
USACE / NAVFAC / AFCEA / NASA

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UFGS-16520N (February 2003)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005

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SECTION 16520

EXTERIOR LIGHTING

08/04

NOTE: This guide specification covers lighting system requirements for exterior installations.

This specification does not cover all possible methods or requirements for exterior lighting; therefore, designer should add special information required to suit a specific project. Industry publications exist to aid the designer in choosing the best lighting system for the project. One such publication is Illuminating Engineering Society (IESNA) RP-8, "Recommended Practice for Roadway Lighting."

Comments and suggestion on this specification are welcome and should be directed to the technical proponent of the specification. A listing of the technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

NOTE: TO DOWNLOAD UFGS GRAPHICS

Go to <http://www.ccb.org/docs/ufgshome/graphtoc.pdf>.

NOTE: This section contains the following sketches (Graphics) and are available in metric (SI) and U.S. Customary (IP) system dimensions. Sketch titles and style numbers are unchanged for both types. The

metric values indicated are a conversion of U.S.
Customary (IP) system dimensions.

Do not include list of sketches, or sketches
themselves, in project specifications. Use
luminaire sketches as details on drawings whenever
possible. If special features are required, do not
modify sketches, but indicate these changes as notes
in fixture schedule. The "XL" style numbers and
dates should remain on the drawing details.

<u>Sketch No.</u>	<u>Title</u>
XL-1	Roadway and Area Light
XL-2	Floodlight
XL-3	Floodlight and Sports Light
XL-4	Roadway and Area Light
XL-5	Sports and Area Light
XL-6	Area and Street Lighting Cutoff Luminaire
XL-7	Low-Pressure Sodium Area Lighting Luminaire
XL-8	Area Luminaire
XL-9	Round Architectural Post Top Area Light
XL-10	Square Architectural Post Top Area Light
XL-11	Area Light (Vertical Lamp)
XL-12	HID Bollard Luminaire
XL-13 thru 19	Reserved for Future Exterior Luminaires
XL-20	Round Fiberglass Pole, Direct Set Tenon Mount
XL-21	Round Fiberglass Pole, Direct Set Mast Arm Mount
XL-22	Round Concrete Pole, Direct Set Tenon Mount
XL-23	Round Concrete Pole, Direct Set Mast Arm Mount
XL-24	Round Steel Pole, Direct Set Tenon Mount
XL-25	Round Steel Pole, Direct Set Mast Arm Mount
XL-26	Round Steel Pole, Anchor Base, Tenon Mount
XL-27	Round Steel Pole, Anchor Base, Mast Arm Mount
XL-28	Luminaire Mounting Brackets
XL-29	Various Luminaire Mounting Arm Types
XL-30	Miscellaneous Luminaire Mounting Brackets
XL-31	Luminaire Mounting Arms
XL-32	Luminaire Mounting Arms
XL-33	Bolt-Down Pole Foundation
XL-34	Grounding Installation Details for Direct Set Poles

NOTE: Do not include this index in project specification.

NOTE: The following information shall be shown on
the drawings or specified in the project
specifications:

a. Luminaire schedule and indicate pertinent
information; i.e., mounting, lamps, ballasts, and
voltage.

1. Type of luminaire;
2. Voltage, wattage, and frequency rating required;
3. Accessories required, such as photocell, time

switches, and auxiliary lamps;

4. Location of poles or standards;

5. Referenced sketch; and

6. Extent and location of the work to be accomplished and wiring and equipment necessary for a complete installation.

NOTE: Demolition work that involves disposal of fluorescent and HID lamps and ballasts will require the use of Section 13286N HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBs AND MERCURY.

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 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 in the text by the basic designation only.

ALLIANCE FOR TELECOMMUNICATIONS INDUSTRY SOLUTIONS (ATIS)

ATIS O5.1 (2002; R 2003) Specifications and Dimensions (for Wood Poles)

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LTS-4 (2001; 2003 Interim) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C1	(2000) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C4	(1999) Poles - Preservative Treatment by Pressure Processes
AWPA M6	(1996) Brands Used on Forest Products

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2004) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 108	(2003a) Aluminum-Alloy Permanent Mold Castings
ASTM C 1089	(1997) Spun Cast Prestressed Concrete Poles
ASTM G 154	(2000ae1) Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

IESNA HB-9	(2000) Lighting Handbook
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INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C136.10	(1996) Roadway Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacle - Physical and Electrical Interchangeability and Testing
IEEE C136.13	(1992) Roadway Lighting Equipment, Metal Brackets for Wood Poles
IEEE C136.20	(1990) Roadway Lighting Equipment - Fiber-Reinforced Plastic (FRP) Lighting Poles
IEEE C136.21	(1987) Roadway Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires
IEEE C136.3	(2005) Roadway and Area Lighting Equipment Luminaire Attachments
IEEE C2	(2002) National Electrical Safety Code
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA C78.1381	(1998) Electric Lamps - 250-Watt, 70 Watt, M85 Metal-Halide Lamps
NEMA C78.41	(2001) Guidelines for Low-Pressure Sodium Lamps
NEMA C78.42	(2004) Electric Lamps - High-Pressure Sodium Lamps
NEMA C78.43	(2004) Electric Lamps - Single-Ended Metal-Halide Lamps
NEMA C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
NEMA ICS 2	(2000; R 2004) Industrial Controls and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993; R 2001) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2005) National Electrical Code
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U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 1728F-700	(1993) Wood Poles, Stubs, and Anchor Logs
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UNDERWRITERS LABORATORIES (UL)

UL 1029	(1994; Rev thru Feb 2001) High-Intensity-Discharge Lamp Ballasts
UL 1598	(2004) Luminaires
UL 773	(1995; Rev thru Mar 2002) Plug-In Locking Type Photocontrols for Use with Area Lighting
UL 773A	(1995; Rev thru Jul 2003) Nonindustrial Photoelectric Switches for Lighting Control

1.2 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.
- b. Average life is the time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

- c. Groundline section is that portion between 305 mm one foot above and 610 mm 2 feet below the groundline.

1.3 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

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" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire drawings[; G][; G, [_____]]

Poles[; G][; G, [_____]]

SD-03 Product Data

Luminaires[; G][; G, [_____]]

Lamps[; G][; G, [_____]]

Ballasts[; G][; G, [____]]

Lighting contactor[; G][; G, [____]]

Time switch[; G][; G, [____]]

Photocell switch[; G][; G, [____]]

Concrete poles[; G][; G, [____]]

Aluminum poles[; G][; G, [____]]

Steel poles[; G][; G, [____]]

Fiberglass poles[; G][; G, [____]]

Brackets

[Auxiliary instant-on quartz system[; G][; G, [____]]]

[SD-04 Samples

NOTE: Samples involve additional shipping cost.
 Use only for special fixtures or for an item for
 which a large quantity is required on a project. If
 samples are not essential to the specific
 application, delete them.

Luminaires[; G][; G, [____]]

Submit one sample of each luminaire type[, complete with lamp and
 ballast]. [Submit one sample for each item other than
 luminaires.] Sample will be returned to the Contractor for
 installation in the project work.

] SD-05 Design Data

[Design Data for luminaires[; G][; G, [____]]]

SD-06 Test Reports

[Pressure treated wood pole quality]

[Tests for fiberglass poles[; G][; G, [____]]]

Operating test

Submit operating test results as stated in paragraph entitled
 "Field Quality Control."

SD-08 Manufacturer's Instructions

Concrete poles

Submit instructions prior to installation.

Fiberglass poles

Submit instructions prior to installation.

1.4 QUALITY ASSURANCE

1.4.1 Drawing Requirements

1.4.1.1 Luminaire Drawings

Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and[computerized] candlepower distribution data shall accompany shop drawings.

1.4.1.2 Poles

Include dimensions, wind load determined in accordance with AASHTO LTS-4, pole deflection, pole class, and other applicable information.[For concrete poles, include: section and details to indicate quantities and position of prestressing steel, spiral steel, inserts, and through holes; initial prestressing steel tension; and concrete strengths at release and at 28 days.]

[1.4.2 Pressure Treated Wood Pole Quality

Ensure the quality of pressure treated wood poles. Furnish an inspection report (for wood poles) of an independent inspection agency, approved by the Contracting Officer, stating that offered products comply with AWP A M6 and RUS 1728F-700 standards. The RUS approved Quality Mark "WQC" on each pole will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWP A treatment standards.

] [1.4.3 Design Data for Luminaires

- a. Distribution data according to IESNA classification type as defined in IESNA HB-9.
- b. Computerized horizontal illumination levels in lux footcandles at ground level, taken every [3050] [6100] [_____] mm [10] [20] [_____] feet. Include average maintained lux footcandle level and maximum and minimum ratio.

] [1.4.4 Tests for Fiberglass Poles

NOTE: Whenever fiberglass poles are required for a project, include the following test.

- a. Ultraviolet resistance tests: Perform according to ASTM G 154 using a UV-B lamp having a 313 nanometer wavelength, operated at 54 degrees C 130 degrees F, cycling the lamp on for 4 hours and off for 4 hours for a total test period of 1500 hours minimum with the following results:

Fiber exposure:	None
Crazing:	None
Checking:	None
Chalking:	None
Color:	May dull slightly

- b. Flexural strength and deflection test: Test loading shall be as a cantilever beam with pole butt as fixed end and a force simulating wind load at the free end.

]1.4.5 Regulatory Requirements

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

1.4.6 Standard Products

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

1.4.6.1 Alternative Qualifications

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

1.4.6.2 Material and Equipment Manufacturing Date

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

1.5 DELIVERY, STORAGE, AND HANDLING

NOTE: Select the applicable paragraph(s) from the following.

[1.5.1 Wood Poles

Stack poles stored for more than 2 weeks on decay-resisting skids arranged to support the poles without producing noticeable distortion. Store poles to permit free circulation of air; the bottom poles in the stack shall be at least 305 mm one foot above ground level and growing vegetation. Do not permit decayed or decaying wood to remain underneath stored poles. Do not drag treated poles along the ground. Do not use pole tongs, cant hooks, and other pointed tools capable of producing indentation more than 25 mm one inch in depth in handling the poles. Do not apply tools to the

groundline section of any pole.

] 1.5.2 Concrete Poles

Do not store poles on ground. Support poles so they are at least 305 mm one foot above ground level and growing vegetation.

] 1.5.3 Fiberglass Poles

Do not store poles on ground. Support poles so they are at least 305 mm one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

] 1.5.4 [Aluminum][Steel]Poles

Do not store poles on ground. Support poles so they are at least 305 mm one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

] 1.6 WARRANTY

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

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

NOTE: For LANTNAVFACENGCOM projects, refer to
Atlantic Division Regional Section 16303N
UNDERGROUND ELECTRICAL WORK in lieu of Section
16302N typical throughout this specification.

Products and materials not considered to be lighting equipment or lighting fixture accessories are specified in[Section 16302N UNDERGROUND TRANSMISSION AND DISTRIBUTION,][Section 16301N OVERHEAD TRANSMISSION AND DISTRIBUTION,][Section 16370A ELECTRICAL DISTRIBUTION SYSTEM, AERIAL,][Section 16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND,][and] Section 16402 INTERIOR DISTRIBUTION SYSTEM.[Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in Section 16510 INTERIOR LIGHTING.]

2.2 LUMINAIRES

NOTE: Luminaire, ballast, and lamp design and
technology have advanced rapidly in recent years;
ensure a luminaire is currently available before
specifying. Light distribution and brightness
characteristics can be helpful for comparison,
selection, and special applications of exterior
luminaires. Computer programs for lighting design
are available from many sources including IESNA and
luminaire manufacturers.

NOTE: As an exception to what may normally be specified, lenses and refractors of acrylic or polycarbonate plastic should be specified if secondary damage by the breakage of a refractor cannot be tolerated. Some plastic refractors are subject to yellowing and in general are not as desirable as glass refractors. Of the plastics, acrylic plastic refractors offer the most desirable properties. If vandalism is a serious problem, polycarbonate plastic refractors are less susceptible to breakage but are susceptible to yellowing after a relatively short period of time. Other types of plastic refractors are available and should be investigated for special applications. Do not use metal-halide lamps without a tempered glass diffuser.

UL 1598. Provide luminaires as indicated. Provide luminaires complete with lamps of number, type, and wattage indicated. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs[, light distribution and brightness characteristics,] and of equal finish and quality will be acceptable as approved.

2.2.1 Lamps

2.2.1.1 High-Pressure Sodium (HPS) Lamps

NEMA C78.42. Wattage as indicated. HPS lamps shall have average rated life of 16,000 hours (minimum) for 35 watt lamps and 24,000 hours (minimum) for all higher wattage lamps. 150 watt lamps, if required, shall be 55 volt lamps.

[2.2.1.2 Standby HPS Lamps

NOTE: In some applications, generally where power interruptions are momentary, standby HPS may be used instead of auxiliary Instant-On Quartz systems. Standby HPS are mogul base only.

NEMA C78.42. Wattage as indicated. Standby HPS lamps shall have two arc tubes and an average rated life of 40,000 hours (minimum). Hot restart instant lumen output shall be 8 percent, minimum, of total light output. 150 watt lamps, if required, shall be 55 volt type.

] 2.2.1.3 Low-Pressure Sodium (LPS) Lamps

NOTE: Use low-pressure sodium where color rendition is not a factor, but high lamp efficiency is.

NEMA C78.41.

] 2.2.1.4 Metal-Halide Lamps

Provide luminaires with tempered glass lens.

[a. Double-ended, 70 watt, conforming to NEMA C78.1381]

[b. Single-ended, wattage as indicated, conforming to NEMA C78.43]

] 2.2.2 Ballasts for High-Intensity-Discharge (HID) Luminaires

UL 1029 and NEMA C82.4, and shall be constant wattage autotransformer (CWA) or regulator, high power-factor type [unless otherwise indicated]. Provide single-lamp ballasts which shall have a minimum starting temperature of minus 30 degrees C. Ballasts shall be:

a. Designed to operate on voltage system to which they are connected.

b. Constructed so that open circuit operation will not reduce the average life.

HID ballasts shall have a solid-state igniter/starter with an average life in the pulsing mode of 10,000 hours at the intended ambient temperature. Igniter case temperature shall not exceed 90 degrees C.

2.3 LIGHTING CONTACTOR

NEMA ICS 2, [electrically] [mechanically] held contactor. [Contacts shall be rated [] volts, [] amperes, and [] poles. Coils shall be rated [] volts.] [Rate contactor as indicated.] Provide in NEMA [4] [] enclosure conforming to NEMA ICS 6. Contactor shall have silver alloy double-break contacts [and coil clearing contacts for mechanically held contactor] and shall require no arcing contacts. [Provide contactor with [hand-off-automatic] [on-off] selector switch.] [Contactor shall be hermetically sealed.]

2.4 TIME SWITCH

NOTE: Photocells and time switches should not always be used together. Use the following information as a guide.

1. Lights on/lights off by photocell: Street lighting and certain parking lots. Any facility or street that requires lighting after dark.

2. Lights on by photocell; lights off by time switch: Most administration facilities, commissaries, hobby shops, or clubs. Any facility that does not stay open all night.

3. Lights on/lights off by time switch: Service stations, snack bars, barracks, or officer's quarters. Facilities that will be open to the public, or have personnel that must report before daylight and after dark, but not all night.

Other considerations: Time switches with skip-a-day

feature may be useful for facilities with a 5-day work week. (Program time switch to skip Saturday and Sunday.) For facilities that do not stay open all night, it may be desirable to have lighting at night for security. Consult activity for local policy and exceptions to these suggestions.

Astronomic dial type or electronic type, arranged to turn "ON" at sunset, and turn "OFF" at predetermined time between 8:30 p.m. and 2:30 a.m. or sunrise, automatically changing the settings each day in accordance with seasonal changes of sunset and sunrise. Provide switch rated [_____] volts, having automatically wound spring mechanism or capacitor, to maintain accurate time for a minimum of 7 hours following power failure. Provide time switch with a manual on-off bypass switch. Housing for the time switch shall be surface mounted, NEMA [3R] [_____] enclosure conforming to NEMA ICS 6.

2.5 PHOTOCELL SWITCH

NOTE: Silicon diode type photocells are solid state devices and have limited sources. Therefore, cadmium-sulfide type cells can not be deleted from specification.

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated [_____] volts ac, 60 Hz with [single-throw contacts] [single pole double-throw (spdt) contacts for mechanically held contactors rated 1000 watts] designed to fail to the ON position. Switch shall turn on at or below 32 lux 3 footcandles and off at 43 to 107 lux 4 to 10 footcandles. A time delay shall prevent accidental switching from transient light sources. [Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition.] Provide switch:

- [a. In a high-impact-resistant, noncorroding and nonconductive molded plastic housing with a [fixture mounted,] locking-type receptacle conforming to IEEE C136.10 and rated 1800 VA, minimum.]
- [b. In a cast weatherproof aluminum housing with adjustable window slide, rated 1800 VA, minimum.]
- [c. In a U.V. stabilized polycarbonate housing with swivel arm and adjustable window slide, rated 1800 VA, minimum.]
- [d. Integral to the luminaire, rated 1000 VA, minimum.]

2.6 POLES

NOTE: This specification does not cover decorative poles or high-mast lighting systems. Poles, luminaire mounting assemblies, and lowering mechanisms for high-mast lighting are specially fabricated and should be individually designed to suit a specific project. Pole specifications for high-mast system should, as a minimum, include wind

loading and ultimate strength meeting the loading requirements of AASHTO LTS-4. Do not specify embedded type metal poles for Army facilities.

Provide poles designed for wind loading of [161] [_____] km/hr [100] [_____] miles per hour determined in accordance with AASHTO LTS-4 while supporting luminaires and all other appurtenances indicated. The effective projected areas of luminaires and appurtenances used in calculations shall be specific for the actual products provided on each pole. Poles shall be [embedded] [anchor]-base type designed for use with [underground] [overhead] supply conductors. [Poles[, other than wood poles,] shall have oval-shaped handhole having a minimum clear opening of 65 by 130 mm (2.5 by 5 inches) 2.5 by 5 inches. Handhole cover shall be secured by stainless steel captive screws.][Metal poles shall have an internal grounding connection accessible from the handhole near the bottom of each pole.] Scratched, stained, chipped, or dented poles shall not be installed.

2.6.1 Concrete Poles

Provide concrete poles conforming to ASTM C 1089. Cross-sectional shape shall be [round] [or] [multi-sided].

NOTE: If other than round pole is chosen, revise Sketch XL-22 and XL-23 to suit the cross-sectional shape selected.

2.6.1.1 Steel Reinforcing

Prestressed concrete pole shafts shall be reinforced with steel prestressing members. Design shall provide internal longitudinal loading by either pretensioning or post tensioning of longitudinal reinforcing members.

2.6.1.2 Tensioned Reinforcing

Primary reinforcement steel used for a prestressed concrete pole shaft shall be tensioned between 60 to 70 percent of its ultimate strength. The amount of reinforcement shall be such that when reinforcement is tensioned to 70 percent of its ultimate strength, the total resultant tensile force does not exceed the minimum section compressive strength of the concrete.

2.6.1.3 Coating and Sleeves for Reinforcing Members

Where minimum internal coverage cannot be maintained next to required core openings, such as handhole and wiring inlet, reinforcing shall be protected with a vaporproof noncorrosive sleeve over the length without the 13 mm 1/2 inch concrete coverage. Each steel reinforcing member which is to be post-tensioned shall have a nonmigrating slipper coating applied prior to the addition of concrete to ensure uniformity of stress throughout the length of such member.

2.6.1.4 Strength Requirement

As an exception to the requirements of ASTM C 1089, poles shall be naturally cured to achieve a 28-day compressive strength of 48.23 MPa 7000 psi. Poles shall not be subjected to severe temperature changes during the

curing period.

2.6.1.5 Shaft Preparation

Completed prestressed concrete pole shaft shall have a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost, and shall be clean, smooth, and free of surface voids and internal honeycombing. Poles shall not be installed for at least 15 days after manufacture.

2.6.2 Aluminum Poles

Provide aluminum poles manufactured of corrosion resistant aluminum alloys conforming to AASHTO LTS-4 for Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys and Alloy 356-T4 (3,5) for cast alloys. Poles shall be seamless extruded or spun seamless type with minimum 4.8 mm (0.188 inch) 0.188 inch wall thickness. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Tops of shafts shall be fitted with a round or tapered cover. Base shall be anchor bolt mounted, made of cast 356-T6 aluminum alloy in accordance with ASTM B 108 and shall be machined to receive the lower end of shaft. Joint between shaft and base shall be welded. Base cover shall be cast 356-T6 aluminum alloy in accordance with ASTM B 108. Hardware, except anchor bolts, shall be either 2024-T4 anodized aluminum alloy or stainless steel. [Aluminum poles and brackets for [walkway] [] lighting shall have a [uniform satin] [dark anodic bronze] [] finish to match fixtures and shall not be painted.] Manufacturer's standard provision shall be made for protecting the finish during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.

2.6.3 Steel Poles

AASHTO LTS-4. Provide steel poles having minimum 11-gage steel with minimum yield/strength of 331 MPa (48,000 psi) 48,000 psi and [hot-dipped galvanized in accordance with ASTM A 123/A 123M] [iron-oxide primed] factory finish. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Pole shall be [direct set] [anchor bolt mounted] type. Poles shall have tapered tubular members, either round in cross section or polygonal. [Pole shafts shall be one piece. Poles shall be welded construction with no bolts, rivets, or other means of fastening except as specifically approved.] Pole markings shall be approximately 900 to 1270 mm 3 to 4 feet above grade and shall include manufacturer, year of manufacture, top and bottom diameters, and length. [Base covers for steel poles shall be structural quality hot-rolled carbon steel plate having a minimum yield of 248 MPa (36,000 psi) 36,000 psi.]

2.6.4 Wood Poles

NOTE: Other wood species which are covered by ANSI
05.1, REA, and AWP may be specified, provided they
are available at the project location. Indicate
pole class and height on the drawings.

ATIS 05.1 and RUS 1728F-700 of [Southern Yellow Pine] [Douglas Fir] []
[]. Poles shall be gained, bored, and roofed before treatment. Poles
shall be treated full length with chromated copper arsenate (CCA) or

ammoniacal copper arsenate (ACA) according to AWPAC1 and AWPAC4 as referenced in RUS 1728F-700. Poles shall be branded by manufacturer with manufacturer's mark and date of treatment, height and class of pole, wood species, preservation code, and retention. Place the brand so that the bottom of the brand or disc is 3050 mm (10 feet) 10 feet from the pole butt for poles up to 15250 mm (50 feet) 50 feet long[and 4270 mm (14 feet) 14 feet from the butt for poles over 15250 mm (50 feet) 50 feet long].

2.6.5 Fiberglass Poles

IEEE C136.20. Designed specifically for supporting luminaires and having factory-formed cable entrance and handhole. Resin color shall be[dark bronze][as indicated][_____], and pigment shall provide uniform coloration throughout entire wall thickness. Finish surface shall be pigmented polyurethane having a minimum dry film thickness of 0.038 mm (1.5 mils) 1.5 mils. Polyurethane may be omitted if the surface layer of the pole is inherently ultraviolet inhibited. Minimum fiberglass content shall be 65 percent with resin and pigment comprising the other 35 percent material content.

2.7 BRACKETS AND SUPPORTS

IEEE C136.3, IEEE C136.13, and IEEE C136.21, as applicable. Pole brackets shall be not less than 31.75 mm (1 1/4 inch) 1 1/4 inch[galvanized steel pipe][aluminum] secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets shall be coordinated to luminaires provided, and brackets for use with one type of luminaire shall be identical. Brackets for pole-mounted street lights shall correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 7320 mm 24 feet above street. Special mountings or brackets shall be as indicated and shall be of metal which will not promote galvanic reaction with luminaire head.

2.8 POLE FOUNDATIONS

Anchor bolts shall be steel rod having a minimum yield strength of 344.5 MPa (50,000 psi) 50,000 psi; the top 305 mm (12 inches) 12 inches of the rod shall be galvanized in accordance with ASTM A 153/A 153M. Concrete shall be as specified in[Section 03300N CAST-IN-PLACE CONCRETE][Section 03300A CAST-IN-PLACE STRUCTURAL CONCRETE].

[2.9 AUXILIARY INSTANT-ON QUARTZ SYSTEM

**NOTE: Specify auxiliary quartz system or standby
HPS lamps for luminaires where the extinguishing of
HID lamps caused by momentary power interruptions is
unacceptable for safety or security reasons.**

UL listed, automatically switched instant-on[150][250]-watt[quartz][_____] lamp. Quartz lamp shall come on when the luminaire is initially energized and immediately after a momentary power outage, and remain on until HID lamp reaches approximately 60 percent light output. Wiring for quartz lamp shall be internal to ballast and independent of incoming line voltage to the ballast.[Provide instant-on quartz system for each HID fixture.][Provide instant-on quartz system as indicated.]

]2.10 MANUFACTURER'S NAMEPLATE

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

2.11 FACTORY APPLIED FINISH

NOTE: This paragraph covers only the basic painting requirements for most electrical equipment. Include any special finishes for high or low temperatures and corrosive atmospheres.

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

PART 3 EXECUTION

3.1 INSTALLATION

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

[3.1.1 Wood Poles

NOTE: Poles set in swampy or rocky soil will require different settings or foundations than those set in average bearing soils. Consult pole manufacturer and structural engineer for proper setting or foundation requirements for these and other unusual soil conditions.

Pole holes shall be at least as large at the top as at the bottom and shall be large enough to provide 100 mm 4 inches of clearance between the pole and the side of the hole.

NOTE: At the text below, delete setting information for pole lengths not required.

- a. Setting depth: Pole setting depths shall be as follows:

Length of Pole	Setting in Soil
6100 mm (20 feet)	1575 mm
7625 mm (25 feet)	1575 mm
9150 mm (30 feet)	1575 mm
10675 mm (35 feet)	1830 mm
12200 mm (40 feet)	1830 mm
13725 mm (45 feet)	1985 mm
12250 mm (50 feet)	2135 mm
16775 mm (55 feet)	2285 mm

Length of Pole	Setting in Soil
18300 mm (60 feet)	2440 mm
Length of Pole (feet)	Setting in Soil (feet)
20	5.0
25	5.5
30	5.5
35	6.0
40	6.0
45	6.5
50	7.0
55	7.5
60	8.0

- b. Soil setting: "Setting in Soil" depths shall apply where pole holes are in soil, sand, or gravel or any combination of these.[At corners, dead ends and other points of extra strain, poles 12,200 mm (40 feet) 40 feet long or more shall be set 150 mm 6 inches deeper.]
- c. Setting on sloping ground: On sloping ground, measure the depth of the hole from the low side of the hole.
- d. Backfill: Tamp pole backfill for the full depth of the hole and mound the excess fill around the pole.

] [3.1.2 Concrete Poles

NOTE: Poles set in swampy or rocky soil will
require different settings or foundations than those
set in average bearing soils. Consult pole
manufacturer and structural engineer for proper
setting or foundation requirements for these and
other unusual soil conditions.

Install according to pole manufacturer's instructions.

] [3.1.3 Fiberglass Poles

NOTE: Poles set in swampy or rocky soil will
require different settings or foundations than those
set in average bearing soils. Consult pole
manufacturer and structural engineer for proper
setting or foundation requirements for these and
other unusual soil conditions.

Install according to pole manufacturer's instructions.

] [3.1.4 [Aluminum] [Steel] Poles

NOTE: Poles set in swampy or rocky soil will
require different settings or foundations than those
set in average bearing soils. Consult pole

manufacturer and structural engineer for proper
setting or foundation requirements for these and
other unusual soil conditions.

Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 1.57 rad (90 degrees) 90 degrees at the bottom end. Provide ornamental covers to match pole and galvanized nuts and washers for anchor bolts. Concrete for anchor bases, polyvinyl chloride (PVC) conduit ells, and ground rods shall be as specified in Section[16302N UNDERGROUND TRANSMISSION AND DISTRIBUTION][16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND]. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.[After installation, paint exposed surfaces of steel poles with two finish coats of[exterior oil paint of a color as indicated][aluminum paint].]

]3.1.5 Pole Setting

[Depth shall be as indicated.][Poles in straight runs shall be in a straight line. Dig holes large enough to permit the proper use of tampers to the full depth of the hole. Place backfill in the hole in 150 mm 6 inch maximum layers and thoroughly tamp. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.]

3.1.6 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations.[Mount switch on or beside each luminaire when switch is provided in cast weatherproof aluminum housing with swivel arm.][Set adjustable window slide for [_____] lux [_____] footcandles photocell turn-on.]

3.1.7 GROUNDING

Ground noncurrent-carrying parts of equipment including[metal poles,] luminaires, mounting arms, brackets, and metallic enclosures as specified in Section[16302N UNDERGROUND TRANSMISSION AND DISTRIBUTION][16375A ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND]. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

3.1.8 FIELD APPLIED PAINTING

NOTE: Use and coordinate paint and coating requirements with Section 09900, PAINTS AND COATINGS when provided in the job. When requirements are beyond what is specified in Section 09900, specify the requirements in this paragraph.

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09900 PAINTS AND COATINGS.

3.2 FIELD QUALITY CONTROL

Upon completion of installation, conduct an operating test to show that the

equipment operates in accordance with the requirements of this section.

-- End of Section --