Minimum size for branch circuits shall be No. 12 AWG; for Class 1 remote-control and signal circuits, No. 14 AWG; for Class 2 low-energy,

remote-control and signal circuits, No. 16 AWG; and for Class 3 low-energy, remote-control, alarm and signal circuits, No. 22 AWG.

2.7.2 Color Coding

Provide for service, feeder, branch, control, and signaling circuit conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals shall be white with a different colored (not green) stripe for each. Color of ungrounded conductors in different voltage systems shall be as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 480/277 volt, three-phase

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

2.7.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN/THHN conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.7.4 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.7.4.1 Telecommunications Bonding Backbone (TBB)

Provide a copper conductor TBB in accordance with TIA J-STD-607-A. The TBB shall be a minimum No. 6 AWG and be sized at 2 kcmil per linear foot of conductor length up to a maximum size of 3/0 AWG. Provide insulated TBB with insulation as specified in the paragraph INSULATION and meeting the fire ratings of its pathway.

2.7.4.2 Bonding Conductor for Telecommunications

Provide a copper conductor Bonding Conductor for Telecommunications between the telecommunications main grounding busbar (TMGB) and the electrical service ground in accordance with TIA J-STD-607-A. The bonding conductor for telecommunications shall be sized the same as the TBB.

2.7.5 Service Entrance Cables

Service Entrance (SE) and Underground Service Entrance (USE) Cables, UL 854.

2.7.6 Cord Sets and Power-Supply Cords

UL 817.

2.8 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires shall be insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

2.9 DEVICE PLATES

Provide UL listed, one-piece device plates for outlets to suit the devices installed. For metal outlet boxes, plates on unfinished walls shall be of zinc-coated sheet steel or cast metal having round or beveled edges. For nonmetallic boxes and fittings, other suitable plates may be provided. [Plates on finished walls shall be nylon or lexan, minimum 0.03 inch wall thickness. Plates shall be same color as receptacle or toggle switch with which they are mounted.] [Plates on finished walls shall be satin finish stainless steel or brushed-finish aluminum, minimum 0.03 inch thick.] Screws shall be machine-type with countersunk heads in color to match finish of plate. Sectional type device plates will not be permitted. Plates installed in wet locations shall be gasketed and UL listed for "wet locations."

2.10 SWITCHES

2.10.1 Toggle Switches

NEMA WD 1, UL 20, single pole, double pole, three-way, and four-way, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Handles shall be white thermoplastic. Wiring terminals shall be screw-type, side-wired. Contacts shall be silver-cadmium and contact arm shall be one-piece copper alloy. Switches shall be rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.

2.10.2 Switch with Red Pilot Handle

NEMA WD 1. Provide pilot lights that are integrally constructed as a part of the switch's handle. The pilot light shall be red and shall illuminate whenever the switch is closed or "on". The pilot lighted switch shall be rated 20 amps and 120 volts or 277 volts as indicated. Provide the circuit's neutral conductor to each switch with a pilot light.

2.10.3 Breakers Used as Switches

For 120- and 277-Volt fluorescent fixtures, mark breakers "SWD" in accordance with UL 489.

2.10.4 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Fused switches shall utilize Class R fuseholders and fuses, unless indicated otherwise. Switches serving as motor-disconnect means shall be horsepower rated. Provide switches in NEMA 1 or 3R enclosure as indicated per NEMA ICS 6.

2.11 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible switch. Time-current characteristics curves of fuses serving motors or connected in series with circuit breakers or other circuit protective devices shall be coordinated for proper operation. Submit coordination data for approval. Fuses shall have voltage rating not less than circuit voltage.

2.11.1 Fuseholders

Provide in accordance with UL 512.

2.11.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 198M, Class RK-1, RK-5, or time-delay type as indicated. Associated fuseholders shall be Class R only.

2.11.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

UL 198M, Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

2.11.4 Cartridge Fuses, Current Limiting Type (Class T)

UL 198M, Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

2.12 RECEPTACLES

UL 498, hard use, heavy-duty, grounding-type. Ratings and configurations shall be as indicated. Bodies shall be of white as per NEMA WD 1. Face and body shall be thermoplastic supported on a metal mounting strap. Dimensional requirements shall be per NEMA WD 6. Provide screw-type, side-wired wiring terminals. Connect grounding pole to mounting strap. The receptacle shall contain triple-wipe power contacts and double or triple-wipe ground contacts.

2.12.1 Switched Duplex Receptacles

Provide separate terminals for each ungrounded pole. Top receptacle shall be switched when installed.

2.12.2 Weatherproof Receptacles

Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. Provide caps with a spring-hinged flap. Receptacle shall be UL listed for use in "wet locations with plug in use."

2.12.3 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Device shall be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFCI devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.12.4 Special Purpose Receptacles

Special purpose receptacles serving specific equipment shall be provided with ratings as indicated by the NEMA configuration on the drawings. Verify requirements with equipment provider prior to purchase and installation. Provide matching cord and plug where necessary.

2.12.5 Plugs

Provide heavy-duty, rubber-covered cord of required size and conductor quantity, install plugs thereon, and attach to equipment. Plugs shall be UL listed with receptacles, complete with grounding blades. Where equipment is not available, turn over plugs and cord assemblies to the Government.

2.12.6 Dryer Receptacles

NEMA 14-30 configuration, rated 30 amperes, 125/250 volts. Furnish one matching plug with each receptacle.

2.13 PANELBOARDS

UL 67 and UL 50. Panelboards for use as service disconnecting means shall additionally conform to UL 869A. Panelboards shall be circuit breaker-equipped. Design shall be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. Where "space only" is indicated, make provisions for future installation of breaker sized as indicated. Directories shall indicate load served by each circuit of panelboard. Directories shall also indicate source of service (upstream panel, switchboard, motor control center, etc.) to panelboard. Type directories and mount in holder behind transparent protective covering. Panelboard shall have nameplates in accordance with paragraph FIELD FABRICATED NAMEPLATES.

2.13.1 Enclosure

Enclosures shall meet the requirements of UL 50. All cabinets shall be fabricated from sheet steel of not less than No. 10 gauge if flush-mounted or mounted outdoors, and not less than No. 12 gauge if surface-mounted indoors, with full seam-welded box ends. Cabinets mounted outdoors or flush-mounted shall be hot-dipped galvanized after fabrication. Cabinets shall be painted in accordance with paragraph PAINTING. Outdoor cabinets shall be of NEMA 3R raintight with conduit hubs welded to the cabinet. Front edges of cabinets shall be form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front. All cabinets shall be so fabricated that no part of any surface on the finished cabinet shall deviate from a true plane by more than 1/8 inch. Holes shall be provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a

1/2 inch clear space between the back of the cabinet and the wall surface. Flush doors shall be mounted on hinges that expose only the hinge roll to view when the door is closed. Each door shall be fitted with a combined catch and lock, except that doors over 24 inches long shall be provided with a three-point latch having a knob with a T-handle, and a cylinder lock. Two keys shall be provided with each lock, and all locks shall be keyed alike. Finished-head cap screws shall be provided for mounting the panelboard fronts on the cabinets.

2.13.2 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2.13.3 Circuit Breakers

UL 489, thermal magnetic-type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker shall be mounted. Breaker terminals shall be UL listed as suitable for type of conductor provided. Where indicated on the drawings, provide circuit breakers with shunt trip devices. Series rated circuit breakers and plug-in circuit breakers are unacceptable.

2.13.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Breaker design shall be such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.13.3.2 Circuit Breaker With GFCI

UL 943 and NFPA 70. Provide with "push-to-test" button, visible indication of tripped condition, and ability to detect and trip on current imbalance of 6 milliamperes or greater per requirements of UL 943 for Class A GFCI devices, for personnel protection, and 20 milliamperes or greater per requirements of UL 943 for Class B GFCI per equipment protection.

2.13.3.3 Circuit Breakers for HVAC Equipment

Circuit breakers for HVAC equipment having motors (group or individual) shall be marked for use with HACR type and UL listed as HACR type.

2.14 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated. Provide solid neutral where required.

2.15 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors, also called motor circuit protectors

(MCPs); shall conform to UL 508 and UL 489 and shall be provided as shown. MSCPs shall consist of an adjustable instantaneous trip circuit breaker used only in conjunction with a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection. MSCPs shall be rated in accordance with the requirements of NFPA 70.

2.16 TRANSFORMERS

NEMA ST 20, general purpose, dry-type, self-cooled, ventilated. Provide transformers in NEMA 1 enclosure. Transformer shall have 220 degrees C insulation system for transformers 15 kVA and greater, and shall have 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient of 40 degrees C. Transformer of 150 degrees C temperature rise shall be capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating.

2.16.1 Specified Transformer Efficiency

Transformers, indicated and specified with: 480V primary, 80 degrees C or 115 degrees C temperature rise, kVA ratings of 37.5 to 100 for single phase or 30 to 500 for three phase, shall be energy efficient type. Minimum efficiency, based on factory test results, shall not be less than NEMA Class 1 efficiency as defined by NEMA TP 1.

2.17 MOTORS

NEMA MG 1; hermetic-type sealed motor compressors shall also comply with UL 984. Provide the size in terms of HP, or kVA, or full-load current, or a combination of these characteristics, and other characteristics, of each motor as indicated or specified. Determine specific motor characteristics to ensure provision of correctly sized starters and overload heaters. Motors for operation on 208-volt, 3-phase circuits shall have terminal voltage rating of 200 volts, and those for operation on 480-volt, 3-phase circuits shall have terminal voltage rating of 460 volts. Motors shall be designed to operate at full capacity with voltage variation of plus or minus 10 percent of motor voltage rating. Unless otherwise indicated, motors rated 1 HP and above shall be continuous duty type.

Where fuse protection is specifically recommended by the equipment manufacturer, provide fused switches in lieu of non-fused switches indicated.

2.17.1 High Efficiency Single-Phase Motors

Single-phase fractional-horsepower alternating-current motors shall be high efficiency types corresponding to the applications listed in NEMA MG 11. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.17.2 Premium Efficiency Polyphase Motors

Polyphase motors shall be selected based on high efficiency characteristics relative to typical characteristics and applications as listed in NEMA MG 10. In addition, continuous rated, polyphase squirrel-cage medium induction motors shall meet the requirements for premium efficiency electric motors

in accordance with NEMA MG 1, including the NEMA full load efficiency ratings. In exception, for motor-driven equipment with a minimum seasonal or overall efficiency rating, such as a SEER rating, provide equipment with motor to meet the overall system rating indicated.

2.17.3 Motor Sizes

Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

2.17.4 Wiring and Conduit

Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment as specified herein. Power wiring and conduit shall conform to the requirements specified herein. Control wiring shall be provided under, and conform to the requirements of the section specifying the associated equipment.

2.18 MOTOR CONTROLLERS

UL 508, NEMA ICS 1, and NEMA ICS 2. Controllers shall have thermal overload protection in each phase and shall have one spare normally open and one spare normally closed auxiliary contact. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay. Magnetic-type motor controllers shall have undervoltage protection when used with momentary-contact pushbutton stations or switches and shall have undervoltage release when used with maintained-contact pushbutton stations or switches. When used with pressure, float, or similar automatic-type or maintained-contact switch, controller shall have hand/off/automatic selector switch. Connections to selector switch shall be such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices, shall be connected in motor control circuit in "hand" and "automatic" positions. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device shall be made in accordance with indicated or manufacturer's approved wiring diagram. For each motor not in sight of controller or where controller disconnecting means is not in sight of motor location and driven machinery location, controller disconnecting means shall be capable of being locked in open position. As an alternative, provide a manually operated, lockable, nonfused switch which disconnects motor from supply source within sight of motor. Overload protective devices shall provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual reset-type pushbutton on outside of motor controller case. Cover of combination motor controller and manual switch or circuit breaker shall be interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit

breaker is in "off" position.

2.18.1 Control Wiring

All control wire shall be stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44, or Type MTW meeting UL 1063, and shall pass the VW-1 flame tests included in those standards. Hinge wire shall have Class K stranding. Current transformer secondary leads shall be not smaller than No. 10 AWG. The minimum size of control wire shall be No. 14 AWG. Power wiring for 480-volt circuits and below shall be of the same type as control wiring and the minimum size shall be No. 12 AWG. Special attention shall be given to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.18.2 Control Circuit Terminal Blocks

NEMA ICS 4. Control circuit terminal blocks for control wiring shall be molded or fabricated type with barriers, rated not less than 600 volts. The terminals shall be removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts. The terminals shall be not less than No. 10 in size and shall have sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal. The terminal arrangement shall be subject to the approval of the Contracting Officer and not less than four (4) spare terminals or 10 percent, whichever is greater, shall be provided on each block or group of blocks. Modular, pull apart, terminal blocks will be acceptable provided they are of the channel or rail-mounted type. The Contractor shall submit data showing that the proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.18.2.1 Types of Terminal Blocks

- a. Short-Circuiting Type: Short-circuiting type terminal blocks shall be furnished for all current transformer secondary leads and shall have provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks shall meet the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.
- b. Load Type: Load terminal blocks rated not less than 600 volts and of adequate capacity shall be provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. The terminals shall be of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, screws shall have hexagonal heads. Conducting parts between connected terminals shall have adequate contact surface and cross-section to operate without overheating. Each connected terminal shall have the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.18.3 Control Circuits

Control circuits shall have maximum voltage of 120 volts derived from a separate control source. Provide terminals and terminal boards. Provide separate control disconnect switch within controller. One secondary lead shall be fused; other shall be grounded.

2.18.4 Enclosures for Motor Controllers

NEMA ICS 6.

2.18.5 Multiple-Speed Motor Controllers and Reversible Motor Controllers

Across-the-line-type, electrically and mechanically interlocked. Multiple-speed controllers shall have compelling relays and shall be multiple-button, station-type with pilot lights for each speed.

2.18.6 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations shall be heavy duty, oil-tight design.

2.18.7 Pilot and Indicating Lights

Provide transformer, resistor, or diode type.

2.19 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

Single pole designed for surface mounting with overload protection and pilot lights.

2.19.1 Pilot Lights

Provide yoke-mounted, candelabra-base sockets rated 125 volts and fitted with glass or plastic jewels. Provide clear, 6 watt lamp in each pilot switch. Jewels for use with switches controlling motors shall be green; jewels for other purposes shall be white, red, or amber.

2.20 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Mechanical isolation of machines and other equipment shall be in accordance with requirements of Division 23, "Mechanical."

2.21 TELECOMMUNICATIONS SYSTEM

Provide system of telecommunications wire-supporting structures (pathway), including: outlet boxes, conduits with pull wires, cable trays, and other accessories for telecommunications outlets and pathway in accordance with TIA/EIA-569-A and as specified herein. Additional telecommunications requirements are specified in Section 27 10 00, BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.22 COMMUNITY ANTENNA TELEVISION (CATV) SYSTEM

Additional CATV requirements are specified in Section 27 54 00.00 20,

COMMUNITY ANTENNA TELEVISION (CATV) SYSTEMS.

2.22.1 Backboards

Coordinate CATV backboard requirements with telecommunications backboard requirements as specified in Section 27 10 00, BUILDING TELECOMMUNICATIONS CABLING.

2.23 GROUNDING AND BONDING EQUIPMENT

2.23.1 Ground Rods

UL 467. Ground rods shall be sectional type, copper-clad steel, with minimum diameter of 3/4 inch and minimum length of 10 feet.

2.23.2 Telecommunications and CATV Grounding Busbar

Provide corrosion-resistant grounding busbar suitable for indoor installation in accordance with TIA J-STD-607-A. Busbars shall be plated for reduced contact resistance. If not plated, the busbar shall be cleaned prior to fastening the conductors to the busbar, and an anti-oxidant shall be applied to the contact area to control corrosion and reduce contact resistance. Provide a telecommunications main grounding busbar (TMGB) in the telecommunications entrance facility. The telecommunications main grounding busbar (TMGB) shall be sized in accordance with the immediate application requirements and with consideration of future growth. Provide telecommunications grounding busbars with the following:

- a. Predrilled copper busbar provided with holes for use with standard sized lugs;
- b. Minimum dimensions of 0.25 in thick x 4 in wide for the TMGB with minimum length of 24 inches;
- c. Listed by a nationally recognized testing laboratory.

2.24 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.25 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.26 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and

NEMA Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. The marking shall be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.27 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations in accordance with Section 07 84 00, FIRESTOPPING .

2.28 WIREWAYS

UL 870. Material shall be steel epoxy painted 16 gauge for heights and depths up to 6 by 6 inches, and 14 gauge for heights and depths up to 12 by 12 inches. Provide in length required for the application with screw-cover NEMA 1 enclosure per NEMA ICS 6.

2.29 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices which comply with UL 1449 at the service entrance and distribution panelboards as indicated. Provide surge protectors in a NEMA 1 enclosure per NEMA ICS 6. Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-
Each phase to neutral (L-N)
Neutral to ground (N-G)
Phase to ground (L-G)

Surge protective devices at the service entrance shall have a minimum surge current rating of 80,000 amperes per mode minimum and downstream protectors shall be rated 40,000 amperes per mode minimum. The maximum line to neutral (L-N) Suppressed Voltage Rating (SVR) shall be:

500V for 208Y/120V, three phase system
900V for 480Y/277V, three phase system

The minimum MCOV (Maximum Continuous Operating Voltage) rating shall be:

300/150V for 208Y/120V, three phase system
600/320V for 480Y/277V, three phase system

EMI/RFI filtering shall be provided for each mode with the capability to attenuate high frequency noise. Minimum attenuation shall be 20db.

2.30 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements as specified herein. Interior and exterior steel surfaces of equipment enclosures shall be thoroughly cleaned and then receive a rust-inhibitive phosphatizing or equivalent treatment prior to painting. Exterior surfaces shall be free from holes, seams,

dents, weld marks, loose scale or other imperfections. Interior surfaces shall receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice. Exterior surfaces shall be primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish. Equipment located indoors shall be ANSI Light Gray, and equipment located outdoors shall be ANSI Light Gray. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.31 SOURCE QUALITY CONTROL

2.31.1 Transformer Factory Tests

Submittal shall include routine NEMA ST 20 transformer test results on each transformer and also contain the results of NEMA "design" and "prototype" tests that were made on transformers electrically and mechanically equal to those specified.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces, shall conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.

3.1.1 Underground Service

Underground service conductors and associated conduit shall be continuous from service entrance equipment to outdoor power system connection.

3.1.2 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures shall be labeled and identified as such.

3.1.2.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, each enclosure, new and existing, shall be labeled as one of several enclosures containing service entrance disconnect devices. Label, at minimum, shall indicate number of service disconnect devices housed by enclosure and shall indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure, shall be provided only as permitted by NFPA 70.

3.1.3 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Minimum conduit size shall be

1/2 inch in diameter for low voltage lighting and power circuits. Vertical distribution in multiple story buildings shall be made with metal conduit in fire-rated shafts. Metal conduit shall extend through shafts for minimum distance of 6 inches. Conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors shall be firestopped in accordance with Section 07 84 00, FIRESTOPPING.

3.1.3.1 Pull Wire

Install pull wires in empty conduits. Pull wire shall be plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

3.1.4 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.

3.1.4.1 Restrictions Applicable to EMT

- a. Do not install underground.
- b. Do not encase in concrete, mortar, grout, or other cementitious materials.
- c. Do not use in areas subject to severe physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.
- d. Do not use in hazardous areas.
- e. Do not use outdoors.
- f. Do not use in fire pump rooms.
- g. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.2 Restrictions Applicable to Nonmetallic Conduit

- a. PVC Schedule 40 and PVC Schedule 80
 - (1) Do not use in areas where subject to severe physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, hospitals, power plants, missile magazines, and other such areas.
 - (2) Do not use in hazardous (classified) areas.
 - (3) Do not use in fire pump rooms.
 - (4) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

(5) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

(6) Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.3 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.4 Service Entrance Conduit, Underground

PVC, Type-EPC 40, galvanized rigid steel or steel IMC. Underground portion shall be encased in minimum of 3 inches of concrete and shall be installed minimum 18 inches below slab or grade.

3.1.4.5 Underground Conduit Other Than Service Entrance

Plastic-coated rigid steel; plastic-coated steel IMC; PVC, Type EPC-40. Convert nonmetallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid, or IMC, steel conduit before rising through floor slab. Plastic coating shall extend minimum 6 inches above floor.

3.1.4.6 Conduit Installed Under Floor Slabs

Conduit run under floor slab shall be located a minimum of 12 inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier. support conduits using 1/4" stainless steel rods spaced maximum 10 feet on centers. Rods shall be wrapped around conduits individually and turned at right angles over reinforcing steel in slab. Where conduits are grouped in parallel runs, entire group may wrapped with both ends of rods turned at right angles over reinforcing steel in slab.

3.1.4.7 Conduit Through Floor Slabs

Where conduits rise through floor slabs, curved portion of bends shall not be visible above finished slab.

3.1.4.8 Conduit Installed in Concrete Floor Slabs

PVC, Type EPC-40, unless indicated otherwise. Locate so as not to adversely affect structural strength of slabs. Install conduit at bottom of first floor concrete slab, but above vapor barrier. Do not stack conduits. Any conduit crossings within slab shall be approved by structural engineer prior to installation. Space conduits horizontally not closer than three diameters, except at cabinet locations. Curved portions of bends shall not be visible above finish slab. Increase slab thickness as necessary to provide minimum one inch cover over conduit. Where embedded conduits cross building and/or expansion joints, provide suitable watertight expansion/deflection fittings and bonding jumpers. Expansion/deflection fittings shall allow horizontal and vertical movement of raceway. Maximum size allowable in slab shall be 3/4" trade size.

3.1.4.9 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that flexible metal conduit may be used 6 inches above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.4.10 Conduit Support

Support conduit by pipe straps, wall brackets, hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Load applied to fasteners shall not exceed one-fourth proof test load. Fasteners attached to concrete ceiling shall be vibration resistant and shock-resistant. Holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints shall not cut main reinforcing bars. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems shall be supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Installation shall be coordinated with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Where conduit crosses building expansion joints, provide suitable expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.4.11 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.4.12 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Locknuts shall have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.4.13 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for recessed and semirecessed lighting fixtures; for equipment subject to vibration,

noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size shall be 1/2 inch diameter. Provide liquidtight flexible metal conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.

3.1.4.14 Telecommunications and Signal System Pathway

Install telecommunications pathway in accordance with TIA/EIA-569-A.

- a. Horizontal Pathway: Telecommunications pathways from the work area to the telecommunications room shall be installed and cabling length requirements in accordance with TIA/EIA-568-B.1. Size conduits, wireways, and cable trays in accordance with TIA/EIA-569-A and as indicated.

3.1.5 Cable Tray Installation

Install and ground telecommunications cable tray in accordance with TIA/EIA-569-A, and TIA J-STD-607-A. Install cable trays parallel with or at right angles to ceilings, walls, and structural members. Support in accordance with manufacturer recommendations but at not more than 10 foot intervals. Adjacent cable tray sections shall be bonded together by connector plates of an identical type as the cable tray sections. Terminate cable trays 10 inches from both sides of smoke and fire partitions. Conductors run through smoke and fire partitions shall be installed in 4 inch rigid steel conduits with grounding bushings, extending 12 inches beyond each side of partitions. Seal conduit on both ends to maintain smoke and fire ratings of partitions. Penetrations shall be firestopped in accordance with Section 07 84 00, FIRESTOPPING. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.6 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to 7 feet above floors and walkways, and when specifically indicated. Boxes in other locations shall be sheet steel, and nonmetallic boxes may be used with nonmetallic conduit system. Each box shall have volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures shall be minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; fixtures shall be readily removable for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. In open overhead spaces,

cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.6.1 Boxes

Boxes for use with raceway systems shall be minimum 1 1/2 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 that 4 by 2 inch boxes may be used where only one raceway enters outlet. Telecommunications outlets shall be a minimum of 4 inches square by 2 1/8 inches deep, except for wall mounted telephones and outlet boxes for handicap telephone stations. Mount outlet boxes flush in finished walls.

3.1.6.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.1.7 Mounting Heights

Mount panelboards, enclosed circuit breakers, motor controller and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount lighting switches 48 inches above finished floor. Mount receptacles and telecommunications outlets 18 inches above finished floor, unless otherwise indicated. Wall-mounted telecommunications outlets shall be mounted at height 60 inches above finished floor or as indicated. Mount other devices as indicated. Measure mounting heights of wiring devices and outlets in non-hazardous areas to center of device or outlet.

3.1.8 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, color coding shall be by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, color coding shall be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations in accordance with Section 23 09 53.00 20, SPACE TEMPERATURE CONTROL SYSTEMS. Provide telecommunications system conductor identification as specified in Section 27 10 00, BUILDING TELECOMMUNICATIONS CABLING SYSTEMS.

3.1.8.1 Marking Strips

White or other light-colored plastic marking strips, fastened by screws to each terminal block, shall be provided for wire designations. The wire numbers shall be made with permanent ink. The marking strips shall be reversible to permit marking both sides, or two marking strips shall be furnished with each block. Marking strips shall accommodate the two sets of wire numbers. Each device to which a connection is made shall be

assigned a device designation in accordance with NEMA ICS 1 and each device terminal to which a connection is made shall be marked with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, additional wire and cable designations for identification of remote (external) circuits shall be provided for the Government's wire designations. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.9 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.9.1 Splices of Aluminum Conductors

Make with solderless circumferential compression-type, aluminum-bodied connectors UL listed for AL/CU. Remove surface oxides from aluminum conductors by wire brushing and immediately apply oxide-inhibiting joint compound and insert in connector. After joint is made, wipe away excess joint compound, and insulate splice.

3.1.10 Terminating Aluminum Conductors

3.1.10.1 Termination to Copper Bus

Terminate aluminum conductors to copper bus either by: (a) inline splicing a copper pigtail, of ampacity at least that of aluminum conductor, or (b) utilizing circumferential, compression-type, aluminum-bodied terminal lug UL listed for AL/CU, and steel Belleville cadmium-plated hardened steel spring washers, flat washers, bolts, and nuts. Carefully install Belleville spring washers with crown up toward nut or bolt head, with concave side of Belleville bearing on heavy-duty, wide series flat washer of larger diameter than Belleville. Tighten nuts sufficiently to flatten Belleville, and leave in position. Lubricate hardware with joint compound prior to making connection. Wire brush and apply joint compound to conductor prior to inserting in lug.

3.1.10.2 Termination to Aluminum Bus

Terminate aluminum conductors to aluminum bus by using aluminum nuts, bolts, washers, and compression lugs. Wire brush and apply joint compound to conductor prior to inserting in lug. Lubricate hardware with joint compound prior to making connection. When bus contact surface is unplated, scratch-brush and coat with joint compound, without grit.

3.1.11 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not

permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.12 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance with Section 07 84 00, FIRESTOPPING.

3.1.13 Grounding and Bonding

Provide In accordance with NFPA 70. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, and neutral conductor of wiring systems. Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70. Interconnect all grounding media in or on the structure to provide a common ground potential. This shall include lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Use main size lightning conductors for interconnecting these grounding systems to the lightning protection system. In addition to the requirements specified herein, provide telecommunications grounding in accordance with TIA J-STD-607-A. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.13.1 Ground Rods

Provide cone pointed ground rods. The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, provide additional rods not less than 10 feet on centers. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

3.1.13.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, excepting specifically those connections for which access for periodic testing is required, by exothermic weld or compression connector.

- a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.
- b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies shall be as recommended by the manufacturer. An embossing die

code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

3.1.13.3 Ground Bus

A copper ground bus shall be provided in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of transformer neutrals and other electrical equipment shall be effectively grounded by bonding to the ground bus. The ground bus shall be bonded to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment.

3.1.13.4 Resistance

Maximum resistance-to-ground of grounding system shall not exceed 5 ohms under dry conditions. Where resistance obtained exceeds 5 ohms, contact Contracting Officer for further instructions.

3.1.13.5 Telecommunications System

Provide telecommunications grounding in accordance with the following:

- a. Telecommunications Grounding Busbars: Provide a telecommunications main grounding busbar (TMGB) in the telecommunications entrance facility. The TMGB shall be as close to the electrical service entrance grounding connection as practicable. Telecommunications grounding busbars shall be installed to maintain clearances as required by NFPA 70 and shall be insulated from its support. A minimum of 2 inches separation from the wall is recommended to allow access to the rear of the busbar and the mounting height shall be adjusted to accommodate overhead or underfloor cable routing.
- c. Telecommunications Grounding Connections: Telecommunications grounding connections to the TMGB shall utilize listed compression two-hole lugs, exothermic welding, suitable and equivalent one hole non-twisting lugs, or other irreversible compression type connections. All metallic pathways, cabinets, and racks for telecommunications cabling and interconnecting hardware located within the same room or space as the TMGB shall be bonded to the TMGB. In a metal frame (structural steel) building, where the steel framework is readily accessible within the room; each TMGB shall be bonded to the vertical steel metal frame using a minimum No. 6 AWG conductor. Where the metal frame is external to the room and readily accessible, the metal frame shall be bonded to the TMGB with a minimum No. 6 AWG conductor. All connectors used for bonding to the metal frame of a building shall be listed for the intended purpose.

3.1.14 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this

section of the specifications but shall be provided under the section specifying the associated equipment.

3.1.15 Government-Furnished Equipment

Contractor shall make connections to Government-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

3.1.16 Watthour Meters

NEMA C12.1.

3.1.17 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.4 FIELD APPLIED PAINTING

Where field painting of enclosures for panelboards, or the like is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer 5 working days notice prior to each test.

3.5.1 Devices Subject to Manual Operation

Each device subject to manual operation shall be operated at least five times, demonstrating satisfactory operation each time.

3.5.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance shall be 250,000 ohms.

3.5.3 Transformer Tests

Perform the standard, not optional, tests in accordance with the Inspection and Test Procedures for transformers, dry type, air-cooled, 600 volt and below; as specified in NETA ATS. Measure primary and secondary voltages for proper tap settings. Tests need not be performed by a recognized independent testing firm or independent electrical consulting firm.

3.5.4 Ground-Fault Receptacle Test

Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed.

3.5.5 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

3.5.6 Watthour Meter

a. Visual and mechanical inspection

(1) Examine for broken parts, shipping damage, and tightness of connections.

(2) Verify that meter type, scales, and connections are in accordance with approved shop drawings.

b. Electrical tests

(1) Determine accuracy of meter.

(2) Calibrate watthour meters to one-half percent.

(3) Verify that correct multiplier has been placed on face of meter, where applicable.

-- End of Section --