Preparing Activity: NAVFAC Superseding
UFGS-26 27 29 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 26 27 29

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05/21

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USACE / NAVFAC / AFCEC / NASA	**UFGS-26 27 29 (May 2021)**

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 26 27 29

MARINA ELECTRICAL WORK
05/21

****
NOTE: This guide specification covers the requirements for procurement, installation, and testing of electrical wiring systems for construction projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

****
NOTE: These wiring systems primarily involve voltages of 600 volts and less and exterior systems. When voltages greater than 600 volts are brought to a facility, consult and use Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION; Section 26 11 16 SECONDARY UNIT SUBSTATIONS; Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION; and Section 26 12 19.10 THREE-PHASE, LIQUID-FILLED PAD-MOUNTED TRANSFORMERS or 26 12 21 SINGLE-PHASE PAD-MOUNTED TRANSFORMERS as required. Requirements for materials and procedures for special or unusual design should be added as necessary to fit specific projects.
****

****

NOTE: The following information must be shown on the project drawings.

1. Where specification identifies type, size, color, finish, or other definitive information to be "as indicated," the engineer must include the information on the drawings.

2. Location of manholes, handholes, ducts, and cables.

3. Types of wire and cable; number and sizes of conductors.

4. Limits of each hazardous location, clearly indicating class, division, and group classification of each hazard.

5. Special conditions.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

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

ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA NEIS 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(2014) Dry-Type Transformers for General Applications
NEMA TC 2	(2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 14	(2002) Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 303	(2021) Fire Protection Standards for Marinas and Boatyards

UNDERWRITERS LABORATORIES (UL)

UL 50	(2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 67	(2018; Reprint May 2023) UL Standard for Safety Panelboards
UL 83	(2017; Reprint Mar 2020) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018; Reprint May 2021) UL Standard for

	Safety Wire Connectors
UL 489	(2016; Rev 2019) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 498	(2017; Reprint May 2023) UL Standard for Safety Attachment Plugs and Receptacles
UL 510	(2020; Dec 2022) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514B	(2012; Reprint May 2020) Conduit, Tubing and Cable Fittings
UL 514C	(2014; Reprint Feb 2020) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(2011; Reprint May 2022) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 869A	(2006; Reprint Jun 2020) Reference Standard for Service Equipment
UL 870	(2016; Reprint Mar 2019) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings
UL 943	(2016; Reprint Feb 2018) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 1203	(2013; Reprint Apr 2022) UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations

1.2 RELATED REQUIREMENTS

26 20 00 INTERIOR DISTRIBUTION SYSTEM, applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Modify submittals paragraphs to ensure that an appropriate submittal is required for each item in the project.

****

SD-02 Shop Drawings

Panelboards; G[, [_____]]

Transformers; G[, [_____]]

Wireways; G[, [_____]]

SD-03 Product Data

Receptacles

Enclosed Circuit Breakers; G[, [_____]]

Disconnect Switches; G[, [_____]]

Conduit and Fittings (each type)

Power Pedestal; G[, [_____]]

Grounding and Bonding Equipment

Device Plates

Wires and Cables

Outlet Boxes and Covers

Transformers; G[, [_____]]

Splice and Termination Components

Wireways

Cabinets, Junction Boxes, and Pull Boxes

Mounting Straps

Conduit Support

Marine Signal Lantern; G[, [_____]]

Solar Power Station; G[, [_____]]

SD-06 Test Reports

Transformer Tests; G[, [_____]]

600-volt Wiring Test; G[, [_____]]

Grounding System Test; G[, [_____]]

Solar Power Station Test; G[, [_____]]

Submit test results for approval in report format.

SD-07 Certificates

Solar Power Station; G[, [_____]]

Submit coordination data as specified in paragraph SOLAR POWER STATION.

1.4 QUALITY ASSURANCE

1.4.1 Grounding System Tests

Submittal must include written results of each test and indicate location of rods as well as resistance and soil conditions at the time measurements were made.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

****
NOTE: Where possible use nonmetallic enclosures, conduits, and mounting hardware.
****

Materials, equipment, and devices must, as a minimum, meet requirements of

UL where UL standards are established for those items, and requirements of NFPA 70 and NFPA 303.

2.2 CONDUIT AND FITTINGS

[Rigid nonmetallic conduit][Plastic-coated rigid steel conduit] conforming to the following:

2.2.1 Rigid Nonmetallic Conduit

PVC Type EPC-80[and EPC-40] in accordance with NEMA TC 2, or fiberglass conduit in accordance with NEMA TC 14.

2.2.2 Plastic-Coated Rigid Steel Conduit

NEMA RN 1, Type 40 one millimeter thick 40 mils thick.

2.2.3 Fittings for Metal Conduit and Liquidtight Flexible Metal Conduit

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

2.2.3.1 Fittings for Rigid Metal Conduit

Threaded type. Split couplings unacceptable.

[2.2.3.2 Fittings for Use in Hazardous Locations

UL 1203.

]

2.2.4 Fittings for Rigid Nonmetallic Conduit

UL 514B and UL 651.

2.2.5 Expansion Joints

Provide conduit expansion joints having 150 mm 6 inch expansion at each expansion joint in the pier and in each conduit run exceeding 75 meters 250 feet. Provide expansion joints having 50 mm 2 inch expansion in each conduit run of less than 75 meters 250 feet.

2.3 POWER PEDESTAL

A complete factory-assembled and prewired unit specifically constructed for marine applications. Power center must be a [two][or][four] outlet [pedestal][surface] mounted type having a separate circuit breaker for each outlet. Circuit breaker size must be the same size as outlet to which it is connected. Power outlets must be single, locking and grounding type, size and voltage as indicated. Power center enclosure must be stainless steel, fiberglass, or foamed thermoplastic with polyurethane coating. Each individual outlet and circuit breaker enclosure must have a separate gasketed weatherproof cover. Entire exterior surface of power center must be nonmetallic design for exposure to saltwater environment.[Provide photo controlled LED station light.][Provide with [one] [_____] telephone outlet[s].]

2.3.1 Warning Sign

Provide permanently mounted waterproof warning sign at each power center.

Sign must have red letters on a white background with letters no less than 6 mm .25 inch in height. Sign must be worded as follows:

"WARNING
To minimize shock and fire hazards:
Turn off the boat's shore connection switch before connecting or disconnecting shore cable.
Connect shore power cable at the boat first.
Disconnect shore power cable at shore outlet first.
Close shore power inlet cover tightly.
DO NOT ALTER SHORE POWER CABLE CONNECTORS"

2.4 OUTLET BOXES AND COVERS

UL 514C.

2.4.1 Outlet Boxes in Hazardous Locations

UL 1203. Suitable for wet locations.

2.5 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 3280 mL 200 cubic inches, UL 50, NEMA 4X [nonmetallic][or][stainless steel].

2.6 WIRES AND CABLES

Must meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Do not provide wires and cables manufactured more than 12 months prior to date of delivery to site.

2.6.1 Conductors

****

NOTE: In overseas locations, for conductor sizes No. 10 AWG and smaller diameter, consideration may be given to the use of stranded wires, if suitable terminal devices can be applied which enable proper connection. Also, stranded wires in sizes No. 10 AWG and smaller diameter may be required for projects involving uninterrupted power supply (UPS) installations.

****

No. 8 AWG and larger diameter must be stranded; No. 10 AWG and smaller must be solid, except that conductors for remote control, alarm, and signal circuits, Classes 1, 2, and 3, must be stranded. Conductors must be copper. Conductor sizes and ampacities shown are based on copper.

2.6.1.1 Minimum Conductor Sizes

Minimum size for branch circuits must 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. 18 AWG; and for Class 3 low-energy, remote-control, alarm, and signal circuits, No. 22 AWG.

2.6.2 Color Coding

Provide for service, feeder, branch, control, and signaling circuit conductors. Color must 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 neutral must be white with colored, except green, stripe. Color of ungrounded conductors in different voltage systems must be as follows:

a. 120/208 volt, three phase:

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

b. 277/480 volt, three phase:

(1) Phase A - brown

(2) Phase B - orange

(3) Phase C - yellow

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

[d. On three-phase, four-wire delta system, high leg must be orange, as required by NFPA 70.

]2.6.3 Insulation

****

NOTE: Be sure conduit fill calculations are based on largest diameter insulation type allowed. Designer may select other insulation types which may be more suitable for a particular project. For rewiring project where existing conduit is to be utilized, specify types THHN and THWN. If conduit is sized for conductors other than THW, ensure the specification is properly edited and a note indicating the conductor type specified is added to the drawings. Type RHW insulation is not allowed on Navy projects.

****

Unless otherwise required by NFPA 70, power and lighting wires must be 600-volt, Type THWN, XHHW, [or RHW,]except that grounding wire may be Type TW; remote-control and signal circuits must be Type TW, THW, or TF. Conductors must conform to UL 83. Where lighting fixtures require 90-degree C conductors, provide only conductors with 90-degree C insulation or better.

2.6.4 Bonding Conductors

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.6.5 Splice and Termination Components

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

2.6.5.1 Watertight Pin Connectors

Connectors must be rated 600 volts, and individual pins must have ampere rating equal to or greater than the cable to which they are joined. Connectors must be molded-to-cable, quick-disconnect, polarized type having full male shroud so that when male and female assemblies are joined the shroud must provide a completely sealed connection. Connector material must be neoprene resistant to oil, dust, acids, and sunlight and must be watertight.

2.7 DEVICE PLATES

Provide UL listed, one-piece device plates for outlets to suit the devices installed. Plates must be nylon or lexan, minimum 2.54 mm 0.10 inch wall thickness. Plates must be same color as receptacle with which they are mounted. Screws must be stainless steel machine type with countersunk heads in color to match finish of plate. Use of sectional-type device plates will not be permitted. Plates must be gasketed and UL listed for wet locations.

2.8 DISCONNECT SWITCHES

****

NOTE: Switches requiring frequent operation should be the heavy-duty type and should be so indicated on the drawings.

****

NEMA KS 1. Switches serving as motor-disconnect means must be horsepower rated. Provide heavy duty-type switches where indicated, where switches are rated greater than 240 volts, and for double-throw switches. Provide switches in NEMA 4X [nonmetallic][or][stainless steel] enclosure in accordance with NEMA ICS 6.

2.9 RECEPTACLES

UL 498 and NEMA WD 1, heavy-duty, grounding type. Bodies must be of [brown] [ivory] thermosetting plastic supported on a metal mounting strap. Provide screw type, side wired wiring terminals. Connect grounding pole to mounting strap.

2.9.1 Duplex Receptacles

Receptacles must be 20 amperes, 125 volts, specification grade.

2.9.2 Weatherproof Receptacles

Provide in nonmetallic box with gasketed, weatherproof, nonmetallic cover plate and gasketed cap over each receptacle opening. Provide caps with a spring-hinged flap. Provide UL listed receptacle for use in wet locations.

2.9.3 Ground-Fault Protection of Equipment (GFPE) and Ground-Fault Circuit Interrupter (GFCI) Receptacles

UL 943. Receptacles providing shore power must have individual GFPE set to open at currents not exceeding 30 milliamperes.

GFCI protection for personnel, duplex type for mounting in standard outlet box. Device must be capable of detecting current leak of 5 milliamperes or greater and tripping in accordance with UL 943 for Class A GFCI devices.

2.9.4 Special-Purpose Receptacles

Receptacles serving [_____] are special purpose.[Provide in ratings indicated.][NEMA [_____] configuration, rated [_____] amperes, [_____] volts.][Furnish one matching plug with each receptacle.]

[2.10 PLUGS

[Provide heavy-duty, rubber-covered[three,][four,][or][five]-wire cord of required size, install plugs thereon, and attach to equipment. Provide UL listed plugs with receptacles, complete with grounding blades. Where equipment is not available, turn in plugs and cord assemblies to the Government.

]2.10.1 Weatherproof Cord and Plug Assemblies

Furnish [one] [_____] cord and plug assembly[ies] consisting of a [30-ampere, 125-volt twist-lock plug on one end, a 8 meter 25 foot length of three conductor, No. 10 type STO cord, and two 20-ampere, 125-volt twist-lock receptacles on the other end][and][furnish [one] [_____] cord and plug assembly[ies] consisting of a 20-ampere, 125-volt twist-lock plug on one end, a 8 meter 25 foot length of three conductor, No. 12 type STO cord and a 20-ampere twist-lock receptacle on the other end.] Plugs must be compatible with power center outlets.

]2.11 PANELBOARDS

UL 67 and UL 50 having a short-circuit current rating of [10,000] [_____] amperes symmetrical minimum. Panelboards for use as service disconnecting means must additionally conform to UL 869A. Panelboards must be circuit breaker equipped. Design must 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 breakers. Key panelboard locks the same. Directories must indicate load served by each circuit in panelboard and main source of service to panelboard, such as Panel PA served from Panel MDP. Type directories and mount in holder behind transparent protective covering. When panelboards are used as a service disconnecting means, conform to UL 869A

2.11.1 Panelboard Buses

Copper. Support bus bars on bases independent of circuit breakers. Design main buses and back pans 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 in accordance with UL 67 for connecting grounding conductors; bond to steel cabinet.

2.11.2 Circuit Breakers

UL 489 thermal magnetic type having a minimum short-circuit current rating equal to the short-circuit rating of the panelboard in which the circuit breaker will be mounted. Breaker terminals must be UL listed as suitable for type of conductor provided. Circuit breakers must be bolt-on type. Din-rail mounted and half-width circuit breakers are not acceptable. Plug-in circuit breakers and series rated circuit breakers are unacceptable.

2.11.2.1 Multipole Breakers

Provide common trip type with single operating handle. Breaker design must 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.

2.11.2.2 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 in accordance with UL 943 for Class A GFCI devices.

2.11.3 Panelboard Enclosure

NEMA 4X [nonmetallic][or][stainless steel]. Hardware must be stainless steel.

2.12 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with short-circuit current rating of [10,000] [_____] amperes symmetrical minimum. Circuit breakers must be bolt-on type. Plug-in circuit breakers and series rated circuit breakers are not acceptable. Enclosure must be NEMA 4X [nonmetallic][or][stainless steel] type.[Provide solid neutral.]

2.13 TRANSFORMERS

NEMA ST 20, general purpose, dry-type, self-cooled, [unventilated] [sealed]. Provide transformers in NEMA [3R] [stainless steel] [_____] enclosure. Transformer must have 220 degrees C insulation system for transformers 15 kVA and greater and must have 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding [150] [115] [80] degrees C under full-rated load in maximum ambient of 40 degrees C.[Transformer of 150 degrees C temperature rise must be capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating.][Transformer of 115 degrees C temperature rise must be capable of carrying continuously 115 percent of nameplate kVA without exceeding insulation rating.][Transformer of 80 degrees C temperature

rise must be capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating.][Transformers must be quiet type with maximum sound level of 3 decibels less than NEMA standard level for transformer ratings indicated.]

[Submit manufacturer factory test reports with transformers provided.

]2.14 TELEPHONE SYSTEM

****
NOTE: This paragraph applies only if provision is made for telephone system by others. If a complete system is provided by contract, refer to Section 27 51 23 INTERCOMMUNICATION SYSTEM and Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.
****

Provide system of telephone wire-supporting structures, including conduits with pull wires, terminal boxes, outlet and junction boxes, [and]other accessories for telephone outlets[, and telephone cabinets].

2.14.1 Outlet Boxes

Standard type, as specified herein, [[_____] mm inches by [_____] mm inches]. Mount at height [indicated][specified for telephone outlet receptacles].

2.14.2 Cover Plates

Blank cover with same finish specified for receptacle and switch cover plates.

2.14.3 Conduit Sizing

****
NOTE: For guidelines on conduit sizing, see UFC 3-520-01. Telephone raceway requirements should be coordinated with the entity providing the telephone wires and cable.
****

Conduit for single outlets must be minimum of 21 mm 3/4 inch and for multiple outlets minimum of 27 mm one inch.

2.14.4 Terminal Cabinets

****
NOTE: For guidelines on sizing cabinets, see UFC 3-580-01. Coordinate with entity providing telephone service.
****

NEMA 4X [nonmetallic][or][stainless steel] with backboard. Hardware must be stainless steel.

2.15 MOUNTING STRAPS

[Fiberglass][or][PVC coated steel], two-hole type designed for rigid steel conduit support. PVC coating must be between 0.5 and one mm 20 and

40 mil thickness.

2.16 GROUNDING AND BONDING EQUIPMENT

UL 467. Ground rods must be copper-clad steel, with minimum diameter of 19 mm 3/4 inch and minimum length of 3050 mm 10 feet.

2.16.1 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible,[excepting specifically those connection for which access for periodic testing is required,] by exothermic weld or high 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 high compression connections using a hydraulic or electric compression tool to provide the correct circumferential pressure. Provide tools and dies as recommended by the manufacturer. Use an embossing die code or other standard method to provide visible indication that a connector has been adequately compressed on the ground wire.

[2.16.2 Ground Rod Mounting Straps

Provide mounting straps to support ground rods at fueling pier. Do not use dissimilar metals.

][2.16.3 Alligator Clips

Heavy duty type, copper, insulated handles, rated 100 amperes and up to 250 volts for maximum No. 2 AWG.

][2.17 HAZARDOUS LOCATIONS

****

NOTE: The following information must be shown on the project drawings.

1. Where specification identifies type, size, color, finish, or other definitive information to be "as indicated," the engineer must include the information on the drawings.

2. Location of manholes, handholes, ducts, and cables.

3. Types of wire and cable; number and sizes of conductors.

4. Limits of each hazardous location, clearly indicating class, division, and group classification of each hazard.

5. Special conditions.

****

Electrical materials, equipment, and devices for installation in hazardous locations must be specifically approved by UL or Factory Mutual Research Corporation (FM) for particular class, division, and group of hazardous locations involved. Equipment must be waterproof and suitable for marine environment.

]2.18 WIREWAYS

UL 870. Material must be [nonmetallic] [or] [stainless steel], 16 gage for size[s] [63.5 by 63.5] [100 by 100] [150 by 150] mm, [2 1/2 by 2 1/2] [4 by 4] [6 by 6] inches, 14 gage for size[s] [200 by 200] [300 by 300] mm [8 by 8] [12 by 12] inches. Provide in length [indicated] [required for the application] with gasketed [hinged] [screw] cover NEMA 4X enclosure in accordance with NEMA ICS 6.

2.19 FIELD FABRICATED NAMEPLATES

****

NOTE: Use the following paragraph where nameplates are fabricated to identify specific equipment designated on the drawings.

****

Provide field fabricated nameplates in accordance with the following:

a. ASTM D709.

b. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.

c. Each nameplate inscription: identify the function and, when applicable, the position.

d. Nameplates: melamine plastic, 3 mm 0.125 inch thick, white with [black] [_____] center core.

e. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.

f. Minimum size of nameplates: 25 by 65 mm one by 2.5 inches.

g. Lettering size and style: a minimum of 6.35 mm 0.25 inch high normal block style.

2.20 ARC FLASH WARNING LABEL

****

NOTE: Include the Arc Flash Warning Label detail on the drawings. See UFC 3-560-01 for more information.

****

Provide arc flash warning labels on electrical equipment likely to require examination, servicing, or maintenance while energized. Some typical types of equipment include pad-mounted transformers, switchgears, switchboards, panelboards, and disconnect switches. Place label on the outside of the enclosure warning of potential electrical arc flash hazards

and appropriate PPE required. Provide label format as indicated.

2.21 MARINE SIGNAL LANTERN

Provide with nonmetallic base, [155-mm] [_____], [red] [_____] [acrylic] [UV stable polycarbonate] fresnel lens, LED light source, [solid state flasher,] [lamp changer,] [solar power station,] [1220 mm] [4 foot] [_____] nonmetallic support pedestal, and photo control. The entire system must be watertight and approved for marine environment.

2.21.1 Flasher

****

NOTE: Refer to "USCG Aids to Navigation Manual - Short Range Aids to Navigation" for signaling sequence for lanterns.

****

Flasher must have a [_____]-second cycle period with [[_____]-second "ON" time] [Morse code letter "[_____]"] [_____].

2.21.2 Lamp Changer

[120 volt ac, four place automatic lamp changer with LED lamps] [[6] [12]] volt dc, six place automatic lamp changer with [_____] ampere lamps. When lamps burn out, lamp changer must stop operation[and power must turn off].

[2.21.3 Ac to Dc Converter

Converter must convert [120] [240] [_____] volts ac input into a [6] [12] volt dc output. Converter must be sized for the signal lantern specified.

]2.21.4 Solar Power Station

Power station must consist of encased silicon solar energy cells, nonmetallic battery box with blocking diodes, rechargeable sealed batteries, and mounting brackets. The solar power station must be a complete unit supplied and coordinated by a single manufacturer, sized to provide adequate year-round power to fully operate the signal lantern specified at the exact geographic location of the signal lantern.

2.22 PIER LIGHTING

****

NOTE: Fixture enclosures located on marina piers must be watertight and constructed on nonmetallic material or cast aluminum with baked enamel or powdered polyester finish. Hardware must be nonmetallic or stainless steel. Conduit or cable entrances into lighting fixtures must be watertight.

****

Provide as specified in Section 26 56 00 EXTERIOR LIGHTING.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations must conform to requirements of NFPA 70 and to

requirements specified herein.

[3.1.1 Underground Service

****
NOTE: Choose this paragraph or the paragraph OVERHEAD SERVICE below. When using this paragraph, designer may insert additional details describing the specific project.
****

Underground service conductors and associated conduit must be continuous from service equipment to the power system connection.

][3.1.2 Overhead Service

****
NOTE: When using this paragraph, coordinate with Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION or Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION (if in project).
****

Overhead service conductors must terminate at service equipment weatherhead. Overhead service conductors and support bracket for overhead conductors are included in Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION.

][3.1.3 Hazardous Locations

Perform work in hazardous locations, as defined by NFPA 70, in strict accordance with NFPA 70 for particular class, division, and group of hazardous locations involved. Provide conduit and cable seals where required by NFPA 70. Conduit must have tapered threads.

]3.1.4 Service Entrance Identification

Label or identify service entrance disconnect devices, switches, and enclosures.

3.1.4.1 Nameplates

Where work results in service disconnect devices in more than one enclosure, as permitted by NFPA 70, label each enclosure, new and existing, as one of several enclosures containing service entrance disconnect devices. Label, at minimum, must indicate number of service disconnect devices housed by enclosure and must indicate total number of enclosures that contain service disconnect devices. Provide laminated nameplates with letters no less than 6 mm 0.25 inch in height; and engrave on black-on-white matte finish. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.1.5 Wiring Methods

Provide insulated conductors installed in rigid conduit, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor must be separate from electrical system neutral conductor. Provide insulated, green equipment grounding conductors for circuits installed in conduit and raceways. Minimum

conduit size must be 16 mm 1/2 inch in diameter for low-voltage lighting and power circuits.

3.1.5.1 Plastic-Coated Galvanized Rigid Steel

Use only for service entrance conduit and as required by NFPA for hazardous locations.

3.1.5.2 PVC Schedule 40 and PVC Schedule 80

a. Do not install PVC Schedule 40 in areas subject to physical damage.

b. Do not install PVC Schedule 80 in areas subject to severe physical damage.

c. Do not install in hazardous areas.

3.1.5.3 Service Entrance Conduit, Overhead

PVC, Type EPC-40, plastic-coated galvanized rigid steel from service entrance to service weatherhead.

3.1.5.4 Service Entrance Conduit, Underground

PVC, Type EPC-40, plastic-coated galvanized rigid steel. Encase underground portion in a minimum of 75 mm 3 inches of concrete. Install a minimum of 460 mm 18 inches below slab or grade.

3.1.5.5 Liquidtight Flexible Metal Conduit

Install in accordance with NFPA 70.

3.1.5.6 Underground Conduit Other Than Service Entrance

****
NOTE: 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.
****

PVC, Type EPC-40, plastic-coated rigid steel, or fiberglass. Convert nonmetallic conduit, other than PVC Schedule 40 or 80, to plastic-coated rigid conduit before rising through pier deck. Plastic coating must extend minimum 150 mm 6 inches above pier deck.

3.1.6 Conduit Installation

Run conduit [exposed on side of [wood][and][existing concrete] pier structures], [supported by hangers under pier structure] [concealed in new concrete pier structure]. Install conduit parallel with or at right angles to structural members.

3.1.6.1 Conduit Support

Support conduit by nonmetallic pipe straps, wall brackets, hangers, or trapeze. Fasten by stainless steel wood screws to wood and by concrete inserts or expansion bolts on concrete. Threaded C-clamps may be provided

on rigid steel conduit only. Load applied to fasteners must not exceed one-fourth proof test load. Fasteners attached to concrete ceiling must be vibration resistant and shock resistant. Holes cut to depth of more than 40 mm 1 1/2 inches in reinforced concrete beams or to depth of more than20 mm 3/4 inch in concrete joints must not cut main reinforcing bars. Fill unused holes. Where conduit crosses expansion joints, provide suitable [watertight]expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means.

3.1.6.2 Directional Changes in Conduit Runs

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

3.1.6.3 Expansion Joints

Install as recommended by the manufacturer for the temperature conditions at time of installation.

3.1.6.4 Pull Wire

Install in empty conduits in which wire is to be installed by others. Pull wire must be plastic having minimum 890 N 200 pound tensile strength. Leave minimum 300 mm 12 inches of slack at each end of pull wire.

3.1.6.5 Telephone and Signal System Conduits

Install in accordance with specified requirements for conduit and with additional requirement that no length of run must exceed 45 meters 150 feet for trade sizes 50 mm 2 inches and smaller and must not contain more than two 1.57 rad 90 degree bends or equivalent. Provide pull or junction boxes where necessary to comply with these requirements. Inside radii of bends in conduits 16 mm one inch trade size and larger must be minimum five times nominal diameter. Terminate conduit in terminal cabinet with two locknuts and plastic bushing.

3.1.6.6 Conduit Installed in Concrete

****
NOTE: 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.
****

Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab.[Do not stack conduits.][Do not stack conduits more than two diameters high with minimum vertical separation of [_____] millimeters inches.] Space conduits horizontally minimum three diameters, except at cabinet locations. Curved portions of bends must not be visible above finish slab. Increase slab thickness as necessary to provide minimum 25 mm one inch cover over conduit. Where embedded conduits cross expansion joints,

provide suitable watertight expansion fittings[and bonding jumpers when using metallic conduits]. Conduit larger than 27 mm one inch trade size must be parallel with or at right angles to main reinforcement; when at right angles to reinforcement, conduit must be close to one of supports of slab.

3.1.6.7 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are provided, and where bushings cannot be brought into firm contact with the box; otherwise, provide minimum single locknut and bushing. Locknuts must 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.

[3.1.6.8 Stub-Ups

Provide conduits stubbed up through concrete structures for connection to freestanding equipment with adjustable top or coupling threaded inside for plugs, set flush with finished structure. Extend conductors to equipment in rigid conduit. Where no equipment connections are made, install screwdriver-operated threaded flush noncorroding plugs in conduit end.

]3.1.6.9 Conduit and Cable Connections

Provide watertight connectors for conduit and cable connections to boxes and cabinets.

3.1.7 Boxes, Outlets, and Supports

Provide boxes in wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways must be stainless steel type 304, hub type, and when specifically indicated. Boxes in other locations must be nonmetallic boxes provided with nonmetallic conduit system. Each box must have volume required by NFPA 70 for number of conductors enclosed in a box. Provide gaskets for boxes. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature. Fasten boxes and supports with wood screws on wood and with bolts and expansion shields on concrete.[Threaded studs driven in by powder charge and provided with lockwashers and nuts[or nail-type nylon anchors] may be provided in lieu of wood screws, expansion shields, or machine screws.] Support boxes directly from structure or by [nonmetallic][or][stainless steel] hangers. Where [nonmetallic] stainless steel bar hangers are provided, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 600 mm 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.7.1 Boxes

Boxes for use with raceway systems must be minimum 38 mm 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes must be minimum 100 mm 4 inches square, except that100 by 50 mm 4 by 2 inch boxes may be provided where only one raceway enters outlet. Telephone outlets must be minimum of 100 mm square by 38 mm 4 inches square by 1 1/2 inches deep.

3.1.7.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 compatible with nonmetallic raceway systems, except where stainless steel boxes are required in locations specified herein. Furnish 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.

3.1.8 Mounting Heights

Mount panelboards, circuit breakers, and disconnecting switches so maximum height of operating handle is 1980 mm 78 inches above finished structure. Mount receptacles a minimum of [460] [_____] mm [18] [_____] inches above finished structure. In no case must entire or part of panelboards, boxes, cabinets, receptacles, and other electrical devices be mounted below the electrical datum plane as defined in NFPA 303. Measure mounting heights of wiring devices and outlets to center of device or outlet.

3.1.9 Conductor Identification

Provide within each enclosure where tap, splice, or termination is made. For conductor sizes No. 6 AWG and smaller diameter, color coding must be by factory-applied, color-impregnated insulation. For conductor sizes No. 4 AWG and larger diameter, color coding must be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations.

3.1.10 Splices

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

3.1.11 Covers and Device Plates

Install gasketed plates with alignment tolerance of 1.6 mm 1/16 inch.

3.1.12 Grounding and Bonding

NFPA 70. Ground-exposed, noncurrent-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, 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. When 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.][Make ground connection to driven ground rods.] Where ground-fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.12.1 Resistance

Maximum resistance-to-ground of grounding system must not exceed [5] [_____] ohms under dry conditions. Where resistance obtained exceeds [5]

[_____] ohms, contact Contracting Officer for further instructions.

[3.1.12.2 Telephone Service

Provide main telephone service equipment ground consisting of separate No. 6 AWG ground wire in conduit between equipment backboard and readily accessible grounding connection. Equipment end of ground wire must consist of coiled length at least twice as long as terminal cabinet.

]3.1.13 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section. Except as otherwise noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section, but must be provided under the section specifying associated equipment.

[3.1.14 Government-Furnished Equipment

Contractor [must rough-in for Government-furnished equipment][must make connections to Government-furnished equipment] to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, and outlet boxes or fittings.

]3.2 REPAIR AND SERVICE OF EXISTING STRUCTURES AND EQUIPMENT

Perform repair of existing structures and equipment[, demolition, and modification of existing electrical distribution systems] as follows:

3.2.1 Workmanship

NECA NEIS 1. Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of existing surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to structure, piping, and equipment using skilled craftsmen of trades involved.

[3.2.2 Existing Concealed Wiring to be Removed

Disconnect from its source. Remove conductors, cut exposed conduit flush with structure, and seal openings with material to match adjacent surfaces.

][3.2.3 Existing Electrical Distribution System Removal

Include removal of equipment's associated wiring, including conductors, cables, exposed conduit, boxes, fittings, anchors, supports, and other such items, [back to equipment's source][as indicated]. Fill holes in structure where electrical equipment is removed with material to match adjacent surface. Provide unused openings in remaining boxes, fittings, and equipment with watertight nonmetallic knockout seals.

][3.2.4 Continuation of Service

Maintain continuity of service to existing circuits of equipment to remain. Existing circuits of equipment must remain energized. Circuits which are to remain but were disturbed during demolition must have circuits wiring and power restored back to original condition.

]3.3 FIELD QUALITY CONTROL

****
NOTE: Provide any additional test requirements for equipment requiring running tests or tests that must be coordinated with mechanical equipment.
****

Furnish test equipment and personnel. Notify Contracting Officer [5] [_____] working days prior to [each] [_____] test[s].

3.3.1 Devices Subject to Manual Operation

Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.

3.3.2 Transformer Tests

Perform tests classified as routine in accordance with NEMA ST 20 on each transformer.

3.3.3 600-Volt Wiring Test

Test wiring rated 600 volts 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 must be 250,000 ohms.

3.3.4 Grounding System Test

Test grounding system to ensure continuity and 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.

3.3.5 Solar Power Station Test

Test solar power station for proper operation in accordance with manufacturer's recommendation.

3.4 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

PRODUCTS	INCH-POUND	METRIC
a. Device plate (thickness)	0.10 inch	2.54 mm
b. Mounting straps (thickness)	20 and 40 mil	0.5 and one mm

PRODUCTS	INCH-POUND	METRIC
c. Ground rod		
Diameter	3/4 inch	19 mm
Length	10 feet	3050 mm
d. Wireways	2 1/2 by 2 1/2 inches	63.5 by 63.5 mm
	4 by 4 inches	100 by 100 mm
	8 by 8 inches	200 by 200 mm
	12 by 12 inches	300 by 300 mm
e. Boxes		
Depth	1 1/2 inches	38 mm
Size	4 inches (square)	100 mm

-- End of Section --