Section 2522. Tower Lighting

2522.01 DESCRIPTION.

A. This specification is for fabrication and construction of tower lighting systems, consisting of footings, towers, luminaires, and associated appurtenant items required by the contract documents. Apply Section 2523 to other components of this system.

B. Each individual installation consists of:
- A reinforced concrete footing,
- A tubular steel tower of circular or other approved cross-section of the length indicated in the contract documents,
- Approved luminaires of the proper number,
- An approved lowering device, and
- The electrical system described in the contract documents.

2522.02 MATERIALS.

A. Submit copies of the following to the Office of Materials for review for compliance before these materials are shipped to the project:
- A certified mill analysis for each heat of steel used in the pole and pole assembly, and
- Certified test results for support cables.

B. Refer to Article 2522.03, D for welding requirements.

C. Notify the Office of Materials of the shop fabrication schedule.

D. Verify one copy of a mill certification accompanies each shipment to the project and two copies are sent to the Office of Materials to:
- Identify materials included in each shipment, and
- Ensure that materials and fabricated materials may be used in the work promptly after delivery.

E. Final approval of all materials and fabricated materials will be based on:
- A certification that methods and materials used in fabrication comply with the contract documents,
- Satisfactory reports from random monitoring inspections performed during fabrication, and
- Verification of satisfactory compliance at the time of final inspection of the construction site.

2522.03 CONSTRUCTION.

A. Shop Drawings.

1. Submit drawings according to Article 1105.03.

a. Tower lighting equipment (if applicable):

1) Tower design data.

2) Lowering device, showing wiring diagram and materials.

3) Luminaires, including photometric data.

b. Additional drawings may be required on a project specific basis according to the contract documents.

2. Along with the shop drawings, include a statement that methods and materials to be used in fabrication comply with the contract documents. Note and identify all materials or methods for which specific requirements have not been previously stipulated.

3. Provide the Engineer with an appropriate certification of compliance with all design requirements. Along with the certification, include copies of all calculations necessary for proper design of the tower shaft and component features of the tower assembly.

4. Have a Professional Engineer licensed in the State of Iowa perform the structural design. The Contractor's certification is to appear on the drawings. Provide the Engineer with the base shear, base moments, and vertical loads on the bottom of the base plate.

5. Obtain the Engineer's written concurrence for the various items involved prior to fabricating or assembling parts.

B. Footings.

1. Construct footings as required in the contract documents at the specified locations. Unless specifically stated otherwise, construct footings using methods and materials complying with current specifications.

2. Place anchor bolts according to Article 2405.03, H, 3. Place conduit and all other appurtenant or optional features of the footing as shown in the contract documents.

C. Transporting Towers.

1. When transporting towers over the highways of the State of Iowa, comply with all applicable laws, rules, and regulations governing such movements. Obtain all required permits for such movements.

2. Limit the overall length of the hauling unit and tower to 120 feet (35 m) or less.

D. Welding.

1. Weld and fabricate steel structures according to Article 2408.03, B except that gas, metal arc, and flux cored arc welding processes will be permitted.

2. A list of approved brands of electrodes may be obtained from the Office of Materials.

3. Examine all fillet welds accessible for inspection using magnetic particle inspection according to ASTM E 709 (at no additional cost to the Contracting Authority).

4. Use ultrasonic inspection, according to the requirements of Article 2408.03, B, to perform a 100% examination of all transverse butt welds and all specified 100% penetration longitudinal butt welds on the pole. Perform a 100% visual inspection of all longitudinal butt welds. Supplement the visual inspection with magnetic particle inspection on all areas of questionable visual results. If defects are found in the area tested, perform additional inspection for a minimum of 5 feet (1.5 m) on each side of the defect (at no additional cost to the Contracting Authority). The cost of these inspections is incidental to other items in the contract.

E. Lighting Tower.

Ensure the structural design of the tower and its appurtenances meet the requirements of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals," with the following clarifications:

1. **Wind Velocity.**
   Use a design wind velocity (V) of 90 mph (145 km/h).

2. **Total Wind Force.**
   Calculate the total wind force on luminaires on the basis of the sum of projected areas for each individual luminaire. Base the projected area of individual luminaires on manufacturer's recommendations.

3. **Steel Tubular Shape.**
   Use a compact section.

4. **Anchor Bolts, Washers, and Nuts.**
   Ensure galvanizing for anchor bolts, washers, and nuts meets the requirements of ASTM F 2329; or ASTM B 695, Class 50, Type I Coating.
   - **a.** Furnish each anchor bolt with one leveling nut and two anchoring nuts. Use anchor bolts that:
     - Meet the requirements of ASTM F 1554, Grade 105 (724 MPa),
     - Are full-length galvanized,
     - Are high-strength low alloy steel, and
     - Unless specified otherwise, are Unified Coarse Thread Series with Class 2A tolerance.
   - **b.** Color code, in red, the end of each anchor bolt intended to project from the concrete to identify the grade.
   - **c.** Use galvanized washers that meet the requirements of ASTM F 436.
   - **d.** Use heavy hex, galvanized nuts that meet the requirements of ASTM A 563, DH. Nuts may be over-tapped according to the allowance requirements of ASTM A 563.

5. Pole Base.

a. Use a solid plate. Keep the holes cut out in the base plate for utility lines to a minimum, subject to the Engineer's approval.

b. Design the pole base and anchor bolt system to resist both tension and compression resulting from bending moments and direct loads.

6. Poles.

The poles may be furnished in single welded units or in telescoping sections.

a. Single Welded Units.

1) Fabricating the tower by welding two or more shaft sections together is permitted. If the pole sections are welded together, butt weld all transverse pole splices with full penetration welds.

2) Use a method for connecting the sections that results in a smooth joint with no projections on the exterior of the shaft.

3) Unless specifically authorized otherwise, all welded connections of shaft sections are to be made in the fabricator's shop.

4) If hauling length restrictions do not allow the tower shaft to be shop fabricated in one piece, furnish a telescoped pole.

b. Telescoping Sections.

1) If the pole sections are telescoped together, ensure the overlapped splices:

- Are equal in strength and rigidity to that of welded splices, and
- Do not exceed four sections for poles up to and including 120 feet (35 m) in length and do not exceed five sections for poles between 120 feet (35 m) and 160 feet (50 m) in length.

2) Ensure the telescoping sections overlap a length which is the larger of the following, and the overlap has full contact between faying surfaces:

- 2 feet (0.6 m), or
- 1.5 times the nominal diameter of the shaft at the splice level.

3) Ensure pole sections to be telescoped together are factory test fit to verify straightness of the pole and accuracy of the mating surfaces. Ensure the sections are match marked for accurate field assembly. In the field, mechanically fit the telescoping sections using factory supplied equipment. Submit field assembly procedures for the Engineer's review and concurrence.

7. Longitudinal Seam Welds.

a. Minimum 60% penetration, except for the following areas where complete penetration welds are required:

1) Within 6 inches (150 mm) of circumferential welds which are complete penetration butt welds.

2) For a distance of the nominal splice length plus 6 inches (150 mm) on both sections of telescopic (slip type) field splices of high level lighting (pole type) supports.

b. When designated in the contract documents:
- Radiographically inspect 100% of the full penetration sections of longitudinal seam weld, and
- Use the magnetic particle method to inspect a random 10% of the partial penetration section of the longitudinal seam welds.

8. Poles with Welded Transverse Splices.
Bevel all backing plates for transverse welds.

9. Poles with Telescoped Lab Joints.
Bevel the lower section of the joint. The beveling is required to prevent possible interference with the operation of the lowering device.

10. Hand Hole.
a. Ensure the pole provides an opening for a minimum 10 inch by 30 inch (250 mm by 750 mm) handhole to allow for servicing and maintenance of the lowering devices. Ensure the handhole is reinforced to maintain the design strength of the pole.
b. Install a neoprene or rubber gasket to make the handhole weatherproof. Obtain the Engineer's acceptance for the gasket prior to installation. Foam adhesive-back rubber gaskets are unacceptable.
c. Ensure the door is hinged and is fabricated from the same type of steel as the poles. Ensure the securing hardware is stainless steel and provisions have been made to allow for the door to be bolted securely shut.

11. Pole Base Plate.
a. Prior to welding, ultrasonically test the pole base plate using a Straight Beam Search Unit, meeting requirements of the current AWS D1.1, Structural Welding Code, to determine the extent of laminar type discontinuities in the plate.
b. After welding the pole to the base plate, use the same ultrasonic testing described above to ensure there are no laminar tears in the base plate.

12. Shaft, Base Plate, and Integral Shaft.
a. Ensure the shaft, base plate, and integral shaft components are fabricated with steel meeting the requirements of ASTM A 709 Grade 50 (345 MPa), with a minimum yield strength of 50,000 psi (345 MPa). All steel required to be ASTM A 709 Grade 50 (345 MPa) shall meet impact requirements specified for main members in Article 4152.02. If the Engineer approves, certain components of the tower assembly may be fabricated from steel meeting requirements of ASTM A 709 Grade 36 (250 MPa).
b. Ensure that after fabrication pole shafts, anchor bolts, base plate, washers, nuts, and all steel items are:
- Fully galvanized inside and outside according to ASTM A 123 or ASTM A 153 as appropriate, and
- Are of uniform color and appearance.

F. Tower Lighting Luminaire.
Meet the following provisions:

1. **Luminaire Assembly.**
   Rain tight aluminum housing and slipfitter with an internally mounted ballast designed for operation with the specified lamp.

2. **Optical System (when required).**
   Specular aluminum or prismatic glass reflector and a prismatic glass refractor or a clear lens.

3. **Luminaires with open bottom optical systems.**
   Prismatic glass reflectors and refractors.

4. **Luminaires with horizontal burning lamps**
   Totally enclosed optical systems with prismatic glass refractors.

5. **Specular aluminum reflectors.**
   Protective coating of oxide applied by the anodic oxidation process. The manufacturer's certification that the coating is not less than 6 milligrams per square inch (0.01 mg/mm^2) and that the reflectivity of the specular surface is not less than 82% is required.

6. **Lamp Socket.**
   Mogul multiple and porcelain enclosed. Lamp gripping device for vertical burning lamp sockets.

7. **Glassware.**
   Annealed, thermal-shock-resisting, borosilicate glass.

8. **Slipfitter.**
   Accommodate a standard two-inch (50 mm) pipe bracket and provide for leveling of the luminaire.

9. **Light source.**
   High pressure sodium lamp of the size shown in the contract documents.

10. **Ballast.**
    Regulated high-power-factor type with starting current lower than operating current. Maintains lamp wattage within ± 10% with a line voltage regulation of ± 10%, with no less than 90% power factor.

G. Luminaire Lowering Device.
Consists of a luminaire frame and head frame, support cables, winch, and electrical cable, along with associated appurtenant devices. Ensure the lowering device properly lowers the luminaires to a position within 5 feet (1.5 m) of the ground for maintenance, and maintains their alignment when raised to the operational position.

1. **Luminaire Frame and Head Frame.**
   - **a.** Ensure the luminaire frame and head frame assembly meet the requirements of ASTM A 709 Grade 50 (345 MPa). For the purpose of Charpy V-notch toughness requirements, all steel required to be ASTM A 709 Grade 50 (345 MPa) will be considered main members. Miscellaneous appurtenant steel components may be constructed using ASTM A 709 Grade 36 (250 MPa) steel. Ensure all steel and the head frame dome are galvanized.
   - **b.** Attach the luminaire frame to two or three lift cables. Attach a multiple conductor electrical cable to the luminaire frame with a double weave, stainless steel, grip type, strain relief connection. Pass all cables through a head frame assembly mounted at the top of the tower shaft, as shown in the contract documents. Ensure they pass freely through the shaft during raising and lowering operations.
   - **c.** Ensure the luminaire frame is designed to accommodate the specified number of luminaires on mounts consisting of 2 inch (50 mm) slipfitters.
   - **d.** Ensure the head frame assembly is enclosed and shielded from the elements by means the Engineer approves.
   - **e.** Install three or more spring loaded centering arms with rubber or nylon rollers (or other approved means) to control lateral movement of the luminaire frame during raising or lowering operations. Ensure the centering arms interlock with each other so the tower is centered within the luminaire frame.

2. **Support Cables.**
   - **a.** Install support cables of anti-rotational aircraft type stainless steel with a minimum diameter of 3/16 inch (4.8 mm) and having a safety factor of 5. Space them 120 degrees apart where attached to the luminaire frame. Attach them to a terminating device which is located within the tower shaft and provides a means of equalizing tension of the lift cables.
   - **b.** Ensure the terminator and attached components are shaped to prevent interference to the raising or lowering operation caused by irregularities on the interior surface of the tower shaft.

3. **Winch.**
   - **a.** Install and securely anchor a winch assembly that:
     - Consists of a worm gear speed reducer with either one or two output shafts with cable drum attached.
     - Is capable of supporting five times the maximum lifted load.
     - Includes an integral drag brake to prevent unwinding, slipping, or free spooling of the winch cable.
     - Includes a drum provided with keepers to ensure that the cable will properly wrap onto the drum.
     - When powered by the internal power unit, raises the luminaire ring at a minimum rate of 12 feet (4 m) per minute.
   - **b.** Install a stainless steel, anti-rotational aircraft type winch cable with 1/4 inch (6.4 mm) minimum diameter and a safety factor of 3 to be used to raise and lower the luminaire frame. Attach the cable to the

terminator. Include a safety device that is capable of stopping upward motion of the terminator at any time, in case of winch cable failure. Include a torque limiting device with the winch or power unit.

c. Install a top-latching system. Do not install non-latching systems. Ensure the following:

- Latch barrels are cast, high strength, copper-free aluminum or cast stainless steel.
- Latching is accomplished by the alternate raising and lowering of the luminaire ring assembly using the winch and hoisting assembly.
- There are no moving latch parts or springs attached to the head frame assembly.
- The latch mechanism is not impaired by the formation of ice and does not require adjustment after the original installation.
- Indicator flags are used to show when the luminaire supporting ring is in the latched or unlatched position.

d. Install pulleys that are:

- Stainless steel type designed for the respective types and sizes of cables used, and
- Equipped with permanently lubricated, sealed bearings or oil impregnated bronze bushings mounted on stainless steel shafts.

4. Electrical Cable.

a. Install a multiple conductor cable complying with the requirements for flexible cord. Ensure it is designed to meet all physical requirements for satisfactory operation of the lowering device. Ensure all provisions for electrical disconnects are accessible from ground level.

b. Attach the electrical cable to the terminator with a strain relief device as used at the luminaire frame. Ensure electrical connectors for the power and control circuits are rigidly attached to the terminator.

c. Ensure conductors for connections from the power cable to the luminaires are protected by suitable raceways or are made with weatherproof cables securely anchored to the luminaire frame. A luminaire frame of hollow cross section may be used as a raceway. Ensure all connections are made in weather tight boxes or within the luminaire housings.

H. Erection.

1. After testing has been accomplished to the satisfaction of the Engineer, the tower may be erected on the foundation.

2. Precise aligning and erecting of all components of the tower lighting system is essential. Plumb towers during full cloud cover, prior to sunrise or after sunset, as approved by the Engineer, to prevent thermal expansion effects on the steel tower due to heat from sunshine. Verify in at least two directions, 90 degrees apart, with a transit. Plumb all towers within a tolerance of 50% of the pole top diameter. Tighten

anchor bolt nuts, after the tower has been plumbed, using the following procedure:

a. Perform this work only on days with winds less than 15 mph (25 km/h). Tighten all of the nuts in the presence of the inspector. Once the tightening procedure is started, it shall be completed on all of the base plate nuts without pause or delay.

b. Use properly sized wrenches or sockets, or both, designed for tightening nuts or bolts, or both, to avoid rounding or other damage to the nuts. Do not use adjustable end or pipe wrenches.

c. Ensure base plates, anchor rods, and nuts are free of all dirt or debris.

d. Apply stick wax or bees wax to the threads and bearing surfaces of the anchor bolt, nuts, and washers.

e. Tighten top nuts so they fully contact the base plate. Tighten leveling nuts to snug tight condition. Snug tight is defined as the full effort of one person on a wrench with a length equal to 14 times the bolt diameter but not less than 18 inches (460 mm). Apply full effort as close to the end of the wrench as possible. Perform tightening by leaning back and using entire body weight to pull firmly on the end of the wrench until the nut stops rotating. Perform a minimum of two separate passes of tightening. Sequence tightening in each pass so that the nut on the opposite side, to the extent possible, is subsequently tightened until all of the nuts in that pass have been tightened.

f. Tighten top nuts to snug tight as described for the leveling nuts.

g. Match-mark the top nuts and base plate using paint, crayon, or other approved means to provide a reference for determining the relative rotation of the nut and base plate during tightening. Further tighten the top nuts tightened in two passes, as listed in the Table 2522.03-1, using a striking or hydraulic wrench. Follow a sequence of tightening in each pass so that the nut on the opposite side, to the extent possible, is subsequently tightened until all nuts in that pass have been turned. Do not allow the leveling nut to rotate during the top nut tightening.

Table 2522.03-1: Bolt Tightening

Anchor Bolt Size	First Pass	Second Pass	Total Rotation
Less than or equal to 1 1/2 inch (38 mm) diameter	1/6 turn	1/6 turn	1/3 turn
Greater than 1 1/2 inch (38 mm) diameter	1/12 turn	1/12 turn	1/6 turn

h. Lubricate the jam nuts, place, and tighten to snug tight.

3. Cover the void between the base plate and top of the foundation as shown in the contract documents.

4. Construct and test all other components of this system according to Section 2523.

I. Miscellaneous.

1. Have a manufacturer's service engineer present, on site, to advise during the installation of at least one complete lowering system. Duties of the manufacturer's service engineer include directing all adjustments to the lowering system to insure positive latching and unlatching (a minimum of three complete raising and lowering cycles) and other necessary work.

2. Provide three complete raising and lowering operations for the other towers, providing the same adjustment and commissioning as demonstrated by the manufacturer's service engineer on the first tower.

2522.04 METHOD OF MEASUREMENT.

Measurement for the various items of work involved in tower lighting, satisfactorily completed, will be as follows:

A. Towers.
By count for the various lengths specified in the contract documents.

B. Luminaires.
By count.

C. Footings.
As outlined in the following sections:

Piling	Section 2501
Structural Concrete	Section 2403
Reinforcement	Section 2404
Excavation	Section 2402

2522.05 BASIS OF PAYMENT.

A. Payment for the various items of work involved in tower lighting will be the contract unit price as follows:

1. Towers.
Each for the various specified lengths.

2. Luminaires.
Each.

3. Footings.
As outlined in the following sections:

Piling	Section 2501
Structural Concrete	Section 2403
Reinforcement	Section 2404
Excavation	Section 2402

B. Payment for towers is full compensation for furnishing all materials, equipment, tools, and labor for construction of the towers complete,

including an approved lowering device, and related equipment, anchor bolt assembly, and responsibility during the testing period.

C. Payment for other components of the tower lighting system will be as provided in Article 2523.05.