

## SECTION 1100 MANUFACTURED MATERIAL

### SECTION 1101—HIGHWAY LIGHTING

**1101.01 GENERAL REQUIREMENTS**—Design, manufacture, and test lighting material and equipment according to the latest applicable standards of IEEE, [ASTM](#), NEMA, ANSI, and the currently adopted AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals” (AASHTO Specifications).

Fabricate highway lighting structural materials according to AWS, the AASHTO Specifications, and [Section 1105](#) (steel members only); except, applying water to the base metal is permitted for the air plasma arc cutting process. [Bulletin 15](#) listing, shop inspection, and AWS certified welding inspectors (CWI) are required for welded aluminum pole manufacturers and for welded steel pole manufacturers. [Bulletin 15](#), shop inspection, and [Section 1105](#) do not apply to cast aluminum poles, cast steel poles, cast iron poles, painting of aluminum poles, or poles without welds on any areas subject to tensile stress.

Design calculations are required for all poles. [Submit design calculations](#) and fatigue analysis within 60 days of contract award, or as directed. If the Bureau of Design has previously approved identical lighting material and equipment, submission of design calculations and fatigue analysis may not be required. Provide calculations signed and sealed by a Professional Engineer registered in Pennsylvania.

Provide steel poles that are fabricated from material conforming to the current AASHTO Specifications. The Charpy V-Notch toughness test is required for load carrying tension members 13 mm (1/2 inch) and greater in thickness, including base plates and arm connection plates, as required for Zone 2 in Table S1 of the applicable AASHTO Specifications. The Charpy V-Notch toughness test is not required for high mast handhole frames. Bend testing is required for material less than 13 mm (1/2 inch) in thickness.

Provide steel poles that are either round or multisided with a minimum of eight sides.

Use radiographic test methods when inspecting complete penetration welds on steel poles with material less than 8 mm (5/16 inch) in thickness, and use radiographic or ultrasonic test methods when inspecting complete penetration welds on steel poles with material 8 mm (5/16 inch) in thickness and greater. Perform and evaluate all non-destructive testing according to cyclically loaded, non-tubular tension criteria. Use radiographic, ultrasonic, or magnetic particle test methods when inspecting other welds on steel poles.

Provide aluminum poles that are round. Provide aluminum welds and aluminum welding material conforming to ANSI/AWS D1.2, Structural Welding Code for Aluminum. Use radiographic test methods when inspecting complete-penetration welds on aluminum poles. Use radiographic or dye penetrant test methods when inspecting other welds on aluminum poles.

Provide testing and test methods according to ANSI/AWS D1.1 (Steel) D1.2 (Aluminum) and as determined by the MTD. Contact the MTD to arrange for proper pole manufacturing inspection. Inspection will include 100% of the length of each complete penetration weld and a minimum of 25% of the length of each other weld. The portion of the other welds to be tested will be selected by the Department's agency inspector. Certify lighting poles, nuts, bolts, and associated hardware as specified in [Section 106.03\(b\)3](#), including Charpy V-Notch test results, bend test results, and weld inspection reports. Provide catalog cuts or shop drawings for approval, instead of certification, for all other highway lighting items. The Department may select test samples at the source of supply before shipping or at the project site after delivery.

Submit for approval, before purchase and at no expense to the Department, catalog cuts, drawings, and manufacturer's specifications for all lighting material including; lighting poles, luminaires, junction boxes, conduits, cables, and power supply components proposed for the project. Refer to the Project Office Manual for material information requirements.

Do not alter or modify any material unless authorized, in writing, by the manufacturer. Inform the Department of any alterations or modifications made outside of the manufacturer's facilities, and furnish proof of authorization from the manufacturer.

Provide poles, which are less than 21.3 m (70 feet) in height in two sections or less.

Provide poles, which are between 21.3 m and 30.5 m (70 feet and 100 feet) in height in three sections or less.

Provide poles, which are over 30.5 m (100 feet) in height in four sections or less.

Furnish minimum pole section lengths of 3.7 m (12 feet) for high-mast poles and 4.6 m (15 feet) for conventional

poles. Obtain approval to furnish shorter section lengths.

Provide all units of any one item; such as luminaires, lamps, cable, and poles; that are of similar type and from the same manufacturer unless approved as a substitute.

**1101.02 POLES AND BASES (CONVENTIONAL LIGHTING)**—Furnish Type A poles with non-breakaway bases or Type S poles with breakaway bases, as indicated, conforming to the details as shown on the [Standard Drawings](#), and as follows:

**(a) General.**

**1. Poles.**

- Manufacture shafts of steel or aluminum, with the shaft uniformly tapered approximately 12 mm/m (0.14 inch per foot). Fabricate multipiece shafts to allow field assembly by overlapping sections.
- Design for a recommended life of 25 years and use the Alternate Method for Wind Pressures contained in Appendix C of the AASHTO Specifications. Fatigue is not a required design element.
- Provide a handhole finished without rough edges and with a reinforcing frame and cover designed to maintain the required pole strength.
- Weld a 60 mm to 80 mm (2 3/8-inch to 3-inch) O.D. vertical tenon, fabricated from the same grade metal as the shaft, at the top of poles with post top luminaire mounting, and on the same axis as the pole.
- Compute the ice load on the luminaire using a surface area equal to six times the Actual Projected Area (APA).
- Design decorative light poles (with no significant arms) for a recommended life of 25 years. Use the Alternate Method for Wind Pressures contained in Appendix C of the AASHTO Specifications. For square cross section poles only, include a fatigue design which considers Vortex Shedding and Natural Wind Gusts per Table 11-1 for Fatigue Category III as found in the AASHTO Specifications.

Furnish poles capable of sustaining loadings as follows:

- Horizontal load of 2200 N (500 pounds) applied 460 mm (18 inches) from the shaft top in any direction with no failure of any component part. The shaft's deflection from vertical is limited to 7.5% of the shaft length.
- Horizontal load of 220 N (50 pounds) applied at the luminaire attachment point and normal to the pole bracket member plane, with a vertical load of 135 N (30 pounds) on the luminaire supporting arm. Rotation of individual sections of two-section poles is not allowed. The horizontal deflection is limited to 10% of the luminaire supporting arm's horizontal length.
- Vertical load of 440 N (100 pounds) applied at the luminaire attachment point. The vertical deflection is limited to 5.5% of the pole arm's horizontal length.
- Vertical load of 1100 N (250 pounds) applied at the luminaire attachment point. Collapse or rupture of any portion of the structure is not allowed.
- Pole arm and luminaire dead load. The deflection from vertical at the top of the pole is limited to 1% of the total shaft length. The pole deflection from vertical is defined as the horizontal distance between the pole top centerline, when the pole alone is installed plumb, and the pole top centerline, after the arm and luminaire combination are installed on the previously plumb pole, measured without

additional shaft adjustment.

## 2. Anchor Bases.

- Finish clean, smooth, and of the dimensions required for adequate pole mounting and structural support.
- Provide holes for anchor bolts.
- Telescope the base over the shaft and secure in place by electric arc welding at the pole bottom and at the top of the base plate.

**3. Anchor Bolt Covers.** Furnish a cover for each anchor bolt and use M6 x 1 (1/4-inch), stainless steel, Phillips-head, or hex-head screws.

**4. Frangible or Breakaway Bases.** Furnish breakaway supports, designed according to the AASHTO Specifications.

## (b) Steel Poles.

### 1. Shaft.

- Fabricate from material conforming to [ASTM A 595](#) and not less than 3.04 mm (No. 11 gage), or from hot-rolled, low carbon, high-strength steel conforming to the following requirements:

Minimum yield strength—345 MPa (50 kips per square inch)  
 Minimum ultimate tensile strength—448 MPa (65 kips per square inch)  
 Carbon content—0.15% min., 0.25% max.  
 Maximum phosphorus content—0.04%  
 Maximum sulfur content—0.05%  
 Maximum silicon content—0.05%

Do not use equivalent steel types unless approved.

- Form into a continuously tapered shaft with one automatic electric arc welded, longitudinal joint per piece.
- Do not use transverse intermediate welds.
- It is permitted, after forming and welding, to use longitudinal cold rolling with sufficient pressure to tighten the weld, form a round shaft, and to increase the metal's minimum yield strength to 345 MPa (50 kips per square inch).
- Grind or bevel longitudinal weld beads and mating edges of two-piece shafts to avoid binding during section assembly.
- Provide complete-penetration longitudinal welds in the slip-joint area (1.5 times the inside diameter of the exposed end of the female section) plus 150 mm (6 inches) beyond, for the female section only.
- Provide a grounding nut for a M14 x 2 (1/2-inch x 13 UNC) threaded bolt or stud, when applicable, on the inside of the shaft, accessible from the handhole.
- Poles octagonal in shape, with flat or fluted faces, may be substituted for round steel poles. Furnish octagonal poles at least equal to round poles in thickness of metal and strength of pole, and meeting the requirements for round poles.

- Provide tapped holes for attaching anchor bolt covers.

**2. Anchor Bases.** Fabricate one-piece bases of cast steel conforming to [ASTM A 27/A 27M](#), Grades 450-240 (Grade 65-35), or steel plate conforming to AASHTO M 270/M 270M ([ASTM A 709/A 709M](#)), Grade 250 (Grade 36).

**3. Finish.**

- Hot-dip galvanize the inside and outside surfaces of poles and bases as specified in [Section 1105.02\(s\)](#) ([ASTM A 123/A 123M](#)) after fabrication and before shipment.
- Clean the welds on poles by sandblasting or by an alternate, approved method before galvanizing.

**(c) Aluminum Poles.**

**1. Shaft.**

- Spin shafts to provide Alloy 6063-T6 according to the AASHTO Specifications.
- Provide a satin finish.
- Weld an aluminum grounding nut or lug for an M14 x 2 (1/2-inch x 13 UNC) threaded bolt or stud, when applicable, on the shaft inside, opposite the handhole.
- Furnish stainless steel hardware, unless otherwise directed.
- Provide poles with a J-Hook at the top of the shaft.

**2. Anchor Bases.** Fabricate one-piece bases of cast Aluminum Alloy SG70A-T6 (356-T6), [ASTM B 26/B-26M](#) or [ASTM B 108/B108M](#). Provide tapped holes for attaching anchor bolt covers.

**1101.03 POLE ARMS (CONVENTIONAL LIGHTING)**—Furnish steel bracket arms and connections conforming to the details shown on the [Standard Drawings](#), and furnish clamp connections for aluminum truss arms and poles, and as follows:

**(a) General.**

- Manufacture arms of steel or aluminum.
- Install the arm with a weather-resistant connection to the shaft, with a smooth raceway for wiring.
- Furnish arms of the same material as the pole.
- Provide ASTM A 325 connecting bolts as specified in [Section 1105.02\(d\)](#) for steel poles.

**(b) Bracket Type.**

- Furnish arm assemblies, consisting of an upper member and a lower member, rigidly secured by vertical struts (truss), or consisting of a cantilever-type arm (single member).
- Provide a fitting on the pole end of each type arm to allow the bracket-arm assembly to be secured to the pole.

**1. Truss Arms.**

**1.a Steel.** Fabricate arms to have a minimum diameter of 50 mm (2 inches). Finish as specified in [Section 1101.02\(b\)3](#).

**1.b Aluminum.** Fabricate upper and lower members using 50 mm (2-inch) or larger diameter aluminum pipe, or using a combination of pipe and elliptical sections. Provide Alloy 6063-T6 according to the AASHTO Specifications

## 2. Single-Member Arms.

**2.a Steel.** Fabricate arms to have the same taper and a minimum diameter of 50 mm (2 inches). Finish as specified in [Section 1101.02\(b\)3](#).

**2.b Aluminum.** Fabricate using 50 mm (2-inch) or larger diameter tapered aluminum tube or using tapered aluminum section, oval in shape, at the pole end and tapering to the luminaire end. Provide Alloy 6063-T6 according to AASHTO Specifications

### 1101.04 ANCHOR BOLTS, NUTS, AND WASHERS (CONVENTIONAL AND HIGH MAST LIGHTING)—

Provide a preassembled high mast, anchor bolt arrangement with six bolts per pole. Mark the anchor bolt assembly for matching with the corresponding high mast, pole base plate. Use an identification mark that will be visible after imbedment in concrete.

Furnish structural steel anchor bolts, hex-head bolts, nuts, and washers for conventional and high mast lighting conforming to [Section 1105.02\(c\)3](#), the following requirements, and as shown on the [Standard Drawings](#):

**(a) Hex Head Bolts.** Provide hot-dipped galvanized bolts conforming to [ASTM A 325](#) for anchor bolts with yield strength of 379 MPa (55 kips per square inch) and [ASTM A 354](#), Grade BC, for anchor bolts with yield strength of 724 MPa (105 kips per square inch).

**(b) Galvanizing.** As specified in [Section 1105.02\(s\)](#) and as follows:

Galvanize the top 300 mm (12 inches) minimum of anchor bolts and all associated hardware according to [ASTM A 153/A 153M](#), or another acceptable method which conforms to the thickness and adherence requirements of [ASTM A 153/A 153M](#). Brushing of the threaded area to remove excess zinc is allowed, as specified in the American Hot-Dip Galvanizers Association's recommended procedures for galvanizing of threaded parts.

**1101.05 POLES (HIGH MAST LIGHTING)—**Furnish poles conforming to the details shown on the [Standard Drawings](#), as specified in [Section 1101.01](#), and the following:

#### (a) General.

- Comply with the AASHTO Specifications. Design for a recommended life of 50 years. Use the Alternate Method for Wind Pressure contained in Appendix C of the AASHTO Specifications. Consider Vortex Shedding and Natural Wind Gusts per Table 11-1 for Fatigue Category I.
- Design poles to provide a maximum deflection equal to 15% of the shaft length.
- Design based on ten luminaires per pole with each luminaire exerting a downward force equal to 334 N (75 pounds) and having an Effective Projected Area (EPA) of 0.19 m<sup>2</sup> (2.0 square feet). Include EPA and downward force for the head frame assembly being used. Compute the ice load on the luminaire using a surface area equal to six times the APA.
- Fabricate pole shafts and base plates from high-strength, low-alloy structural steel conforming to AASHTO M 270/M 270M ([ASTM A 709 /A 709M](#)) Grade 345 (Grade 50 ). Do not use equivalent steel types unless approved.

- Galvanize poles and base plates as specified in [Section 1101.02\(b\)3](#).
- Grind or bevel mating edges of multi-section poles to avoid binding during section assembly.
- Do not use transverse welds.
- Provide base plates with a minimum thickness of 76 mm (3-inch) unless otherwise approved.
- Provide bottom shaft sections with an 8 mm (0.3125 inch) minimum thickness.
- Provide a complete joint penetration weld for the connection of the shaft to the base plate.
- Provide complete-penetration longitudinal welds in the slip-joint area (1.5 times the inside diameter of the exposed end of the female section) plus 150 mm (6 inches) beyond, for the female section only.
- Join each pole section by telescoping the individual sections. Overlap a minimum length of 1.5 times the inside diameter of the exposed end of the female section. Do not field weld.
- Mark corresponding pole sections for field mating and assembly.
- Mark the inner telescoping section to show the minimum required telescoping length.
- Clearly mark and identify each pole base plate for matching to the corresponding anchor bolt assembly, to ensure proper fit in the erection of each pole.
- Permanently inscribe each pole with manufacturing identification and reordering information, or show on a nameplate attached to the pole.
- Provide four-conductor copper 5.26 mm<sup>2</sup> (No. 10 AWG) minimum, 600 V, electrical cable, of the type and length required, with a watertight electrical plug and receptacle suitable for use.
- Provide a matching watertight power receptacle having sufficient cord length to be brought outside for energizing the lowered luminaire mounting ring and the electrical power drive.
- Provide a low resistance grounding lug at the top of the pole for grounding the lightning rod to the pole shaft.
- Provide stainless steel hardware; such as nuts, bolts, screws, and washers.

**(b) Head Frame Assembly.** Provide a head frame assembly with each high-mast pole, to support the luminaire ring with its required number of luminaires, and as follows:

- Mount pulleys and mechanisms on the head-frame assembly; cover with a protective non-corrosive housing.
- Make necessary cable openings as small as practical to prevent the entry of birds.
- Provide a housing that can be easily removed from the head-frame assembly for servicing of pulleys and other mechanisms.
- Provide a 610 mm (24-inch), nickel-tip copper lightning rod on each pole, extending not less than 500 mm (20 inches) above the head-frame cover and located on or near the pole centerline.
- Ground the lightning rod to a grounding lug at the pole top, using 53.4 mm<sup>2</sup> (No. 1/0 AWG) braided copper wire, adapters, and cable connectors. Provide a grounding lug furnished by the lightning rod manufacturer.

- Mount the lightning rod with brass or bronze hardware.
- Provide pulleys large enough to contain the various required cables, without exceeding the recommended bending radii.
- Fabricate pulleys of either cast steel with a nylon bushing or aluminum with a bronze bushing, both with a stainless-steel shaft Type 304, and both equipped with guards to prevent the cable from jumping off the pulley.
- Furnish a head frame that provides three-point suspension and positive centering and engagement between the mating parts of the head frame and the luminaire ring assembly.
- Hot-dip galvanize the head frame, after fabrication, as specified in [Section 1105.02\(s\)](#) ([ASTM A 123/A 123M](#)), or completely zinc-electroplate with an additional 0.13 mm (5-mil) minimum thickness of approved zinc-rich paint or an epoxy powder coating.

**(c) Latching.** Furnish each high mast pole assembly with either a latching device or two safety cables to secure the luminaire ring in the fully raised position after tension is removed from the winch hoist cable.

- If a latching device is furnished, the mechanism is required to release either automatically or by manual pull of a cable after the luminaire ring has been raised from the latching pins or fingers. Provide a mechanically operated indicator for each of the three luminaire ring latches to indicate positive latching at each point on the luminaire ring.
- If two safety cables are furnished, anchor the cables to the winch-mounting frame or to eyebolts embedded in the foundation. Attach the safety cables to the cable terminator securing the luminaire ring in the fully raised position removing tension from the winch hoist cable. Provide a mechanically operated indicator for each of the three cables to indicate a fully seated ring.

**(d) Luminaire Ring Assembly.**

- Equally space 50 mm (2-inch) luminaire tenons around the ring for the indicated number of luminaires.
- Hot-dip galvanize the entire luminaire ring assembly after fabrication as specified in [Section 1105.02\(s\)](#) ([ASTM A 123/A 123M](#)).
- Provide a weatherproof male plug wired to the terminal box, for energizing the luminaires in the servicing position.
- Provide a 30 A, four-wire type watertight plug to mate with the power receptacle.
- Provide a ring-mounted enclosure as specified in [Section 1101.11\(c\)](#) to house a terminal block, fuse block, and lightning arrester.
- Provide guide rollers or pads to cushion excess swing during raising and lowering operations.

**(e) Winch Assembly.** Provide a self-locking, permanently lubricated, worm gear winch assembly, enclosed within the pole mast, capable of raising and lowering the entire luminaire ring at a rate of approximately 76 mm/s (15 feet per minute) when driven by a portable winch drive. Provide a drive unit of a size and speed determined by the lifting and lowering force required, and the required raising and lowering speed, without exceeding 50% of the capacity of the worm gear assembly or the drive unit. Provide a winch that remains locked in any position to prevent the luminaire ring assembly from falling under its own gravitational force if the operator interrupts the raising or lowering operations. Provide a winch designed to ensure proper spooling of the cable upon the drum at all times.

**(f) Electrical Winch Drive.** Furnish, for each project, one portable, heavy-duty, industrial-rated, reversible, electrical winch drive as follows:

- Provide the drive with a torque limiter that causes drive slipping at a predetermined torque to prevent damage to the system.
- Provide sufficient length of cable and mating plug to directly utilize the power supply.
- Equip the drive to attach to the winch drive shaft and the pole so the drive is completely self-supporting.
- Furnish a drive that operates from a remote switch, with sufficient cable length so the operator can stand a safe distance outside the radius of the luminaire ring assembly.
- A 120 V drill motor and transformer may be provided instead of a 240 V drill motor. The maximum transformer mass (weight) allowed is 220 N (50 pounds). Provide a transformer enclosure, carrying handle, and connectors.

**(g) Hoist Cables.** Furnish hoist cables made from stainless-steel aircraft cable, conforming to Military Specification MIL-W-83420J.

- Attach the support cables to a self-leveling yoke, to which is attached the winch cable from the winch drum.
- Provide guide cables or other acceptable means to prevent cable entanglements in the pole shaft.

**(h) Miscellaneous Hardware.** Furnish miscellaneous hardware of stainless steel, [ASTM A 167](#), Type 304.

**1101.06 LUMINAIRES (CONVENTIONAL LIGHTING)**—Furnish luminaires complete including lamps, ballasts, decals, associated hardware, and necessary wiring.

**(a) General.**

- Furnish materials incorporating the latest available ratings and design improvements.
- Provide individual photoelectric cell control as specified in [Section 1101.11\(b\)](#), when indicated.
- Furnish luminaire certification of UL approval, as applicable.
- Furnish a sample luminaire for review and acceptance, if directed, when data is submitted for a product that has not previously been accepted by the Department.
- Furnish luminaire photometric data and ballast data with catalog cut information.
- Install glare shields, where indicated.
- Furnish clear high pressure sodium lamps. Provide lamps with a date marking code on the base. The nominal lamp voltage for less than 150 W is 55 V, and for 150 W and greater is 100 V.
- Provide luminaires with internal prewired ballasts, regulator or auto-regulator, capable of operating within  $\pm 10\%$  of the specified supply voltage. Furnish ballasts that provide dependable starting of the lamp at a temperature of  $-29\text{ }^{\circ}\text{C}$  ( $-20\text{ }^{\circ}\text{F}$ ), with a power factor of not less than 90%, and in compliance with the latest ANSI specifications.

**(b) Arm Mount Luminaires (Cobra Head).****1. Housings.**

- Provide a precision cast or formed housing of aluminum, with a refractor holder and an integral 50 mm (2-inch) slipfitter, capable of adapting to the mounting tenons.
- Provide a gasketed, thermal, shock-resistant glass prismatic refractor accurately molded to give the specified light distribution pattern, held in position in the lower housing with retaining clips.
- Provide a detachable reflector of processed aluminum, with a sealed anodic coating over an electrolytically or chemically brightened surface.
- Install the reflector with a gasket between it and the refractor, designed for easy removal from the housing. Silicone rubber gaskets are acceptable for luminaires up to and including 1000 W, and ethylene propylene (EPT or EPDM) gaskets are acceptable for luminaires up to and including 400 W. For Cobra head and other luminaires where the housing provides a drip-proof protection, refractor gaskets of high density, filtering type, non-wicking dacron polyester not less than 6 mm (1/4 inch) thick are also permitted. Die cut gaskets and overlay at joints.
- Include an adjustable mogul lamp socket.
- Furnish a luminaire capable of accommodating the appropriate lamps, properly positioned relative to the optical system. Provide a slip-fitter designed to prevent linear creep or rotation of the luminaire on the tenon.
- Provide a frame size for conventional High-Pressure Sodium Luminaires as follows, or equal:

Watts	American Electric	Cooper Lighting	General Electric	Hubbell
Less than 200	115	OVZ	M-250	RM 150
200, 250 & 400	125	OVF	M-400R	RL 400

- Provide luminaires with a maximum EPA of 0.14 m<sup>2</sup> (1.5 square feet), and a maximum mass (weight) of 25 kg (55 pounds).

**(c) Post Top Mount Luminaires (Offset).** Furnish as specified in the applicable requirements of [Section 1101.06\(b\)](#) and as follows:

- Furnish a precision cast aluminum housing, with a refractor holder.
- Provide a gasketed, thermal, shock-resistant glass prismatic refractor accurately molded to give the specified light distribution pattern, held in position in the lower housing with retaining clips.
- Join the upper and lower housings by stainless steel hinges and provide with twin trigger latches for access to internal components.
- Install gaskets at critical points to prevent entry of moisture and contaminants.
- Provide a detachable reflector, of processed aluminum, with a sealed anodic coating over an electrolytically or chemically brightened surface.
- Permanently attach the lamp socket to the reflector, to ensure correct lamp positioning. Provide the socket with a quick disconnect for easy removal of the reflector/socket assembly.

- Provide the luminaire with a slipfitter designed to accept a 60 mm to 80 mm (2 3/8-inch to 3-inch) O.D. vertical tenon for lateral orientation.
- Provide external adjustments for horizontal luminaire leveling.
- Provide infinite angular fixture adjustment in the vertical plane for proper luminaire aiming.

**(d) Wall Mount Luminaires (Underpass).** Furnish as specified in the applicable requirements of [Section 1101.06\(b\)](#) and as follows.

Furnish luminaires that provide total available downward street side lumens, between one mounting height and three mounting heights transverse distance, of not less than 20% of the bare lamp lumen output.

**(e) Overhead Mount Luminaires (Underpass).** Furnish as specified in the applicable requirement of [Section 1101.06\(b\)](#).

**1101.07 LUMINAIRES (HIGH-MAST LIGHTING)**—Furnish open-type, cutoff luminaires complete with lamps, ballasts, associated hardware, and necessary wiring as specified in the applicable parts of [Sections 1101.06\(a\)](#) and [\(b\)](#), and as follows:

- Provide with adjustable slipfitters designed for a 50 mm (2-inch) tenon to allow a positioning adjustment of  $\pm 3$  degrees about the tenon axis.
- Provide with a heavy-duty, porcelain-enclosed, lamp socket, with the brass shell impregnated to prevent thermal freezing with the lamp base.
- Provide a lamp-stabilizing clamp that is nonasbestos-lined, heat-resistant, and stainless steel.
- Equip luminaires with ballasts, as specified in [Section 1101.06\(a\)](#).
- Furnish 400 W, high-pressure sodium lamps with a minimum initial output rating of 50 000 lumen and a minimum rated life of 24 000 hours based on 10 hours of operation per start.
- Furnish lamps that burn in a vertical (base-up) position.
- Provide luminaires with a maximum luminous intensity angle nominally 60 to 65 degrees from nadir.
- Furnish luminaires having a projected area not exceeding 0.33 m<sup>2</sup> (3.5 square feet), an EPA not exceeding 0.19 m<sup>2</sup> (2.0 square feet), and exerting a gravitational force not more than 334 N (75 pounds).
- Provide glare shields, when indicated.
- Furnish luminaires that provide the following nominal initial luminous intensity at the angles shown:

Vertical Angle (degrees)	Luminous Intensity (candelas)
20	2850
30	4170
40	4760
50	7500
55	9550
60	12900
65	13800
70	9250*
72 1/2	7350*
75	4350*

\* These are minimum values at the respective angles. Other candelas are nominal values.

Furnish vertical luminous intensity trace data to ascertain compliance with luminous intensity distribution requirements.

**1101.08 CABLE**—Furnish cable as follows:

**(a) General.**

- Provide 600 V conductors with insulation, and jacket as applicable, conforming to ICEA S-95-658/NEMA WC-70, or provide bare conductors for ground wire.
- Provide color-coded cables. Color code by surface markings, pigmented insulation, or tape. If surface markings are used, place marks at intervals not exceeding 610 mm (24 inches), located so as not to conflict with the required NEC markings. Provide cable with surface markings, except as specified in [Section 1101.01](#). If taping is provided, overlap the tape for a minimum of 150 mm (6 inches) on the cable, at all access locations, and for each conductor.
- Conductors for all types of cables, including ground wire, as follows:

	Copper
Conductor	Soft Drawn <a href="#">ASTM B 3</a>
Stranding	<a href="#">ASTM B 8</a> 5.26 to 33.6 mm <sup>2</sup> (10-2): 7 Strand 42.4 to 107.2 mm <sup>2</sup> (1-4/0): 19 Strand

(b) **Underground Cable.** Furnish with insulation and jacket, as required, conforming to the following:  
**METRIC**

	Rubber-Neoprene	XLP
Insulation	<b>**SBR Rubber</b>  <b>***Ethylene Propylene (EP) Rubber</b>	<b>Cross-Linked</b>
	Thickness (mm) 3.30 - 5.26 mm <sup>2</sup> : 1.14 8.38 - 33.6 mm <sup>2</sup> : 1.52 42.4 - 107.2 mm <sup>2</sup> : 2.03	Thickness (mm) 3.30 - 5.26 mm <sup>2</sup> : 1.14 8.38 - 33.6 mm <sup>2</sup> : 1.52 42.4 - 107.2 mm <sup>2</sup> : 2.03
Jacket	<b>Neoprene</b> <a href="#">ASTM D 4247</a>  Thickness (mm) 3.30 - 33.6 mm <sup>2</sup> : 0.76 42.4 - 107.2 mm <sup>2</sup> : 1.14	None
Max. Normal Operating Temperature	<b>**75 °C</b> <b>***90 °C</b>	Wet: 75 °C Dry: 90 °C
Code	<b>**RHW</b> <b>***RHW, RHH, USE</b>	<b>RHW, RHH, USE</b>

**ENGLISH**

	Rubber-Neoprene	XLP
Insulation	<b>**SBR Rubber</b>  <b>***Ethylene Propylene (EP) Rubber</b>	<b>Cross-Linked</b>
	Thickness (in.) 12-10: 3/64 or 0.045 8-2: 4/64 or 0.060 1-4/0: 5/64 or 0.080	Thickness (in.) 12-10: 3/64 or 0.045 8-2: 4/64 or 0.060 1-4/0: 5/64 or 0.080
Jacket	<b>Neoprene</b> <a href="#">ASTM D 752</a>  Thickness (in.) 12-2: 2/64 or 0.030 1-4/0: 3/64 or 0.045	None
Max. Normal Operating Temperature	<b>**167F</b> <b>***194F</b>	Wet: 167F Dry: 194F
Code	<b>**RHW</b> <b>***RHW, RHH, USE</b>	<b>RHW, RHH, USE</b>

**(c) Aboveground Cable.** The cables specified for Underground applications may be used for above ground applications.

Furnish with PVC insulation without nylon jacket or thinner XLP-insulated, as applicable, and as follows:

#### METRIC

	PVC (Without Jacket)	XLP
Insulation	Thickness (mm) 3.30 - 5.26 mm <sup>2</sup> : 1.14 8.38 - 33.6 mm <sup>2</sup> : 1.52 42.4 - 107.2 mm <sup>2</sup> : 2.03	<b>Cross-Linked Polyethylene</b>  Thickness (mm) 3.30 - 5.26 mm <sup>2</sup> : 0.76 8.38 - 33.6 mm <sup>2</sup> : 1.14 42.4 - 107.2 mm <sup>2</sup> : 1.40
Jacket	None	None
Max. Normal Operating Temperature	Wet: 75 °C Dry: 90 °C	Wet: 75 °C Dry: 90 °C
Code	THW	XHHW

#### ENGLISH

	PVC (Without Jacket)	XLP
Insulation	Thickness (in.) 12-10: 3/64 or 0.045 8-2: 4/64 or 0.060 1-4/0: 5/64 or 0.080	<b>Cross-Linked Polyethylene</b>  Thickness (in.) 12-10: 0.030 8-2: 0.045 1-4/0: 0.055
Jacket	None	None
Max. Normal Operating Temperature	Wet: 167F Dry: 194F	Wet: 167F Dry: 194F
Code	THW	XHHW

**(d) Cable Duct.** When indicated, furnish cable, preinstalled in a polyethylene Schedule 40 plastic conduit conforming to Nema TC-7. Provide cable conductors and stranding, as specified for Underground Cable, with cable insulation RHW/RHH/USE, and with insulation thickness as specified above.

#### (e) Application, Testing, and Shipping.

- Utilize acceptable cable as follows:

With luminaires	90 °C (194F)
Other uses	75 °C (167F)

- Show the name of the manufacturer, conductor size in mm<sup>2</sup> (AWG or MCM), and cable voltage rating on the outer cable covering with the code clearly printed or molded on the sheath.

- Manufacture, inspect, and test cable, according to the latest issues of ICEA Publications.
- Submit certification of these tests identifying each cable reel with the test data supplied.
- Ship cable on reels, plainly and indelibly marked with the name of the manufacturer, gross, net and tare masses, size, type, voltage rating, and length of cable per reel.
- Ship on a reel having a minimum drum diameter not less than 14 times the nominal cable diameter.
- Seal cable ends against entrance of moisture.
- Provide a covering of heavy cardboard, burlap, or lagging to protect the cable during handling or shipping.

**1101.09 CONDUIT**—Furnish conduit and protective coating for conduit.

**(a) General.** Furnish PVC and fiberglass conduit, conduit fittings, and conduit elbows and expansion fittings from the same manufacturer. Provide expansion/deflection fittings required for structures as shown on Standard Drawing BC-721M (BC-721). Use cement labeled by or recommended by the conduit manufacturer.

If metal conduit bodies and fittings are specified and hot dipped galvanized parts are not available, apply two coats of zinc paint as specified in [Section 910.3\(r\)](#).

Provide manufactured sweep bends or as specified in [Section 910.3\(g\)](#).

**(b) Direct Burial.**

**1. Polyvinyl Chloride (PVC) Conduit.** Provide Schedule 40; 90 °C (194F), UL-listed conduit conforming to NEMA Standard TC-2 (EPC-40-PVC), with fittings conforming to NEMA Standard TC-3 (EPC-40-PVC).

**2. Fiberglass Reinforced Epoxy Conduit.** Provide UL-rated conduit conforming to NEMA Standard TC-14, Part B; and as follows:

- Filament wound
- Minimum glass content of 68%
- Minimum tensile strength of 76 MPa (11,000 pounds per square inch)
- Containing carbon black for ultra-violet protection.

**(c) Concrete Encased or Exposed.** Provide one of the following:

**1. Rigid Steel Conduit.** Hot-dipped galvanized, inside and outside; and conforming to ANSI C80.1 and Federal Specification WW-C-581E. Provide hot-dipped galvanized conduit bodies and fittings.

**2. Polyvinyl Chloride (PVC) Conduit.** As specified in [Section 1101.09\(b\)](#) for Direct Burial Conduit.

**3. Fiberglass Reinforced Epoxy Conduit.** As specified in [Section 1101.09\(b\)](#) for Direct Burial Conduit.

**(d) Conduit Sleeve – Jacked, Augered, or Bored Conduit.** Rigid steel conduit, as specified for concrete encased or exposed conduit.

**1101.10 JUNCTION BOXES AND BURIED CABLE AND CONDUIT MARKERS—**

**(a) Junction Boxes.** Furnish as shown on the [Standard Drawings](#) for the type indicated, and as follows:

- **Concrete Junction Boxes.** Provide cast-in-place boxes made from Class A cement concrete as specified in [Section 704](#); or provide precast boxes as specified in [Section 714](#). Provide frames as specified in [Section 605](#). Refer to [Standard Drawings](#) RC-81M and RC-82M for details of junction boxes JB-1, 2, 11, and 12.
- **Cast iron or Welded Steel Plate Junction Boxes.** Provide boxes as specified in [Section 605](#). Provide boxes hot-dipped galvanized as specified in [Section 1105.02\(s\)](#) ([ASTM A 123/A 123M](#)) after fabrication. Provide a cover with a closed cell neoprene gasket with screws to secure cover. Provide a factory installed grounding stud and hex nut in rear of the box, as applicable. Refer to Standard Drawing BC-721M for junction box JB-25 details.

**(b) Buried Cable and Conduit Markers.** Furnish cast-in-place or precast, Class A cement concrete markers as shown on the [Standard Drawings](#). Form letters and arrows by making depressions in the plastic concrete. Refer to [Standard Drawing RC-84M](#) for marker details.

**1101.11 POWER SUPPLY—**Furnish the power supply, consisting of:

**(a) Service Poles.**

- Conforming to ANSI specifications.
- Of Western Red Cedar, Southern Yellow Pine, or equal.
- Minimum size, as listed under Class 4.
- Minimum length of 9 m (30 feet).
- Impregnate with non-leaching, waterborne preservative Chromated Copper Arsenate (CCA), Type C, conforming to AWWA-P5, preservative applied in closed cylinder by pressure process according to AWWA-C4. Provide retention of CCA dry salts of 10 kg/m<sup>3</sup> (0.60 pounds per cubic foot) (Oxide basis). Approved trade names: Chrom-Ar-Cu; Osmose K-33C; Wolman CCA, and Wolmanac CCA. Include treatment certification with each shipment.

**(b) Photoelectric Control Device.**

- Photo cell of the cadmium-sulphide type with fail-safe in the “On” position.
- Weatherproof phenolic, cycolac, or acrylic plastic housing, not susceptible to distortion, discoloration, cracking, or crazing.
- Adaptable for pole-top or cross-arm mounting in a plug-in, locking-type receptacle, conforming to UL Specification 773.
- Rated 1,800 VA.
- Control unit, with a built-in surge protective device for protection from induced high voltage and follow-through currents, and having a turn-off time delay to prevent false turn-off, due to lightning, stray lighting, or flashing lights.

- Designed to operate at the required voltage, and to operate satisfactorily at -29 °C (-20F) ambient temperature, with performance characteristics equal to, or exceeding, EEI and NEMA standards.

A separate photoelectric cell conforming to the above requirements may be installed as an integral part of each luminaire assembly, as a substitute for the above, when indicated.

**(c) Control Cabinet (Enclosure).** As shown on the [Standard Drawings](#) and as follows:

**1. Cabinet Construction.** Conforming to one of the following:

- Code gage stainless steel, [ASTM A 167](#), Type 304.
- Code gage aluminum sheet alloy, No. 5052-H32, having mechanical properties of not less than [ASTM B 209/B 209M](#).

**2. Other Requirements.**

- NEMA 3R or 4.
- Having closed cell neoprene gasket, welded seams, continuous hinge with stainless steel pin, and stainless steel external hardware.
- Having a backboard for mounting apparatus.
- Having two weep holes in the bottom.
- Equipped for padlocking. Provide acceptable outdoor, tumbler-type padlocks, keyed as directed. Furnish two keys with each lock.
- Having manufacturer's nameplate.

**(d) Main Disconnect.** Two-pole, 10000 A.I.C. minimum, molded-case circuit breaker, with lugs and capacity to accommodate the specified conductors and current, and conforming to Federal Specification W-C-375b. If greater interrupting capacity is required by the local utility, the main disconnect may be a fused device.

**(e) Lightning Arrester.** Rated for an operating voltage of 650 V, rms, with a bracket for mounting on the control cabinet backboard.

**(f) Lighting Contactor.** Magnetic, 600 V, two-pole lighting contactor with coil and contacts rated as specified.

**(g) Selector Switch (for the Photoelectric Control Contactor).** Provide a 600 V, three position (automatic-off-manual), maintained-contact control station.

**(h) Distribution Circuit Breakers.**

- Minimum rating of 10000 A.I.C.
- No fuse, quick-make, quick-break type; having tumbler mechanism, full contact, and positive pressure until opening, whether operated automatically or manually.
- Stationary contacts as an integral breaker part and nonwelding contacts when operating.
- Trip free from handle so the contacts cannot be held closed against short circuit or abnormal overload.

- Mounted individually or in a panel.
- Handle position, indicating the breaker contact position.
- Size and capacity, as indicated

**(i) Circuit Breaker Panels.** Enclosure mounted panel with solid neutral; and with bus bars and solderless lugs of large enough rating and size to accommodate the required voltage, current, and conductors.

**(j) Ground Rod.** Copper-clad steel, UL listed. Provide with bronze clamp or exothermic weld for connection to grounding conductor.

**(k) Transformers (Less Than or Equal to 25 KVA).**

- Secondary windings for three-wire unbalanced circuits.
- Step-up or step-down as indicated.
- Copper or aluminum windings.
- Totally enclosed nonventilated outdoor type.
- Enclosure degreased, primed, and finished with a coat of outdoor enamel.
- Core and coil assembly encapsulated with an epoxy compound for transformers rated 25 KVA and less.
- Insulation of Class F material that does not exceed 115 °C (239F) raise above a 40 °C (104F) ambient, when tested according to ANSI and NEMA Standards.
- Terminal compartment located in the transformer bottom, with provisions for side or bottom, conduit entrance.
- Certified copy of results required for transformer temperature, performance, and sound tests, conforming to ANSI and NEMA Standards.

**(m) Guy Anchor Assembly.** Single down guy consisting of:

- A cone-type anchor having a diameter of not less than 300 mm (12 inches).
- A 20 mm (3/4-inch) thimble-eye, anchor rod.
- A 13 mm (1/2-inch), seven-strand, galvanized steel, guy wire.
- Three bolt, heavy-duty, guy clamps.
- A strain insulator.
- Strain and load plates on the pole.
- An angle thimble-eye through bolt of the required length.
- Curved washer and nuts.
- Hardware, galvanized as specified in [Section 1105.02\(s\) \(ASTM A 123/A 123M\)](#) or other acceptable method conforming to the thickness, adherence, and quality requirements of [ASTM A 153/A 153M](#).

**1101.12 MISCELLANEOUS MATERIAL**—Furnish as follows:

- (a) **Hardware** Stainless-steel or hot-dipped galvanized, as directed.
- (b) **Shims.** Stainless steel, nonmagnetic, 300 Series, or acceptable aluminum.
- (c) **Pulling Lubricant.** As recommended by the cable manufacturer.
- (d) **Cable Tags.** Acceptable, nonconducting.
- (e) **Plastic Marking Tape.** Provide one of the following or approved equal:
  - “Allen Marking Tape” (Allen Systems Inc.)
  - “Brady Identoline Tape” (W.H. Brady Co.)
  - “Terra Tape” (Reef Industries Inc.)
- (f) **Ground Rod.** As specified in [Section 1101.11\(j\)](#).