

SECTION 16525

HIGHWAY LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Materials and procedures for installing lighting for highway, understructure, sign, bridge, parking lot, and other lighting systems.

1.2 RELATED SECTIONS

- A. Section 00727: Control of Work
- B. Section 02741: Hot Mix Asphalt (HMA)
- C. Section 02842: Delineators
- D. Section 02892: Traffic Signal
- E. Section 03055: Portland Cement Concrete
- F. Section 03211: Reinforcing Steel and Welded Wire
- G. Section 03575: Flowable Fill
- H. Section 05210: Structural Steel
- I. Section 09972: Painting for Structural Steel
- J. Section 16135: Electrical Junction Boxes

1.3 REFERENCES

- A. AASHTO Standard Specification Structures Supports for Highway Signs, Luminaires, and Traffic Signals (current edition)
- B. AASHTO M 111: Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
- C. AASHTO M 183: Structural Steel

- D. American Wire Gauge
- E. American Iron & Steel Institute (AISI) Type 201: Stainless Steel
- F. ANSI/UL 467
- G. ANSI/UL 486A
- H. ANSI 136.10, NEMA Base
- I. ANSI C80
- J. ANSI C82.4, C82.6, and C92.1
- K. ANSI/IEEE C37.13. C37.27 and C62.41; Relays
- L. ANSI C57.12.25. and C57.27 NEMA 260 (Cabinet): Substation
- M. ANSI/UL 1029
- N. ASTM A 123 (Cabinet): Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- O. ASTM A 307: Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
- P. ASTM A 570, Grade 33: Steel, Sheet and Strip, Carbon Hot-Rolled Structural Quality
- Q. ASTM A 576: Steel Bars, Carbon, Hot Wrought, Special Quality
- R. ASTM B 3: Soft or Annealed Copper Wire
- S. ASTM B 8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- T. ASTM B 117: Operating Salt Spray (Fog) Apparatus
- U. ASTM B 209: Aluminum and Aluminum-Alloy Sheet and Plate (Alloy 5052-H38)
- V. ASTM B 766: Electrodeposited Coatings of Cadmium
- W. Insulated Power Cable Engineers Association (IPCEA) Standards

- X. ITE/ANSI Lamp Codes: I, M, H, and S
- Y. NEC 250-1
- Z. NEMA 3R K91, Type HD
- AA. NEMA 3R, Type 4
- BB. NEMA FAI 1973R1979: Understructure, sign bridge luminaire
- CC. NEMA TC-2/TC-3 UL Listed
- DD. NEMA WC7
- EE. NFPA 70: National Electric Code
- FF. Standard Specifications for Construction and Bridges on Federal Highway Projects FP-92 type III Flexible
- GG. UL: Underwriters' Laboratories, Inc
- HH. UL Class CC, RK5, R, and 1572
- II. UL E-50076

1.4 SUBMITTALS

- A. Samples of all materials.
- B. Wiring schematics, detailed shop drawings, and certifications within 15 calendar days after receiving the Notice to Proceed.
- C. Manufacturer's warranties, guarantees, instruction sheets, and parts lists.
- D. List of equipment and materials including name of manufacturer, size, and identification numbers. (Within calendar 15 days after receiving the Notice to Proceed).

1.5 QUALITY ASSURANCE

- A. Electrical components must conform to the requirements of the National Electrical Code. (NEC)

1.6 ACCEPTANCE

- A.. Lighting Warranties and Guarantees
1. The notice of acceptance for highway lighting work is not given until six months after the date of the inspection.
 2. During this period, all manufacturer's warranties and guarantees on Contractor- furnished electrical and mechanical equipment are enforced.
 3. At the end of the period and after all electrical and mechanical defects within the scope of warranties and guarantees are corrected, the Engineer makes written acceptance of the work completed and relieves the Contractor of further responsibility for that portion of the project.
 4. Partial acceptance does not void or alter any terms of the Contract
- B. The six-month warranty period for lighting does not affect the processing of a semi- final estimate when the Contract is 95 percent or more complete, or after completion of work on the project.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Wire and Cable: As per American Wire Gauge.
- B. Conductors:
1. Wire up to 600 V: Single-conductor, copper cable with cross-link polyethylene insulation per ASTM B3 and B8, RHH-USE-RHW, as specified.
 2. Cable above 600 V: Conform to NEMA WC7. Single-conductor, stranded copper with full concentric neutral as specified.
- C. Ground wire: Bare, soft-drawn copper wire per NEC 250-1, as specified.
- D. Ground Rod: Copper-coated steel per ANSI/UL 467, as specified.
- E. Insulation: RHH-USE-RHW grade cross link polyethylene compound.
- F. Splicing: Compression splice compatible with individual cable insulation and water seal for underground use. Comply with UL code.

- G. Conduit: as indicated.
 1. Schedule 40 PVC and 80 PVC conduit and fittings rated at 200 degrees F as specified. NEMA TC-2/TC-3 UL.
 2. Galvanized rigid steel conduit and fittings as specified. Meet ANSI C80.

2.2 JUNCTION BOXES

- A. Refer to Section 16135.

2.3 POWER CABLE ROUTE MARKER

- A. Meet ASTM B 29, alloy 5052-H38. 0.08 inch thick sheet aluminum as specified.
- B. White and red enamel paint: Refer to Section 09972.
- C. Mounting hardware: Refer to Section 05120.
- D. Flanged channel mount post: Refer to Section 02842.

2.4 SPLICE, MOLDED CONNECTOR, AND FUSE HOLDER

- A. Use individually insulated and water sealed compression splice.
- B. Use spring-loaded, molded connector and fuse holder with 90 percent minimum conductivity as per ANSI/UL 486A, as specified.

2.5 FUSE

- A. 600 V current limiting with 200,000 A interrupting rating. Meet UL Class CC.
- B. Light pole fuses with rating according to Table 1.

Table 1

Voltage	Wattage	Current (Amps)
120	250/400	20
208/240	250/400	15
277/480	250/400	10

- C. Lighting Circuit Fuses: Meet UL Class RK5, as specified.
- D. Service Disconnect Fuses: Meet UL Class R, as specified.

2.6 POLES - GENERAL

- A. Use tapered steel poles per Standard Drawings SL 14, SL 15 and SL 17, and AASHTO Standard Specifications Structural Supports for Highway Sign, Luminaires and Traffic Signals (current edition).
- B. Galvanized per ASTM A 123, as specified.
- C. Performance criteria:
 - 1. Wind load: 80 mph wind with 105 mph gusts.
 - 2. Designed for luminaire weight of 77 lbs with projected area of 3.0 ft².
 - 3. Maximum allowable deflection of 4-3/4 inch (Deflection criteria is based on a 100 lb horizontal load applied at 6 inches below shaft top).
- D. Pole designated for decorative lighting:
 - 1. Provide a festoon outlet located 16 ft from the base plate with duplex receptacle and weather-proof cover.
 - 2. As per UL Listed.
- E. Light Pole Numbers:
 - 1. 4 inch series C legend, green reflectorized sheeting as specified.
 - 2. Meet Standard Specification for Construction and Bridges on Federal Highway Projects, FP-92 type III Flexible.
- F. Foundation:
 - 1. Concrete: A(AE). Refer to Section 03055.
 - 2. Coated reinforcing steel. Refer to Section 03211.
 - 3. Anchor bolts: Galvanized steel per ASTM A 307 and ASTM A 123.

2.7 POLES - MOUNTING HEIGHT UNDER 45 FEET

- A. Allowable stresses for steel, as specified, except increased 40 percent for Group II and Group III loading. Meet ASTM A 570, Grade 33.
 - 1. $F_b = 21,750 \text{ psi } (0.66 F_y)$
 - 2. $F_v = 10,900 \text{ psi } (0.33 F_y)$
- B. Breakaway base: Standard Drawing SL 15.
- C. Steel Base Plate: Type NS.
- D. Anchor bolts:
 - 1. Meet ASTM A 307 and A 123.
 - 2. Minimum yield strength of 47,800 psi, as specified.

- E. Slip bolts:
 - 1. Cadmium-plated. Type NS.
 - 2. With nuts and washers.

2.8 POLES - MOUNTING HEIGHT OVER 45 FEET (HIGH MAST)

- A. Allowable steel stresses as specified. Meet ASTM A 570, Grade 33.
 - 1. $F_b = 21,750 \text{ psi } (0.66 F_y)$
 - 2. $F_v = 10,900 \text{ psi } (0.33 F_y)$
- B. Steel base-plate. ASTM A 570, Grade 36, as specified.
- C. Anchor bolts: Minimum yield strength of 55,000 psi as per ASTM A 576, as specified.
- D. High mast service hoist assembly:
 - 1. Head frame: zinc, electroplated with yellow chromatic dip after fabrication, and a head frame cover of spun aluminum, and with 6 each 5 inches cast aluminum hoist cable sheaves with oil-impregnated, sintered-bronze bushings with stainless steel shaft.
 - 2. Aircraft cables: 3 each stainless steel 1/4 inch x 3/4 inch strand (minimum 3/16 inch).
 - 3. Latch shaft, cam, and hardware: stainless steel.
 - 4. Luminaire support ring: minimum 7-gauge galvanized steel; rising rate of at least 12 ft/min.
 - 5. Power cable sheaves: minimum 6 inch diameter, brushed with oil-impregnated, sintered-bronze bushings with a stainless steel shaft.
 - 6. Centering arm: roller-contact, spring-loaded, water-resistant, non-marking roller on stainless steel shaft.
 - 7. Winch: worm-gear driven, self-locking, with reversing electric motor.
- E. Portable drive unit, UL Listed as heavy duty, reversing, with torque limiter, and 125 V transformer.

2.9 LUMINAIRE

- A. As specified, with die cast aluminum top housing, pre-wired integral ballasts with quick disconnect plugs mounted for ease of removal.
 - 1. Reflectors, sockets, mounting cradles, and clamps fitted to upper housing.
 - 2. Optical assembly: formed aluminum reflectors with a chemically bonded, non-breakable, glass finish.

3. Adjustable mogul base sockets: split-shell, tempered-brass, lamp grips, free-floating, spring-loaded, center contacts, and heat- and impact-resistant glass prismatic refractors.
 4. Weight: No more than 77 lbs with a projected area of not more than 3 ft².
 5. Mounting adjustment: Not less than 10 degrees above a horizontal position on reflector and refractor, and not less than 5 degrees of adjustment from a vertical position on the bracket arm.
 6. Glare shields: Steel or aluminum, when indicated on the plans.
- B. High mast luminaire: UL 1572, and as specified.
1. Symmetrical or asymmetrical with the asymmetrical capable of a 360 degrees rotation.
 2. Cast aluminum ballast, slipfitter mounts with adjustment of at least 3 degrees.
 3. Optical assembly: Enclosed and filtered, with heat and impact resistant tempered glass lens.
- C. Understructure luminaire: NEMA FA1-1973R1979, and as specified.
1. Specifically designed for understructure application.
 2. Die-cast aluminum housing, vandal-proof fastener, integral ballast.
 3. Optical assembly: heat- and impact-resistant, tempered glass lens, stainless steel lens guard.
 4. Adjustable sockets for minimum 60-degree beam angle.
- D. Sign bridge luminaire: NEMA FA1-1973R1979, and as specified.
1. Die-cast aluminum housing, die-cast aluminum door and integral glare shield, single piece, closed-cell gasket. Immunity to rain and snow damage.
 2. 1-3/16 inch conduit clamp support.
 3. Refractor: shock-and thermal-resistant, borosilicate, prismatic. Designed specifically for sign illumination.
 4. Integral ballast.

2.10 LUMINAIRE BALLASTS

- A. Meet ANSI C82.4, C82.6 and C92.1; and ANSI/UL 1029.
- B. High pressure sodium ballast.
1. Power Factor: must maintain 90 percent for nominal secondary load, and a least 70 percent for any 10 percent voltage variation.
 2. Lamp Wattage: maintain no more than 5 percent variation.
 3. Regulation: maintain no more than 35 percent for 10 percent line-voltage variation.

4. Must start and operate at the rated lamp wattage at ambient temperatures down to -40 degrees F for the rated life of the lamp.
 5. Must sustain lamp operation for a minimum of 4 seconds at a voltage dip of 35 percent.
- C. Mercury and Metal Halide Ballast.
1. Power Factor: minimum of 90 percent for a 10 percent voltage variation.
 2. Lamp Wattage: no more than 5 percent variation.
 3. Regulation: maintain no more than 30 percent for 10 percent line-voltage variation.
 4. Must start and operate at the rated lamp wattage at ambient temperatures down to -13 degrees F for the rated life of the lamp.
 5. Must sustain lamp operation for a minimum or 4 seconds at a voltage dip of 40 percent.

2.11 LAMP

- A. Heavy duty, long life incandescent (I) lamp, as specified. Meet ITE/ANSI lamp codes: I, M, H, and S.
- B. Phosphor-coated mercury (M) lamp that uses or has:
1. Apparent color temperature of 3300 K.
 2. CIE chromaticity of $X = 0.410$, $Y = 0.385$.
 3. Rated life of no less than 24,000 hours at 10 hours per start-up.
- C. Phosphor-coated metal halide (H) lamp that uses or has:
1. Correlated color temperature of 3800 K.
 2. CIE chromaticity of $X = 0.390$, $Y = 0.388$.
 3. Rated life of no less than 15,000 hours at 10 hours per start-up.
- D. Clear high pressure sodium (S) lamp that uses or has:
1. Apparent color temperature of 2100 K.
 2. CIE chromaticity of $X = 0.512$, $Y = 0.420$.
 3. Rated life of no less than 24,000 hours at 10 hours per start-up.

2.12 SERVICE DISCONNECT SWITCH

- A. Meet NEMA 3R K91, Type HD.
- B. 100 A Service disconnect switch with padlock, as specified.
- C. Circuit Breaker
1. 10,000 A interrupting rating for 240 V.

2. 5,000 A interrupting rating for 480 V.

2.13 CONTROL EQUIPMENT

- A. Photocell control units.
 1. Meet ANSI 136.10, NEMA Base.
 2. Solid state photo cells that match input voltage, minimum 1800 V@ capacity.
 3. Crystal sensing devices with inverted turn-on and turn-off features.
 4. Fail safe in the “on” position. Turns on at 32 Lx \pm 10 percent.
 5. Dedicated, inverted, control circuits with turn-off values of 19 lx \pm 25 percent.
 6. Time delay range of 5 seconds to 10 seconds.
 7. Minimum 236 ft/lb metal oxide varistor lighting arrestors.
 8. Secondary sensor diodes and transient filters.
 9. Flame-retardant, high-impact covers, and acrylic windows with ultra-violet stabilizers.
 10. Clip voltage at 400 V.
- B. Lighting contactor:
 1. Hermetically sealed, steel tube mercury contacts.
 2. Manually operated, mechanically held contact.
 3. Remote, or photoelectric-operated, magnetic, electrically held contactor.
 4. Three-position slide selector with “on-off-auto” switch.
- C. Control Relay: Meet ANSI/IEEE C37.13, C37.27 and C62.41.
 1. Contact rating of 3,000 W minimum.
 2. Normally open.
 3. Multiple relay: Zinc/di-chromate-plated magnet; Class B insulation rating coil; Cadmium oxide contact, dual expulsion gap lightning arrester; valve type line arrester with no less than 650 V rating.
- D. Enclosure: NEMA 3R Type 4. Encase in a cabinet with padlock as specified.
- E. Circuit breaker UL rated at:
 1. 240 V at 10,000 A interrupting rating.
 2. 480 V at 5,000 A interrupting rating.

2.14 SUBSTATION

- A. ANSI C57.12.25 and C57.27 NEMA 260 (cabinet) as specified.

- B. 480 V secondary power, IOCA oil coolant, 150 degrees F temperature rise, 60 Hz frequency, $\pm 2 \frac{1}{2}$ percent voltage compensation taps.
- C. Foundation: Follow Standard Drawing SL 16.

2.15 UNDERGROUND SERVICE PEDESTAL

- A. Meet ASTM B 117, A 123 (cabinet), UL E-50076 as specified.
- B. Galvanized Steel: Enclosure 0.12 inch, covers 0.08 inch. Meet ASTM A 123.
- C. Bottom access opening; detachable, pad mount base; baffled ventilation louver.
- D. Paint: Meet ASTM B 117. Environmental green, baked enamel over zinc-chromate primer as specified.
- E. Circuit Breaker: Main, with six space metered bus and six space unmetered bus.
- F. Meter socket with safety socket test blocks.

2.16 CONCRETE

- A. Concrete: Class A(AE) per Section 03055.
- B. Asphalt Concrete: Refer to Section 02741.
- C. Flowable Fill: Refer to Section 03575.

2.17 HARDWARE

- A. Screws: Stainless steel.
- B. Nuts, bolts, and washers:
 - 1. Galvanized: ASTM A 123.
 - 2. Cadmium-plated: ASTM A 165.
 - 3. Type NS, as specified.
- C. Mounting bands and buckles: stainless steel, 3/4 inch wide, from 0.020 inch to 0.022 inches thick meeting AISI, Type 201.
- D. Padlock: Master, No. P-848.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate utility locations. Refer to Section 00727, article, "Cooperation with Utilities."
 - 1. Contact the appropriate power company at least 30 days before the desired connection date.
 - 2. Verify the exact location, voltage, procedures, and material required by the appropriate power company.
- B. Saw cut concrete or other improved surface that requires removal in the sidewalk area. Replace with in-kind material to match the existing grade.
- C. Load, transport and install State-furnished material.

3.2 POLE FOUNDATION

- A. Construct foundation following Standard Drawings SL 14 and SL 17.
- B. Do not weld reinforcing steel, conduit, or anchor bolts.
- C. Tie reinforcing steel and conduit securely in place.
- D. Place the concrete directly into the excavation. Use minimum forming.
- E. Align and secure anchor bolts or extensions with a template.

3.3 CONDUIT TRENCHING

- A. Refer to Section 02892, Part 3, article, "Trench for Conduit."
- B. Conduit offset from roadway by more than 20 ft may be installed by plowing.
- C. Installing high voltage power cable (exceeding 600 V);
 - 1. Trench should be no more than 18 inches wide and at least 3 ft deep.
 - 2. Place 3 inches of sand in the bottom of trench before installing cable.
 - 3. Cover the power cables with at least 6 inches of sand.

3.4 INSTALL CONDUIT

- A. Refer to Section 02892, Part 3, article, "Install Conduit."

3.5 INSTALL WIRING

- A. Refer to Section 02892, Part 3, article, "Install Wiring," paragraphs A-E.
- B. Install molded connectors on the cable so that the load side retains the fuse when it is disconnected at the cable's breakaway point.
- C. When splicing, use compression or split bolt, and waterproof as specified, meeting UL Listed.
- D. When using 600 V or higher power cable:
 - 1. Provide a manufacturer's certified plot of X.Y. partial discharge.
 - 2. Perform a high-voltage DC field test per the industry standard before connecting to the high voltage power source.
 - 3. Must meet Insulated Power Cable Engineers Association (IPCEA) standards.

3.6 INSTALL CONDUCTOR

- A. Install wiring in accordance with the appropriate articles of NFPA 70. Neatly arrange wiring within cabinets, junction boxes, etc.

3.7 INSTALL LUMINAIRES AND BALLASTS

- A. Immediately prior to installation, clean all light control surfaces, refractors, and reflectors to provide the maximum lumen output possible. Clean in accordance with the luminaire manufacturer's recommendations.
- B. Adjust luminaires with a level.
- C. Adjust sign bridge luminaires for optimum and uniform light distribution.
- D. High mast luminaire:
 - 1. Employ a representative from the luminaire company to optimize the light pattern.
 - 2. Obtain manufacturer's certification that the service hoist operation is correctly installed.

3.8 INSTALL POWER SOURCE CONNECTION

- A. Install the grounded neutral conductor from secondary power source to the switch box.

- B. Install mounting bracket within 1 ft of both top and bottom of the switch box and within 3 ft of other cabinet or fitting.
- C. Provide and install material required by the appropriate power company.
- D. Install padlock on the switch box door and handle.

3.9 INSTALL SUBSTATION

- A. Follow Standard Drawing SL 16.
- B. Locate foundation in a well-drained area.
- C. Dig a trench and backfill for the primary power cable.
- D. Install padlocks on doors.

3.10 PHOTO-ELECTRIC CONTROL

- A. Adjust to “North Sky” position.

3.11 POLE

- A. Follow Standard Drawings SL 14, SL 17, and SL 18.
- B. Center the shaft top over the center of the foundation after the arm extension, luminaire, and all accessories are in place or per the manufacturer’s requirements.
- C. Install pole identification numbers at a 45 degree angle to approaching traffic. Remove old identification numbers without damage to galvanizing.
- D. Torque:
 - 1. Anchor bolts to 11 lb/ft.
 - 2. Slip bolts to 8 lb/ft, release, and re-torque to 6 lb/ft.
- E. When installing items on a pole:
 - 1. Do not drill steel pole.
 - 2. Use stainless steel mounting bands.

3.12 FIELD QUALITY CONTROL (ACCEPTANCE TESTS)

- A. Continuity of grounding conductor to maintain 1,000 watt load at circuit ends, maintaining 95 percent of supply voltage.

- B. Test for grounds in each circuit.
- C. Insulation resistance of supply conductor to ground shall be no less than 40 MΩ (500 V megger meter test).

3.13 SALVAGE

- A. Remove equipment to be reused or salvaged carefully so that it remains in the condition existing prior to its removal.
- B. Pole assembly remains the property of the Department. Transport to the location specified.
- C. Remove luminaire, arm, and conductor.
 - 1. Grease and reinstall fastener.
 - 2. Remove foundation to a depth of 6 inches below the existing surface and backfill with local material.
 - 3. Dispose of discarded junction box. Backfill with local material and compact to match adjacent area.

END OF SECTION

Change One
Revised August 29, 2002
Articles Revised
1.6 A, B