

SECTION 16521 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Exterior luminaires with lamps and ballasts, but not mounted on exterior surfaces of buildings.
2. Luminaire-mounted photoelectric switches.

B. Related Sections include the following:

1. Division 2 Section "Lighting Poles and Standards" for poles and other support structures and for requirements of resistance to wind and ice loads.
2. Division 16 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.2 DEFINITIONS

- A. CRI: Color-rendering index.
- B. HID: High-intensity discharge.
- C. Luminaire: Complete lighting fixture, including ballast housing if provided.
- D. Pole: Luminaire support structure, including tower used for large area illumination.
- E. Standard: Same definition as "Pole" above.

1.3 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.
- B. Live Load: Single load of 500 lbf (2224 N), distributed as stated in AASHTO LTS-4.
- C. Ice Load: Load of 3 lbf/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-4.
- D. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4 and as determined by analysis of local conditions.

1.4 SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.

2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
 - a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
6. Photoelectric relays.
7. Ballasts, including energy-efficiency data.
8. Lamps, including life, output, and energy-efficiency data.
9. Materials, dimensions, and finishes of poles.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Anchor bolts for poles.
12. Manufactured pole foundations.

B. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.
3. Wiring Diagrams: Power and control wiring.

C. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For luminaires poles and luminaire lowering devices to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

C. Comply with IEEE C2, "National Electrical Safety Code."

- D. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate exterior luminaires with mounting and wind load requirements in Division 2 Section "Lighting Poles and Standards."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace luminaires or components of luminaires and lamps that fail in materials or workmanship; corrode; or fade, stain, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
 - a. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
 - b. Warranty Period for Color Retention: Five years from date of Substantial Completion.
 - 2. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Ballasts: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 LUMINAIRES, GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind

welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected from manufacturer's standard catalog of colors.

N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

2.2 FLUORESCENT BALLASTS AND LAMPS

A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures minus 20 deg F (minus 29 deg C) and higher.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
3. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
4. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures minus 20 deg F (minus 29 deg C) and higher.

D. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

E. Compact Fluorescent Lamps: CRI 80 (minimum), color temperature 3500 K, averaged rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated.

1. T4, Double-Twin Tube: Rated 18 W, 1200 initial lumens (minimum).
2. T4, Double-Twin Tube: Rated 26 W, 1800 initial lumens (minimum).

2.3 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS

A. General: Comply with NEMA C82.4 and UL 1029. Shall include the following features, unless otherwise indicated:

1. Type: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 30 deg C for single-lamp ballasts.
3. Normal Ambient Operating Temperature: 50 deg C.

4. Open-circuit operation will not reduce average life.
 5. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.
- B. Auxiliary, Instant-On, Quartz System: Automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when high-intensity-discharge lamp reaches approximately 60 percent light output.
- C. High-Pressure-Sodium Ballasts: Solid-state igniter/starter with an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.
1. Instant Restrike Device: Solid-state potted module, mounted inside high-pressure-sodium fixture and compatible with high-pressure-sodium lamps, ballasts, and sockets up to 150 W.
 - a. Restrike Range: 200 to 260 V ac.
 - b. Maximum Voltage: 440 V peak or 260 V ac RMS.
 2. Single-Lamp Ballasts: Minimum starting temperature of minus 50 deg C.
 3. Open-circuit operation will not reduce average life.

2.4 HID LAMPS

- A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900 K, and average rated life of 24,000 hours, minimum.
1. Dual-Arc Tube Lamp: Arranged so only one of two arc tubes is lighted at one time and, when power is restored after an outage, the cooler arc tube, with lower internal pressure, lights instantly, providing an immediate 8 to 15 percent of normal light output.
- B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.

2.5 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Use steel or aluminum poles. Wood poles are not acceptable.
- B. Structural Characteristics: Comply with AASHTO LTS-4.
1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- C. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.
- D. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
 3. Anchor-Bolt Template: Plywood or steel.
- E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

2.6 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.
1. Shape: Round, tapered .
 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- B. Steel Mast Arms: [**Single-arm**] [**Truss**] [**Davit**] type, continuously welded to pole attachment plate. Material and finish same as pole.
- C. Brackets for Luminaires: Detachable, cantilever, without underbrace.
1. Adapter fitting welded to pole and bracket, then bolted together with stainless -steel bolts.
 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
 3. Match pole material and finish.
- D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch (381-mm) vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet (3 m) above finished grade.
- F. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch (76-by-127-mm) handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.
- G. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 16 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.
- H. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.
- I. Platform for Lamp and Ballast Servicing: Factory fabricated of steel with finish matching that of pole.

- J. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
 3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: **[As indicated by manufacturer's designations] [Match Contracting Agent's sample] [As selected by Contracting Agent from manufacturer's full range].**

2.7 POLE ACCESSORIES

- A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 16 Section "Wiring Devices" for ground-fault circuit-interrupter type.
1. **[Surface mounted] [Recessed], [12 inches (300 mm)]** above finished grade.
 2. Nonmetallic polycarbonate plastic or reinforced fiberglass cover, that when mounted results in NEMA 250, Type **[3R] [4X]** enclosure.
 3. With cord opening.
 4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.
- B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.
- C. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.
- D. Transformer Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and accept **[ballast(s)] [indicated accessories]**.

2.8 LOWERING SYSTEM FOR LUMINAIRES

- A. Arrange system to lower luminaire assembly to a servicing position within 36 inches (900 mm) of finished grade in winds up to 30 mph (49 km/h) and to provide for manual plug connection to electrical power in the lowered position for testing.
- B. Coordinate with luminaire and pole manufacturers for assembly details, wind-load and vibration analysis, and compatibility of materials for electrolysis-free attachment and connection for luminaire mounting assembly, lowering device, lowering cable, and portable winch.
- C. Structural and Mechanical Design: Use a minimum safety factor of 5.0 for static and dynamic loads of load-bearing components, including cable.

- D. Luminaire Mounting and Disconnect Arrangement: Multiple [**ring**] [**carriage**]-mounted luminaires, arranged for lowering and raising as a group.
 - 1. Electrical cable for normal operating power to luminaires manually disconnects inside pole base, using weatherproof multipin connector, and shall be arranged to move within the pole during lowering and raising of luminaire assembly.
 - 2. Electrical cable for normal operating power to luminaires automatically disconnects at a weatherproof multipin connector within the pole-top lowering head at the beginning of the lowering cycle and reconnects when luminaire or luminaire assembly is raised to the operating position.
- E. Lowering Device: Weatherproof, cast-aluminum housing and multiple mechanical latches. Moving parts of latching assembly shall be located in the portion of the unit that is lowered to the servicing position. Positive latching in the operating position shall be indicated to the operator at the base of the pole by a clear visual signal, or by other means acceptable to Government or authorities having jurisdiction.
- F. Lowering Cable: Zinc-electroplated- or stainless-steel aircraft cable.
- G. Portable Winch: [**Manual**] [**120 V electric**] type. One required.
 - 1. Winch Power Connection: Cord and plug.
 - 2. Winch Raise-Lower Control: Remote-control station with 15 feet (5 m) of cable.
- H. Winch Transformer: Portable, totally enclosed, encapsulated, single-phase, dry type. Primary rated at lighting-circuit voltage; secondary rated at 120 V. Permanent, primary and secondary, twist-locking plug connectors on pigtails shall match pole-base power outlet and winch plug.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.2 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
3. Trees: 15 feet (5 m).

- C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- D. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.
- E. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

- A. Align units for optimum directional alignment of light distribution.
- B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 3 Section "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Division 16 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING

- A. Ground metal poles and support structures according to Division 16 Section "Grounding and Bonding."
1. Install grounding electrode for each pole, unless otherwise indicated.
 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 16 Section "Grounding and Bonding."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundations.

3.7 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.8 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 1. Verify operation of photoelectric controls.
- C. Illumination Tests:
 1. The U.S. Government will conduct light intensity tests using the following IESNA testing guides. Photometers, with calibration referenced to NIST, will be used.
 - a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting."
 - b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
 - c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
 - d. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - e. IESNA LM-72, "Directional Positioning of Photometric Data."
- D. The U.S. Government will prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. The Contractor will make needed adjustments. If adjustments are made to lighting system, the U.S. Government will retest to demonstrate compliance with standards.

END OF SECTION 16521