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DEPARTMENT OF THE NAVY
NAVAL FACILITIES
ENGINEERING COMMAND
GUIDE SPECIFICATION

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SECTION 16402
INTERIOR WIRING SYSTEMS (A)

PART 1 - GENERAL

1.1 APPLICABLE PUBLICATIONS: 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. (B)

FEDERAL SPECIFICATIONS (Fed. Spec.):

W-C-375B	Circuit Breaker, Molded Case, Branch Circuit and Service

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI):

C80.1-83	Specification for Rigid Steel Conduit, Zinc-Coated
C80.3-83	Specification for Electrical Metallic Tubing, Zinc-Coated
C80.5-83	Specification for Rigid Aluminum Conduit

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM):

B 1-85	Hard-Drawn Copper Wire
B 8-81	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA):

BU1-1983	Busways
ICS1-83(85)	General Standards for Industrial Control and Systems
ICS2-83(84)	Standards for Industrial Control Devices, Controllers and Assemblies
ICS4-83	Terminal Blocks for Industrial Control Equipment and Systems
ICS6-83	Enclosures for Industrial Controls and Systems
KS1-83(85)	Enclosed Switches
MG1-78(84)	Motors and Generators
RN1-80	PVC Externally Coated Galvanized Rigid Steel Conduit and EMT
TC2-83	Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
TC3-82(84)	PVC Fittings for Use with Rigid PVC Conduit and Tubing
VE1-84	Metallic Cable Tray Systems
WD1-83	General Requirements for Wiring Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA):

70-87	National Electrical Code (NEC)

UNDERWRITERS LABORATORIES, INC. (UL):

1-85	Flexible Metal Conduit
4-80(83)	Armored Cable
5-85	Surface Metal Raceways and Fittings
50-80(85)	Cabinets and Boxes
67-79(85)	Panelboards
83-83(86)	Thermoplastic-Insulated Wires and Cables
198C-81(85)	High-Interrupting Capacity Fuses, Current-Limiting Types
198E-82(85)	Class R Fuses
360-80(82)	Liquid-Tight Flexible Steel Conduit
467-84(85)	Grounding and Bonding Equipment
486A-80(86)	Wire Connectors and Soldering Lugs for Use with Copper Conductors
486B-82(86)	Wire Connectors for Use with Aluminum Conductors
486C-83(85)	Splicing Wire Connectors
489-80(86)	Molded-Case Circuit Breakers and Circuit Breaker Enclosures
498-81(84)	Attachment Plugs and Receptacles
506-79(84)	Specialty Transformers
510-82	Insulating Tape
514A-83(85)	Metallic Outlet Boxes
514B-82(85)	Fitting for Conduit and Outlet Boxes
719-85(86)	Nonmetallic-Sheathed Cables
854-79(86)	Service-Entrance Cables
869-84(85)	Service Equipment
886-85	Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
943-85	Ground-Fault Circuit Interrupters
984-84	Hermetic Refrigerant Motor-Compressors
1053-82	Ground-Fault Sensing and Relaying Equipment
1242-83	Intermediate Metal Conduit
1569-83(86)	Metal-Clad Cables

1.2 GENERAL REQUIREMENTS: Section 16011, "Electrical General Requirements," applies to this section with additions and modifications specified herein. In each of the standards referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears. Interpret reference in these standards to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. (C)

1.2.1 Underground Service: Underground service conductors and associated conduit shall be continuous from the service entrance equipment to the outdoor power system connection. (D)

** OR **

1.2.1 Underground Service: Underground service into buildings shall terminate at a point 5 feet outside the building and projections thereof, except that service conductors shall be continuous to the interior terminating point indicated. The underground portion of the conduit shall be encased in a concrete envelope having a wall thickness of not less than 3 inches and shall

be buried not less than 24 inches. Where a conduit enters through a concrete floor, the curved portion shall not be visible above the finished floor and the entire conduit below the floor slab shall be encased in a concrete envelope having a wall thickness of not less than 3 inches. Ends of the underground conduit shall be protected by threaded metal caps until connections are made. Underground service from 5 feet outside the building to the existing power system shall be provided under Section 16301, "Underground Electrical Work."

** OR **

1.2.1 Overhead Service: Overhead service conductors into buildings shall terminate at the service entrance fittings or weatherhead outside the building. The overhead service conductors and support bracket for the overhead conductors are included in Section 16302, "Overhead Electrical Work."

1.3 SUBMITTALS: (E)

1.3.1 Manufacturers' Data:

a. Receptacles
b. Circuit breakers
c. Switches
d. Conduit and fittings (each type)
e. Surface metal raceway
f. Ground rods
g. Device plates
h. Insulated conductors
i. Outlet and junction boxes
j. _____

1.3.2 Shop Drawings:

a. Panelboards
b. Transformers
c. Busway
d. Wireway
e. Cable trough
f. Motor control center
g. _____

1.3.3 Government Approval: Government approval is required for the following: (F)

[a. _____]
[b. _____]

1.3.4 Transformer Tests and Test Reports: Perform tests classified as "routine" in accordance with UL 506 on each transformer and submit the results for approval in report form. Submittal shall also contain the results of "design" and "prototype" tests that were made on transformers electrically and mechanically equal to those specified.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT, GENERAL: All materials, equipment, and devices shall, as a minimum, meet the requirements of UL where UL standards are established for those items, and the requirements of NFPA 70. All items shall be new unless specified or indicated otherwise.

2.2 CONDUIT AND FITTINGS:

2.2.1 Rigid Steel Conduit (Zinc-Coated): ANSI C80.1.

2.2.2 Rigid Aluminum Conduit: ANSI C80.5.

2.2.3 Rigid Nonmetallic Conduit: PVC Type EPC-40 in accordance with NEMA TC2, or UL approved fiberglass reinforced epoxy (FRE).

2.2.4 Intermediate Metal Conduit (IMC): UL 1242, zinc-coated steel only.

2.2.5 Electrical Metallic Tubing (EMT): ANSI C80.3.

2.2.6 Plastic-Coated Rigid Steel and IMC Conduit: NEMA RN1, Type 40 (40 mils thick).

2.2.7 Flexible Metal Conduit: UL 1.

2.2.7.1 Liquid-Tight Flexible Metal Conduit (Steel): UL 360.

2.2.8 Fittings for Metal Conduit, Electrical Metallic Tubing, and Flexible Metal Conduit: UL 514B. All ferrous fittings shall be cadmium- or zinc-coated in accordance with UL 514B.

2.2.8.1 Fittings for rigid metal conduit and IMC shall be threaded type. Split couplings are not acceptable.

2.2.8.2 Fittings for electrical metallic tubing (EMT) shall be the compression type.

2.2.8.3 Fittings for use in Hazardous Locations: UL 886.

2.2.9 Fittings for Rigid Nonmetallic Conduit: NEMA TC3.

2.2.10 Fittings for flexible metal conduit shall be the compression type.

2.3 SURFACE METAL RACEWAY AND FITTINGS: 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 in this section of the specifications and shall be spaced a minimum of one every [18] [__] inches.] [Alternate receptacles shall be wired on different circuits.]

2.4 BUSWAYS: NEMA BU1. Buses shall be [copper] [or] [aluminum]. Enclosures shall be steel. Short-circuit ratings shall be as indicated.

2.4.1 Feeder Busways: Provide [ventilated, except that vertical busways within 6 feet of floors shall be unventilated,] [unventilated] low-impedance busway.

2.4.2 Plug-In Busways: Unventilated type. Plug-in units shall be the [fusible, handle-operated switch type, horsepower-rated] [circuit breaker type] [handle-operated switch type equipped with high-interrupting -capacity current-limiting fuses].

2.5 CABLE TRAYS: NEMA VE1. Material shall be of [steel] [or] [series 6000 aluminum alloy]. [Steel cable trays shall be hot-dip zinc coated after fabrication.] Fittings shall have not less than the load-carrying ability of straight tray sections. Cable trays shall terminate 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 the partitions. The installation shall be sealed to preserve the smoke and fire ratings of the partitions.

2.5.1 Trough-Type Cable Trays: Trays shall be [sized as indicated] [of a nominal [6] [12] [18] [24] [30] [36]-inch width].

2.5.2 Ladder-Type Cable Trays: Trays shall be [sized as indicated] [of nominal [6] [12] [18] [24] [30] [36]-inch width with rung spacing of [6] [9] [12] [18] inches maximum].

2.5.3 Channel-Type Cable Trays: Trays shall be [sized as indicated] [[3] [4] inches in width].

2.5.4 Solid-Bottom Type Cable Trays: Trays shall be [sized as indicated] [of nominal [6] [12] [18] [24] [30] [36]-inch width].

2.6 OUTLET BOXES AND COVERS: UL 514A, cadmium- or zinc-coated if of ferrous metal.

2.6.1 Outlet Boxes in Hazardous Locations: UL 886.

2.6.2 Floor Outlet Boxes: Boxes shall be adjustable and concrete-tight. Each outlet shall consist of a cast-metal body with threaded openings for conduits, adjustable ring, brass flange ring, and cover plate with 3/4-inch threaded plug. Telephone outlets shall consist of a [surface-mounted horizontal] [flush] aluminum or stainless steel housing with a [one-inch bushed side opening] [3/4-inch top opening]; outlets shall have provisions to accommodate a 10-wire telephone terminal block. Receptacle outlets shall consist of [surface-mounted horizontal] [flush] aluminum or stainless steel housing with a duplex receptacle as specified in this section of the specifications. Gaskets shall be used where necessary to insure watertight installation.

2.6.3 Clock Outlet for Use in Other than a Wired Clock System: Provide an outlet box, a plaster cover where required, and a single receptacle with clock-outlet plate. The receptacle shall be recessed sufficiently within the box to allow the complete insertion of a standard cap, flush with the plate. A suitable clip or support for hanging the clock shall be secured to the top plate. Material and finish of the plate shall be as specified in paragraph, "Device Plates."

2.7 CABINETS, JUNCTION BOXES, AND PULL BOXES (WITH VOLUME GREATER THAN 100 CUBIC INCHES): UL 50, hot-dip zinc-coated if of sheet steel.

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

2.8.1 Conductors: Conductors No. 10 AWG and smaller shall be solid, and those No. 8 AWG and larger shall be stranded. Unless indicated otherwise, conductor sizes shown are based on copper. All conductors indicated to be No. 6 AWG and smaller shall be copper. All conductors indicated to be No. 4 AWG and larger shall be either copper or aluminum, at the Contractor's option, unless the type of conductor material is specifically indicated, specified, or required by equipment manufacturer.

2.8.1.1 Equipment Manufacturer Requirements: Where Contractor provides equipment whose manufacturer requires copper conductors at the terminations, or requires that only copper conductors be provided between components of equipment, it shall be the Contractor's responsibility to provide copper conductors, or all necessary splices, splice boxes, and other work required to satisfy manufacturer's requirements.

2.8.1.2 Aluminum Conductors: Aluminum conductors shall be of an aluminum alloy that is listed or labeled by UL as "component aluminum-wire stock (conductor material)." Type EC/1350 aluminum is not acceptable. Should the Contractor choose to use the aluminum option for conductors No. 4 AWG and larger, the Contractor shall be responsible for: increasing the conductor size to have the same ampacity as the copper size indicated; increasing the conduit and pull box sizes to accommodate the larger size aluminum conductors in accordance with NFPA 70; insuring that the pulling tension rating of the aluminum conductor is sufficient; providing panelboards [and motor control centers] that are UL listed for use with aluminum, and so labeled; relocating equipment, modifying equipment terminations, resizing equipment, and resolving to the satisfaction of the Contracting Officer all problems that are direct results of the use of aluminum conductors in lieu of copper. (G)

2.8.1.3 Minimum Conductor Sizes: Minimum size for branch circuits shall be No. 12 AWG; for Class 1 remote-control and signal circuits, No. 14 AWG; and for Class 2 low-energy remote-control and signal circuits, No. 16 AWG.

2.8.2 Color Coding: Provide for all 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, the other neutral shall be white with a colored (not green) stripe. The color of the ungrounded conductors in different voltage systems shall be as follows:

a. 120/208 volt, 3-phase: Phase A - black
Phase B - red
Phase C - blue

b. 277/480 volt, 3-phase: Phase A - brown
Phase B - orange
Phase C - yellow

c. 120/240 volt, single phase: red and black.

[d. On a 3-phase, 4-wire delta system, the high leg shall be orange as required by NFPA 70.]

2.8.3 Insulation: Unless specified or indicated otherwise, or required to be otherwise by NFPA 70, all power and lighting wires shall be 600-volt, Type THW, THWN, XHHW, or RHW, except that grounding wire may be Type TW; remote-control and signal circuits shall be Type TW, THW or TF. Conductors shall conform to UL 83. Where lighting fixtures require 90-degree C conductors, only conductors with 90-degree C insulation or better shall be used. (H)

2.8.4 Bonding Conductors: ASTM B 1, solid copper wire for sizes No. 8 AWG and smaller; ASTM B 8, Class B, stranded copper wire for sizes No. 6 AWG and larger.

2.8.5 Service Entrance and Underground Secondary Conductors: UL 854, Type USE, single conductor, rated 600 volts, except that Type SE may be used from meter socket to service entrance panel.

2.8.6 Nonmetallic-Sheathed Cable: UL 719, Type NM (or NMC).

2.8.7 Wire and Cable for 400 Hertz Circuits: Insulated copper conductors only.

[2.8.8 Metal-Clad Cable: UL 1569, NFPA 70, Type MC cable.] (I)

[2.8.9 Armored Cable: UL 4, NFPA 70, Type AC cable.] (J)

[2.8.10 Mineral-Insulated, Metal Sheathed Cable: UL listed, NFPA 70, Type MI cable.] (K)

[2.8.11 Flat Conductor Cable: UL Listed, NFPA 70, Type FCC.] (L)

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

2.10 DEVICE PLATES: Plates on exposed raceways shall be cast metal or zinc-coated sheet steel having round or beveled edges. Provide UL listed, one-piece device plates for outlets and fittings to suit the devices installed. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel or cast metal having round or beveled edges. [Plates on finished walls shall be [urea or phenolic] [nylon or lexan], minimum 0.10-inch wall thickness. Plates shall be the same color as the receptacle or toggle switch with which it is 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 a color to match the finish of the plate. The use of sectional type device plates will not be permitted. Plates installed in wet locations shall be gasketed.

2.11 SWITCHES:

2.11.1 Toggle Switches: NEMA WD 1, No. 1121, totally enclosed with bodies of thermosetting plastic and a mounting strap. Handles shall be [brown] [ivory]. Wiring terminals shall be of the screw type, side wired. Switches shall be rated quiet-type ac only, 120/277 volts, with the current rating and number of poles indicated.

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

2.11.3 Disconnect Switches: NEMA KS1. Switches serving as motor-disconnect means shall be horsepower rated. 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. Provide switches in NEMA [1] [3R] [__] enclosure per NEMA ICS6. (M) (N)

2.11.4 Breakers Used as Switches for 120- and 277-Volt Fluorescent Fixtures: Breakers shall be marked "SWD" in accordance with UL 489.

2.12 RECEPTACLES: UL 498 and NEMA WD1, heavy-duty, grounding type. Ratings and configurations shall be as indicated. Bodies shall be of [brown] [ivory] thermosetting plastic supported on a metal mounting strap. Wiring terminals shall be of the screw type, side wired. Connect grounding pole to the mounting strap.

2.12.1 Switched Duplex Receptacles: Provide separate terminals for each ungrounded pole. The top receptacle shall be switched when installed.

2.12.2 Weatherproof Receptacles: Provide in a cast metal box with a gasketed, weatherproof, cast-metal cover plate and a gasketed cap over each receptacle opening. The cap(s) shall be provided with a spring-hinged flap. Receptacle shall be UL approved for use in "wet locations."

2.12.3 Ground Fault Circuit Interrupter Receptacles: UL 943, and shall be duplex type for mounting in a standard outlet box. The device shall be capable of detecting a current leak of 5 milliamperes. (O)

2.12.4 Special Purpose Receptacles: Receptacles serving _____ are considered special purpose for this project. [Provide in ratings indicated] [NEMA ___ configuration, rated ____ ampere, ___ volts.] [Furnish one matching plug with each receptacle.]

2.12.5 Duplex Receptacles: 20 amperes, 125 volts, No. 5342.

2.12.6 Range Receptacles: NEMA 14-50 configuration, rated 50 ampere, 125/250 volts. [Furnish one matching plug with each receptacle.] (P)

2.12.7 Dryer Receptacles: NEMA 14-30 configuration, rated 30 ampere, 125/250 volts. [Furnish one matching plug with each receptacle.] (Q)

2.12.8 Plugs: Provide heavy-duty rubber-covered 3, 4, or 5 wire cord of the required size, install the plugs thereon, and attach to the equipment. The plugs shall be as listed with the receptacles, complete with grounding blades. Where equipment is not available, turn over the plugs and cord assemblies to the Government.

2.13 PANELBOARDS: UL 67 and UL 50. Panelboards for use as service disconnecting means shall additionally conform to UL 869. Panelboards shall be circuit breaker equipped [unless indicated otherwise]. Design shall be such that any individual breaker can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as a means of obtaining clearances as required by UL. Where "space only" is indicated, make provisions for the future installation of a breaker sized as indicated. All panelboard locks included in the project shall be keyed alike. Directories shall be typed to indicate load served by each circuit and mounted in a holder behind transparent protective covering.

2.13.1 Panelboard Buses: Support bus bars on bases independent of the circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide an isolated neutral bus in each panel for connection of circuit neutral conductors. Provide a separate ground bus marked with a green stripe along its front and bonded to the steel cabinet for connecting grounding conductors.

2.13.2 Circuit Breakers: Fed. Spec. W-C-375 thermal magnetic type with interrupting capacity [as indicated] [of 10,000 amperes symmetrical minimum]. Breaker terminals shall be UL listed as suitable for the type of conductor provided. Plug-in circuit breakers are not acceptable.

2.13.2.1 Multipole Breakers: Provide common-trip type with a single operating handle. Breaker design shall be such that an 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.

2.13.2.2 Circuit Breaker with Ground-Fault Circuit Interrupter: UL 1053 and NFPA 70. Provide with "push-to-test" button, visible indication of tripped condition, and ability to detect a current imbalance of approximately 5 milliamperes. (O)

[2.13.3 Fusible Switches for Panelboards: NEMA KS1, hinged door type. Switches serving as motor disconnect means shall be horsepower rated.]

2.14 FUSES: Provide a complete set of fuses for each fusible [switch] [panel] [and] [control center]. 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 a voltage rating not less than the circuit voltage. (N)

2.14.1 Cartridge Fuses, Current-limiting Type (Class R): UL 198E, Class [RK-1] [RK-5] [time-delay type]. Associated fuseholders shall be Class R only.

2.14.2 Cartridge Fuses, Current-limiting Type (Classes J and L): UL 198C, Class J for 0 to 600 amps and Class L for 601 to 6000 amps.

2.15 TRANSFORMERS: UL 506, general-purpose, dry-type, self cooled, [ventilated] [nonventilated] [sealed]. Provide transformers in a NEMA [1] [3R] [__] enclosure. Transformer shall have 220 degrees C insulation system with a temperature rise not exceeding [150] [115] [80] degrees C under full rated load in a maximum ambient of 40 degrees C. Transformer shall be capable of carrying continuously 115 percent of the nameplate kVA without exceeding the insulation rating. [Transformers shall be the quiet type with an average sound level of at least 3 decibels lower than NEMA standard level for the transformer size indicated.] (R)

2.16 MOTORS: NEMA MG1, except sealed (hermetic-type) motor-compressors shall meet UL 984. The approximate size of each motor is indicated. Determine specific motor characteristics to insure provision of correctly sized starters and overload heaters. Motors for operation on 208-volt, 3-phase circuits shall have a voltage rating of 200 volts, and those for operation on 480-volt, 3-phase circuits shall have a voltage rating of 460 volts. Motors shall be designed to operate at full capacity with a voltage variation of plus or minus 10 percent of the motor voltage rating. (S)

2.16.1 Motor Sizes: The approximate size of each motor is indicated. Size shall be sufficient for the duty to be performed and shall not exceed its full load nameplate current rating when driven equipment is operated at specified capacity under the most severe conditions likely to be encountered. When motor size provided differs from the size indicated (or specified), the Contractor shall make the necessary adjustments to the wiring, disconnect devices, and branch circuit protection to accommodate the equipment actually provided.

2.17 MOTOR CONTROLLERS: NEMA ICS1 and NEMA ICS2. All controllers shall have thermal overload protection in each phase. Magnetic-type motor controllers shall have under voltage protection when used with momentary-contact pushbutton stations or switches and shall have under voltage release when used with maintained-contact pushbutton stations or switches. When used with a pressure, float, or similar automatic-type or maintained-contact switch, the controller shall have a hand-off-automatic selector switch. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the "hand" position. All safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices, shall be connected in the motor control circuit in both the "hand" and the "automatic" positions. Control circuit connections to any hand-off-automatic selector switch or to more than one automatic regulatory control device shall be made in accordance with an indicated, or a manufacturer's approved, wiring diagram. The selector switch shall have means for locking in any position. For each motor not in sight of the controller, the controller disconnecting means shall be capable of being locked in the open position or a manually operated, nonfused switch which will disconnect the motor from the source of supply shall be placed within sight of the motor location. Overload protective devices shall give adequate protection to the motor windings, be of the thermal inverse-time-limit type, and include a manual-reset type pushbutton on the outside of the motor controller case. The cover of a combination motor controller and manual switch or circuit breaker shall be interlocked with the operating handle of the switch or circuit breaker so that the cover cannot be opened unless the handle of the switch or circuit breaker is in the off position. (S)

2.17.1 Enclosures for Starters and Controllers: NEMA ICS6. (T)

2.17.2 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 the multiple-button station type with pilot lights for each speed.

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

2.17.4 Pilot and Indicating Lights: Provide transformer, resistor, or diode type.

2.17.5 Terminal Blocks: NEMA ICS4.

2.17.6 Reduced-Voltage Controllers: Provide for polyphase motors _____ horsepower and larger. Reduced-voltage starters shall be of the single-step closed transition autotransformer, reactor, or resistor type, or as indicated, and shall have an adjustable time interval between application of reduced and full voltages to the motors. Wye-delta reduced voltage starter or part winding increment starter having an adjustable time delay between application of voltage to first and second winding of motor may (U)

be used in lieu of reduced voltage starters for starting of [motor-generator sets,] [centrifugally operated equipment] [or] [reciprocating compressors provided with automatic unloaders].

2.17.7 Manual Starters: [Single] [Double] [Three] pole designed for [flush] [surface] mounting with overload protection [and pilot light].

2.18 MOTOR CONTROL CENTERS: NEMA ICS2, Class [I] [II], Type [A] [B] [C], in NEMA Type [1] [3R] [12] enclosure. Control centers shall be rated at _____ volts, _____-phase, _____ hertz, _____-ampere bus braced for [42,000] [_____] amperes RMS symmetrical. Incoming power feeder shall be [busway] [cable] entering at [top] [bottom] of the enclosure and terminating on [lugs] [main protective device]. [Main protective device shall be [molded case circuit breaker] [low-voltage power circuit breaker] [fusible switch] rated at _____ amperes RMS symmetrical interrupting capacity.] Arrange busing so that control center can be expanded from both ends. Bus shall be [tin-] [silver-] plated copper. Interconnecting wires shall be copper. Terminal blocks shall be plug-in type so that controllers may be removed without disconnecting individual control wiring. (V)

2.19 TELEPHONE SYSTEM: Provide a system of conduits with pull wires, terminal boxes, outlet and junction boxes, and other accessories for telephone outlets. The complete system shall be ready for use by others who will install wire and equipment. (W)

2.19.1 Outlet Boxes for Telephone System: Standard type, as specified hereinbefore. Mount flush in finished walls at the height [indicated] [specified for the outlet receptacles].

2.19.2 Cover Plates: [Blank cover] [Modular telephone type] of the finish specified for receptacle and switch cover plates.

2.19.3 Conduit Sizing: Unless otherwise indicated, conduit for single outlets shall be a minimum of 3/4 inch and for multiple outlets a minimum of 1 inch. Size conduits for telephone risers to telephone cabinets, junction boxes, distribution centers, and telephone service as indicated.

2.19.4 Backboards: Interior grade plywood, 3/4 inch thick.

2.19.5 Terminal Cabinets: Construct of cold-rolled sheet steel. Match trim, hardware, doors, and finishes to lighting panelboards.

2.20 GROUNDING AND BONDING EQUIPMENT: UL 467. Ground rods shall be copperweld type, 3/4-inch in diameter and 10 feet long.

2.21 HAZARDOUS LOCATIONS: Electrical materials, equipment, and devices for installation in hazardous locations, as defined by NFPA 70, shall be specifically approved by Underwriters' Laboratories, Inc., or Factory Mutual for the particular "Class," "Division," and "Group" of hazardous locations involved. The boundaries and classifications of hazardous locations shall be as indicated on the drawings. (X)

2.22 _____: (Y)

PART 3 - EXECUTION

3.1 INSTALLATION:

3.1.1 General Requirements: Equipment that has been approved and listed by UL shall be installed as specified in the UL "Green Book", Electrical Materials Directory. Electrical installations shall conform to the requirements of NFPA 70 and to the requirements specified herein.

3.1.2 Hazardous Locations: Work in hazardous locations, as defined by NFPA 70, shall be performed in strict accordance with NFPA 70 for the particular "Class," "Division," and "Group" of hazardous locations involved. Provide conduit and cable seals where required by NFPA 70. All conduit shall have tapered threads.

3.1.3 Wiring Methods: Wiring method shall be insulated conductors installed in conduit, except where specifically indicated or specified otherwise, or required by NFPA 70 to be installed otherwise. An [insulated] equipment grounding conductor shall be provided in all feeder and branch circuits, including lighting circuits. Provide insulated, green-colored conductor for grounding conductors installed in conduit or raceways.

3.1.3.1 Aluminum Conduit: Do not install underground or encase in concrete. Do not use brass or bronze fittings.

3.1.3.2 Electrical Metallic Tubing:

Do Not:

1. Install underground
2. Encase in concrete
3. Use in areas where subject to severe physical damage
4. Use in hazardous areas
5. Use in outdoor work

3.1.3.3 Nonmetallic Conduit: Do not use above ground floor slab except where specifically indicated or specified for special situations or systems.

3.1.3.4 Service Entrance Conduit, Overhead: Rigid steel or IMC from the service equipment to the service entrance fitting or weatherhead outside the building.

3.1.3.5 Service Entrance Conduit, Underground: Rigid steel or steel IMC. The underground portion shall be encased in a minimum of 3 inches of concrete, and shall be installed at least 18 inches below slab, or grade.

3.1.3.6 Underground Conduit (Other Than Service Entrance): Plastic-coated rigid steel; plastic-coated steel IMC; PVC, Type EPC-40; or FRE. Where nonmetallic conduit is used, it shall be converted to plastic-coated rigid (or IMC) steel conduit before rising through floor slab; plastic coating shall extend at least 6 inches above floor. (Z)

3.1.3.7 Conduit in Floor Slabs: Rigid steel; steel IMC; FRE; or PVC, Type EPC-40. (AA)

3.1.3.8 Conduit for 400-Hertz circuits shall be aluminum. Where circuit runs through concrete, the aluminum conduit shall be installed in a nonmetallic conduit sleeve.

3.1.3.9 Conduit for Circuits Rated Above 600 Volts: Use rigid metal conduit or IMC only.

[3.1.3.10 Metal Clad Cable: Install in accordance with NFPA 70, Type MC cable.] (I)

[3.1.3.11 Armored Cable: Install in accordance with NFPA 70 Type, AC cable.] (J)

[3.1.3.12 Flat Conductor Cable: Install in accordance with NFPA 70, Type FCC cable.] (L)

3.1.4 Conduit Installation: Unless indicated otherwise, conceal conduit within finished walls, ceilings, and floors. Keep conduit at least 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. [Conduits in crawl space under slab shall be run as if exposed.]

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

3.1.4.2 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; 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. The load applied to fasteners shall not exceed one-fourth of the proof test load. Fasteners attached to concrete ceiling shall be vibration and shock resistant. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4 inch in concrete joints shall not cut the main reinforcing bars. Fill holes that are not used. In partitions of light steel construction, use sheet-metal screws. In suspended-ceiling construction, run conduit above the ceiling. Do not support conduits from the ceiling support system. Spring steel fasteners may be used for lighting branch circuit conduit supports in suspended ceiling in dry locations. [Support exposed risers in wire shafts of multistory buildings by U-clamp hangers at each floor level and at intervals not to exceed 10 feet.] Where conduit crosses building expansion joints provide a suitable [watertight] expansion fitting that maintains the conduit electrical continuity by bonding jumpers or other means.

3.1.4.3 Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with a 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 all obstructions.

3.1.4.4 Install pull wires in empty conduits in which wire is to be installed by others. The pull wire shall be plastic having not less than 200-pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

3.1.4.5 Telephone and Signal System Conduits: Install in accordance with the previous requirements for conduit and with the additional requirement that no length of run shall exceed 150 feet for trade sizes 2 inches and smaller and shall not contain more than two 90-degree bends or the equivalent. Provide pull or junction boxes where necessary to comply with these requirements. Inside radii of bends in conduits one-inch trade size and larger shall be not less than five times the nominal diameter. Terminate conduit [at bottom edge of backboard] [in terminal cabinet with two locknuts and a plastic bushing].

3.1.4.6 Conduit Installed in Concrete Floor Slabs: Locate so as not to adversely affect the structural strength of the slabs. Install conduit within the middle one-third of the concrete slab. [Do not stack conduits.] [Do not stack conduits more than two diameters high with a minimum vertical separation of ___ inches.] Space conduits horizontally not closer than three diameters except at cabinet locations. Curved portions of bends shall not be visible above the finish slab. Increase slab thickness as necessary to provide a minimum one-inch cover over conduit. Where embedded conduits cross expansion joints, provide suitable watertight expansion fittings and bonding jumpers. Conduit larger than one-inch trade size shall be parallel with or at right angles to the main reinforcement; when at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Where nonmetallic conduit is used, raceway must be converted to rigid steel or steel IMC before rising above floor, unless specifically indicated otherwise. (AB)

3.1.4.7 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 a single locknut and bushing. Locknuts shall be the type with sharp edges for digging into the wall of metal enclosures. Install bushings on the ends of conduits and provide insulating type where required by NFPA 70.

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

3.1.4.9 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 all motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size shall be 1/2 inch diameter. Liquid-tight flexible conduit shall be used in wet locations. A separate ground conductor shall be provided across flexible connections.

3.1.5 Busway Installation: Install busways parallel with, or at right angles to, ceilings, walls, and structural members. Support busways at intervals not exceeding 5 feet, and brace to prevent lateral movement.

3.1.6 Cable Tray Installation: Install cable trays parallel with, or at right angles to, ceilings, walls, and structural members. Support [as indicated] [at not more than [6] [_____]-foot intervals]. [Contact surfaces of aluminum connections shall be coated with an antioxidant compound prior to assembly.] All edges, fittings, and hardware shall be finished free from burrs and sharp edges. Provide a No. 2 AWG bare copper wire throughout the cable tray system and bond to each section, except use No. 1/0 aluminum wire if cable tray is aluminum.

3.1.7 Boxes, Outlets, and Supports: Provide boxes in the wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be of the cast-metal hub type when located in normally wet locations, when surface mounted on outside of exterior surfaces, when installed exposed up to 7 feet above interior floors and walkways, and when installed in hazardous areas. Boxes in other locations shall be sheet steel, except that aluminum boxes may be used with aluminum conduit[, and nonmetallic boxes may be used with nonmetallic [sheathed cable] [conduit] system]. Each box shall have the volume required by NFPA 70 for the number of conductors enclosed in the box. Boxes for mounting lighting fixtures shall be not less than 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 the outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by the fixture terminal operating temperature; fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of the ceiling supports or make adequate provisions for distributing the load over the ceiling support members in an approved manner. 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 work. [Threaded studs driven in by powder charge and provided with lockwashers and nuts [or nail-type nylon anchors] may be used in lieu of wood screws, expansion shields, or machine screws.] 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 the building structure or by bar hangers. Where bar hangers are used, attach the bar to

raceways on opposite sides of the box and support the raceway with an approved type fastener not more than 24 inches from the box. When penetrating reinforced-concrete members, avoid cutting any reinforcing steel.

3.1.7.1 Boxes for use with raceway systems shall not be less than 1-1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting-fixture outlets shall be not less than 4 inches square, except that 4 inch by 2 inch boxes may be used where only one raceway enters the outlet. Telephone outlets shall be a minimum of 4 inches square by 1-1/2 inches deep.

3.1.7.2 Pull Boxes: Construct of not less than the minimum size required by NFPA 70 of code-gage aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified above. Furnish boxes with screw-fastened covers. Where several feeders pass through a common pull box, tag the feeders to indicate clearly the electrical characteristics, circuit number, and panel designation.

[3.1.7.3 Extension rings may be used only on existing boxes in concealed conduit systems where wall is furred out for new finish.]

3.1.8 Mounting Heights: Mount panelboards, circuit breakers, and disconnecting switches so the height of the operating handle at its highest position will not exceed 78 inches from the floor. Mount lighting switches [46 inches above finished floor], receptacles [18 inches above finished floor], [and other devices] [as indicated]. Measure mounting heights of wiring devices and outlets to the center of device or outlet.

[3.1.9 Nonmetallic Sheathed Cable Installation: Install cables concealed behind ceiling or wall finish where practicable. Thread cables through holes bored on the approximate centerline of wood members; notching of end surfaces will not be permitted. Provide sleeves through concrete or masonry for threading cables. Install exposed cables parallel or at right angles to walls or structural members. Protect exposed nonmetallic sheathed cables less than 4 feet above floors from mechanical injury by installation in conduit or tubing. When cable is used in metal stud construction, insert plastic stud grommets in the studs at each point through which the cable passes.] (AC)

[3.1.10 Mineral Insulated-Metal Sheathed (Type MI) Cable Installation: Cables shall be fastened within 12 inches of each turn or offset and at intervals of not more than 6 feet. Cable terminations shall be made in accordance with NFPA 70 and the cable manufacturer's recommendations.] (K)

3.1.11 Conductor Identification: Provide numerical identification of each circuit conductor within each enclosure; identification shall denote panelboard and branch circuit number. Provide conductor identification within each enclosure where a tap, splice, or termination is made. For conductors No. 6 and smaller, color coding shall be by factory-applied color-impregnated insulation. For conductors No. 4 and larger, 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.

3.1.12 Splices: Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller with an insulated pressure type connector. Make splices in conductors No. 8 AWG and larger with a solderless connector and cover with an insulation material equivalent to the conductor insulation.

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

3.1.13 Terminating Aluminum Conductors:

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

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

3.1.14 Covers and Device Plates: Install with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional type device plates will not be permitted. Plates installed in wet locations shall be gasketed.

3.1.15 Grounding and Bonding: In accordance with NFPA 70. Ground all exposed non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in nonmetallic raceways, [grounding conductor of nonmetallic sheathed cables,] and neutral conductor of wiring systems. [Make ground connection at the main service equipment and extend grounding conductor to the point of entrance of the metallic water service. Make connection to the water pipe by a suitable ground clamp or lug connection to a plugged tee. If flanged pipes are encountered, make connection with the lug bolted to the street side of the flanged connection. Supplement the metallic water service grounding system with an additional made electrode in compliance with NFPA 70.] [Make ground connection to driven ground rods on

the exterior of the building.] Where ground fault protection is employed, take care that the connection of ground and neutral does not interfere with the correct operation of the fault protection.

3.1.15.1 Grounding Conductor: Provide an insulated, green-colored equipment grounding conductor in all feeder and branch circuits. This conductor shall be separate from the electrical system neutral conductor.

[3.1.15.2 Telephone Service: Provide a main telephone service equipment ground consisting of a separate No. 6 AWG ground wire in conduit between the telephone equipment backboard and a readily accessible grounding connection. The equipment end of the ground wire shall consist of a coiled length at least twice as long as the terminal cabinet or backboard height.]

3.1.15.3 Resistance: The maximum resistance to ground of the grounding system shall not exceed 25 ohms under normally dry conditions. Where the resistance obtained exceeds 25 ohms, contact the Contracting Officer for further instructions. (AD)

3.1.16 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. (AE)

[3.1.16.1 Elevator: Connections to the elevator shall include providing a circuit to the line terminals of the elevator controller, a disconnect switch ahead of this controller in the circuit to it, an outlet for control power, an outlet receptacle and work light at the midheight of the elevator shaft, and a work light and outlet receptacle in the elevator pit.]

3.1.16.2 Government-Furnished Equipment: The Contractor [shall rough-in for this equipment] [shall make connections to this equipment] to make it operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

3.1.17 Repair of Existing Work: Cut existing surfaces as required to install conduits, raceways, and other electrical work; repair damage caused by this work. Lay out the work carefully in advance. Where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, do this work carefully. Repair any damage to buildings, piping, or equipment using skilled mechanics of the trades involved.

3.1.18 Reworking Existing System: Work shall conform to applicable requirements of this division of the specifications. Remove or deenergize existing electrical equipment, conduit, conductors, etc., not in use after reworking the existing system, as indicated. Keep equipment not scheduled for replacement in operation at all times. Schedule work to be renovated, changed, or modified so as not to interfere with normal operation.

3.2 FIELD TESTS: The Contractor shall provide all test equipment and personnel and submit written copies of all test results. As an exception to requirements that may be stated elsewhere in the contract, the Contracting Officer shall be given [5] [__] working days notice prior to [each] [_____] test[s]. (AF)

3.2.1 Devices Subject to Manual Operation: Each device subject to manual operation shall be operated at least five times, demonstrating satisfactory operation each time.

3.2.2 Test on 600-Volt Wiring: Test all 600-volt wiring to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on all wiring No. 6 AWG and larger using an instrument which applies a voltage of approximately 500 volts to provide a direct reading of resistance; minimum resistance shall be 250,000 ohms.

3.2.3 Grounding System Test: Test the grounding system to assure continuity and that the resistance to ground is not excessive. Test each ground rod for resistance to ground before making any connections to the rod; then tie entire grounding system together and test for resistance to ground. Make resistance measurements in normally dry weather, not less than 48 hours after rainfall. Submit written results of each test to the Contracting Officer and indicate the location of the rods as well as the resistance and soil conditions at the time the measurements were made.

*** END OF SECTION ***

GENERAL NOTES

1. Do not refer to this guide specification in the project specification. Use it as a manuscript to prepare the project specifications. Edit and modify this guide specification to meet project requirements. Where "as shown," "as indicated," "as detailed," or words of similar import are used, include all requirements so designated on the project drawings.

2. Do not include the following parts of this NFGS in the project specification:

   a. Table of Contents.
   b. Sketches.
   c. General Notes.
   d. Technical Notes.
   e. Other supplemental information, if any, attached to this guide specification.

   As the first step in editing this guide specification for inclusion in a project specification, detach all parts listed above and, where applicable, use them in the editing process. If required in the construction contract, sketches and figures shall be placed on the project drawings. Where there are no project drawings, sketches and figures may be included as a part of the project specification, if required.

3. Each capital letter in the right-hand margin of the text indicates that there is a technical note pertaining to that portion of the guide specification. Do not include these letters in the project specification. If this is a regionally tailored version of this NFGS, i.e. an EFD Regional Criteria Master, some technical notes and their designating letters may have been deleted.

4. Where numbers, symbols, words, phrases, clauses, sentences, or paragraphs in this guide specification are enclosed in brackets, [], a choice or modification must be made; delete inapplicable portion(s). Where blank spaces enclosed in brackets occur, insert appropriate data. Delete inapplicable paragraphs and renumber subsequent paragraphs accordingly.

5. Project specification number, section number, and page numbers shall be centered at the bottom of each page of the section created from this guide specification.

   EXAMPLE:

   05-88-8787
   16402-1

6. CAUTION: Coordination of this section with other sections of the project specification and with the drawings is mandatory. If materials or equipment are to be furnished under this section and installed under other sections or are indicated on the drawings, state that fact clearly for each type of material and item of equipment. Review the entire project

specification and drawings to ensure that language is included to provide complete and operational systems and equipment.

7. Specifications shall not repeat information shown on the drawings. Specifications shall establish the quality of materials and workmanship, methods of installation, equipment functions, and testing required for the project. Drawings shall indicate dimensions of construction, relationship of materials, quantities, and location and capacity of equipment.

8. Suggestions for improvement of this specification will be welcomed. Complete the attached DD Form 1426 and mail the original to:

Commander, Atlantic Division
Naval Facilities Engineering Command (04A4)
Norfolk, Virginia 23511-6287

Mail a copy to:

COMMANDER
Naval Facilities Engineering Command
Code 04M2B
200 Stovall Street
Alexandria, VA 22332-2300

TECHNICAL NOTES

A. This guide specification covers the requirements for the procurement, installation, and testing of interior electrical wiring systems for construction projects. Requirements for materials and procedures for special or unusual design should be added as necessary to fit specific projects.

B. Paragraph 1.1: The latest issue of applicable publications shall be used, but only after reviewing the latest issue to ensure that it will satisfy the minimum essential requirements of the project. If the latest issue of a referenced publication does not satisfy project requirements:

1. Use the issue shown; or
2. Select and refer to a document which does; or
3. Incorporate the pertinent requirements from the document into the project specification.

Use DD Form 1426 to inform the Preparing Activity and NAVFACENGCOM if the latest issue of a referenced publication is not compatible with this guide specification.

Delete those publications not referred to in the text of the section created from this guide specification.

C. Paragraph 1.2: Insert additional details describing the specific project for which this specification is being used.

D. Paragraph 1.2.1: Coordinate with Section 16301 (if in project).

E. Paragraph 1.3: Editing should include the following considerations:

1. In projects using the Contractor Quality Control System, add the words, "Submit to the Contracting Officer.", at submittals deemed sufficiently critical or complex or aesthetically significant to merit approval by the Government.

2. Do not include the vertical bars in the final manuscript of the project specification. (Project Submittals Lists may be extracted from project specifications prepared on NAVFAC-programmed word processors. Vertical bars indicate points at which automatically extracted entries will terminate.)

F. Paragraph 1.3.3: Use this paragraph only on jobs that utilize Contractor Quality Control (CQC). List only critical or highly specialized items. DO NOT OVERUSE.

G. Paragraph 2.8.1.2: In certain instances you may want to require compact stranding (i.e., when outside diameter of cable must be limited). When necessary, specify that: "Conductors shall be compact stranded utilizing the method of stranding specified in ASTM B 400, however, the conductor material shall be as specified herein."

H. Paragraph 2.8.3: Designer may select other insulation types which may be more suitable for a particular project. For rewiring projects where existing conduit is to be utilized, specify Types THHN and THWN.

I. Paragraphs 2.8.8 and 3.1.3.10: Type MC cable is UL and NFPA 70 approved for most common building applications. Review NFPA 70, Article 334. MC cable does not protect conductors as well as rigid conduit, but is more flexible to install and relocate.

J. Paragraphs 2.8.9 and 3.1.3.11: Type AC cable has more restricted applications than MC cable but offers the same advantage. Review NFPA 70, Article 333.

K. Paragraphs 2.8.10 and 3.1.10: Type MI cable used for low temperature, high temperature, hazardous locations, life safety, and heating applications. Refer to NFPA 70, Article 330. Drawings must clearly show the MI cable. Surge suppressors should be considered in hazardous locations and where high voltage surges are likely. MI cable is not available in ratings above 600 volts.

L. Paragraphs 2.8.11 and 3.1.3.12: Type FCC cable has been approved by UL and NFPA 70 for under carpet tile applications. Flat conductor is often used where vertical space between floors is limited. Review NFPA 70,

Article 328. FCC cable is available off-the-shelf for power, telephone, and data transmission applications.

M. Paragraph 2.11.3: Switches requiring frequent operation should be the heavy duty type and should be so indicated on the drawings.

N. Paragraphs 2.11.3 and 2.14: Designer must know the requirements of the electrical system and the equipment serviced to determine the proper fuse class and type. Show the fuses' ampere and voltage ratings on the drawings. This note briefly summarizes some of the UL fuse standards and their application.

UL 198E Class R:	200,000 amp. rms sym. interrupting rating, RK1 and RK5 may have time delay option, are not interchangeable with other UL fuse classes, are labeled current limiting. Peak let through currents for RK1 and RK5 are the same as K-1 and K-5, respectively. Use these Class R fuses for most new equipment.
UL 198C Classes J&L:	200,000 amp. rms sym. interrupting rating, is not interchangeable with any other UL fuse class, is labeled current limiting, is rated 600 volts ac. Class L may be fast acting or time delay type. Class J time delay type is not UL rated.
UL 198B Class H:	Maximum 10,000 amp. sym. interrupting rating, optional time delay available. Use <u>only</u> in existing equipment where the available fault is <u>known</u> to be less than 10,000 amps.
UL 198D Class K-1, K-5:	Two interrupting ratings available, K-5 may have time delay option, are interchangeable with Class H fuses. Peak let through current is lowest with K-1, highest with K-5. Use <u>only</u> in existing equipment.

O. Paragraphs 2.12.3 and 2.13.2.2: For Child Care Center projects, coordinate project drawings and specifications to include Ground Fault Circuit Interruption (GFCI) for receptacles in bathrooms, kitchens, laundry facilities, exterior locations, and swimming pools.

COMNAVFACENGCOM has established these GFCI safety standards for Child Care Centers at a higher level of protection than NFPA 70's minimum requirements as a result of a GAO report and DOD concern about health and safety at these facilities.

P. Paragraph 2.12.6: Use NEMA 14-50 if ranges are provided by Contractor. Use NEMA 10-50 if ranges are customer-furnished residential type. If ranges are existing, verify plug type.

Q. Paragraph 2.12.7: Use NEMA 14-30 if dryers are provided by Contractor. Use NEMA 10-30 if dryers are customer-furnished residential type. If dryers are existing, verify plug type.

R. Paragraph 2.15: Coordinate the location of dry-type transformers with mechanical designer to ensure adequate ventilation. This specification does not apply to transformers over 500 kVA, substation transformers, and transformers rated greater than 600 volts. For these types provide separate specification section using other appropriate guides. Specify 80 C or 115 C transformers when transformer is loaded above 60 percent of nameplate and has continuous duty cycle. Delete quiet type where noise level does not affect personnel.

S. Paragraphs 2.16 and 2.17: Motor and controller specifications shall be thoroughly coordinated with and cross-referenced in all affected mechanical sections. Design Manual DM-3.3 provides application data on motors and controllers.

T. Paragraph 2.17.1: Type of enclosure shall be indicated on the drawings to suit the application.

U. Paragraph 2.17.6: The designer must determine, based on the power system characteristics and motor usage, where reduced-voltage controllers must be specified. Design Manual DM-4.4 includes criteria on this subject. Specify reduced-voltage controllers based on the power system characteristics and motor usage, such as when the locked rotor current of motors exceed the full load rating of supply transformers or supply conductors.

V. Paragraph 2.18: Motor control center should be specified for groups of large motors requiring coordinated control. In other applications, individual controllers or motor control panelboards should be used. Coordinate controller specifications with the mechanical equipment requirements.

W. Paragraph 2.19: This paragraph applies only if provision is made for telephone system by others. If a complete system is provided by contract, it shall be in a separate section of the specifications.

X. Paragraph 2.21: Indicate very clearly the limits of all hazardous locations.

Y. Paragraph 2.22: Add specifications for other interior electrical products that are included in the project, and not covered elsewhere in the project specification.

Z. Paragraph 3.1.3.6: Soil conditions in some locations require that underground conduit be supported to prevent damage due to settlement. The designer must determine if the problem exists, and, if so, determine the best method for supporting the conduit.

AA. Paragraph 3.1.3.7: Do not specify metal conduit in concrete that contains coral aggregate or is made with salt or brackish water. This type of concrete is rarely allowed.

AB. Paragraph 3.1.4.6: Electrical designer must closely coordinate this information with the designer of the slab to ensure that slab thickness, conduit placement/separation, and reinforcement spacing is sufficient to meet requirements of this paragraph.

AC. Paragraph 3.1.9: Use this paragraph only when Type NM or NMC cable is indicated.

AD. Paragraph 3.1.15.3: If difficulties are encountered in obtaining the proper resistance, the Contracting Officer will make a decision on the number of ground rods to be used, based on local conditions and on the type and size of electrical installation in the project. Insulating grounding conductors will be required where electrolytic corrosion may be encountered.

AE. Paragraph 3.1.16: In order to achieve a complete specification, the electrical designer shall ensure that the controls for HVAC, fire alarm systems, and special systems are definitely and properly covered by the other sections of the specification named in this paragraph. Should controls appear in this section of the specification, this paragraph shall be modified accordingly. The contract drawings shall indicate all required equipment connections.

AF. Paragraph 3.2: Provide any additional test requirements for equipment requiring running tests or tests that must be coordinated with mechanical equipment.

AG. Following the text, not less than two nor more than six lines below the last line of text, insert ***END OF SECTION*** centered on the page.

*** E N D ***

$$\frac{225 \times 100}{26{,}000} \rightarrow 8.65$$

16,000