Section 2523. Highway Lighting

2523.01 DESCRIPTION.

Furnish all work, apparatus, and materials to construct, install, and place in operation, to the Engineer's satisfaction, a complete highway lighting system as shown in the contract documents.

2523.02 MATERIALS.

A. Install lighting materials that meet the requirements of Division 41.

B. Use cast-in-place concrete that meets the requirements of Section 2403.

2523.03 CONSTRUCTION.

A. General.

1. Furnish and install all components of the lighting system not furnished by the utility company serving the installation, including all incidental items appurtenant to the operation of the system.

2. Ensure all apparatus, materials, and work comply with the contract documents and with standards, practices, and codes of the electrical industry. Particular attention is directed to the following:

- NEC, latest edition, including amendments.
- IEEE Standards and Practices.
- ANSI Standards and Practices.
- NEMA Standards.
- UL Standards.

3. Ensure the completed lighting installation complies with all local and special laws, codes, or ordinances of all Federal, State, and municipal authorities with due jurisdiction.

4. The Contracting Authority will be responsible for the cost of electric power used during installation and testing of lighting equipment and prior to final acceptance of the work. Do not put the installation into use prior to final acceptance without the Engineer’s approval.

B. Shop Drawings.

1. Before any items are ordered or installation is started, the following list of shop drawings shall be submitted for approval according to Article 1105.03:

a. Required Shop Drawings:

1) Lighting poles and mastarms.
2) Transformer bases.
3) Slip bases.
4) Roadway luminaires with lamps.
5) Iowa DOT Standard Road Plan RM-41, Underdeck Lighting (High Pressure Sodium Luminaire).

6) Control cabinet components.
   a) Enclosure.
   b) Door latch mechanism.
   c) Contactor.
   d) Circuit breaker (main).
   e) Circuit breaker (branch).
   f) Photoelectric control.
   g) Test switch(es).
   h) Breather drain.
   i) Wiring diagram, showing wire type and size
   j) Component placement drawing.
   k) Control fuse holder.
   l) Surge suppressor.
7) Iowa DOT Standard Road Plan RM-40, Cable Splices and Connectors.
8) Insulated wire and cable.
9) Additional drawings may be required on a project specific basis in accordance with the contract documents.

b. Shop Drawings Not Required:

1) Wood pole.
2) Concrete.
3) Reinforcing steel.
4) Anchor bolts, nuts, and washers.
5) Other bolts, nuts, and washers.
6) Ground rods and clamps.
7) Iowa DOT Standard Road Plan RM-42, Type 1 Handhole.
8) Rigid steel conduit and fittings.
9) Rigid aluminum conduit and fittings.
10) Plastic conduit and fittings.
11) Plastic warning tape.
12) Bare copper ground wire.

2. Meet the following provisions for shop drawings:

a. Submit all drawings simultaneously for each project.

b. Include catalog cuts, diagrams, drawings, brochures, or other descriptive data required by the Engineer.

c. Include a schematic diagram and a component placement diagram of the control cabinet and panel.

d. Ensure all wire and cable sizes, placement of components, and dimensions are shown on the diagrams.

e. Ensure all drawings are completely legible and contain adequate information to identify that the described components comply with the contract documents.

f. Ensure identification markings on the described items correspond to like markings shown on the drawings to provide easy identification of the item.

g. Ensure apparatus or materials are not installed until the Engineer has reviewed and concurred with descriptive data.

h. Ensure each sheet or bound pamphlet is imprinted with the county and project number.

i. Ensure each set is assembled and contains one copy of the required data for each item listed on the schedule.

3. Incorrect or incomplete submittals will be returned to the Contractor for correction. The Engineer may require certified test results and samples of materials for consideration of all items including those described by reviewed drawings.

C. Cooperation with Utility Companies.

1. The utility company is to provide secondary service to the project in the vicinity indicated. Consult and cooperate with the utility company in locating the distribution lines and service poles so lines will be as short and direct as possible. If the utility company is unable to perform the required work, furnish and install the service poles (payment will be according to Article 1109.03). The Contracting Authority will be responsible for the cost for extension of power lines and for furnishing and installing meter sockets and meter loops as required in the contract documents.

2. The entire transformer pole installation, when required, including all accessories and appurtenances, is to be installed by the utility company that is to supply service according to their agreement for service. Cooperate with the utility company so that connections may be made in the proper manner and at the proper time.

3. Furnish all apparatus and material for the pole mounted control station, as shown in the contract documents. Upon acceptance of the project, they will become the Contracting Authority's property.

4. If pad mounted transformers and control stations are specified, ensure they are furnished and installed as specified in the contract documents. Ensure they are approved by the designated utility company.

D. Excavation.

1. Drill the holes for pole footings and direct embedded poles.

2. Details of trenching for underground circuits will be shown in the contract documents.

3. Pile the excavated material away from the trench to prevent cave-ins.

4. Accurately grade the trench bottom to provide for placement of cable or duct work at a uniform depth.

5. Ensure surface water does not enter the trench. Remove water that is present before duct work is installed, unless directed otherwise by the Engineer.

E. Placing Backfill.

1. After inspection of the completed trench, duct work, and cables, place backfill consisting of the material that was removed into the trench, unless stated otherwise in the contract documents or directed by the

Engineer. Place backfill material in layers with the first layer not exceeding 2 feet (0.6 m) of loose thickness and each succeeding layer not exceeding 1 foot (0.3 m) of loose thickness. Compact each layer using hand or mechanical tampers. Do not use material containing glass, metal, concrete, brick, cinders, or any other abrasive material for backfill within 6 inches (150 mm) of the cable or conduit. Install approved plastic warning tape in all trenches.

2. Use the removed material to place backfill around direct embedded poles and handholes. Place the material in layers not exceeding 6 inches (150 mm) of loose thickness. Compact using hand or mechanical tampers.

3. Shape excess material to original contours as directed by the Engineer.

4. Shape all other disturbed areas to the original contours as directed by the Engineer.

F. Seeding and Fertilizing.

In locations where erosion control work has been completed or turf has been established, restore the areas disturbed by application of seed and fertilizer as indicated in the contract documents.

G. Footings.

1. Construct cast-in-place concrete footings for all lighting units not located on structures or barriers. Form and pour the top portion of all footings in form work to at least 6 inches (150 mm) below the finished ground level. Ensure the footings conform in all respects to the details, including reinforcement and alignment to provide the correct overhang, as indicated in the contract documents.

2. Ensure finished surfaces are smooth and free from stains and foreign material.

3. Construct an alternate footing, as directed by the Engineer, when shale, sandstone, broken and shattered rock, solid rock, or other similar materials are encountered.

4. Place anchor bolts to provide for placement of nuts and washers on the top and bottom of the transformer base or pole flange, leaving ample room for adjustment and plumbing the pole. When slip bases are used, position anchor bolts so that they do not interfere with the operation of the slip base. Place anchor bolts according to Article 2405.03, H, 3.

H. Breakaway and Slip Bases.

1. Furnish and install breakaway bases or slip bases of the size and type specified in the contract documents for each light pole not mounted on a roadway bridge. Use the same type and manufacturer for all bases for a project. Install a commercially available product. Comply with the details of bases shown in the contract documents.

2. Ensure each breakaway base has a nonmetallic spacer impervious to galvanic action placed between the breakaway base and pole base mounting flange.

I. Aluminum Transformer Bases.

Ensure the bottom flange of aluminum transformer bases are painted on the inside and outside surfaces with two coats of zinc-rich paint.

J. Poles and Mastarms.

1. Furnish and install poles at all locations indicated in the contract documents. Install poles of the lengths shown in the contract documents.

2. Carefully erect all poles and mastarms. Check for vertical alignment, mounting height, and overhang, after installation, with mastarm and luminaire installed.

3. Rake single mastarm poles so the side of the shaft opposite the mastarm is plumb. Erect poles without mastarms, or with more than one mastarm, so the center line of the pole shaft is plumb within a tolerance of 1/32 inch per foot (3 mm/m).

4. Check the pole posture at no less than three radial locations on the shaft. For poles required to have plumb shaft center lines, space the checking positions approximately 120 degrees apart, as viewed from above. For raked poles required to have one side plumb, space the check points on the side to be plumbed at 90 degrees in either direction, as viewed from above.

5. Plumb the poles using double nuts on each anchor bolt. Locate the nuts:

- Above and below the bottom mounting flange of the breakaway base, or
- Above and below the pole base or slip base mounting flange where breakaway bases are not required.

6. Install anchor bolt washers according to the details in the contract documents.

7. Base leveling shims or alternate pole mounting methods will be permitted only when indicated.

8. After the erection has been inspected and approved, fill the space between the mounting flange and the concrete footing with an approved non-shrink grout and finish as detailed.

9. Install mastarms of the type and length specified. Unless shown otherwise in the contract documents, mastarms greater than 8 feet (2.4 m) in length are to be Type B, and all others Type A. Use the same type and material for all lighting poles and mastarms on a project.

10. Install insect barriers in the ends of all mastarms at the point of luminaire attachment.

11. Install wood poles of the length and class specified. Set them plumb in drilled holes as directed by the Engineer. Embed the poles no less than 8 feet (2.5 m). Additional embedment may be required by the Engineer if warranted by soil conditions.

K. Luminaires.

1. Furnish and install luminaires of the type and rating specified.

2. All roadway luminaires shall be leveled after installation unless a tilt is specified.

3. When light distribution is specified, ensure the luminaire has the necessary components and is adjusted properly.

4. Provide the Engineer with printed instructions regarding luminaire components and adjustment.

L. Circuits.

1. Unless specified otherwise, install an underground, multiple system roadway lighting circuit that is totally encased in conduit. Construct circuits and control stations according to the contract documents.

2. Ensure circuits are complete with all necessary accessories for proper operation. Thoroughly coordinate disconnecting devices, protective devices, and all other equipment to secure a safe operating lighting system. If any changes in arrangement of the circuit system are considered necessary by the Contractor, submit details of changes and reasons to the Engineer for approval. Obtain the Engineer's approval prior to making changes.

M. Grounding.

1. General Requirements.

a. A component of the lighting system will be defined to be grounded when it is electrically bonded to a driven ground rod or a multiple system of ground rods producing a resistance to ground of 25 ohms or less when installed and tested according to the contract documents.

b. Use ground rods and connections described in Article 4185.04 to ground major components of the lighting system, such as control stations, lighting units, and sign structures, and all metal duct work in exposed locations or installed on roadway bridges. Refer to the contract documents for details of these and other locations to be grounded.

2. Grounding Installations.

a. Whenever the ground rod installation does not have a resistance to ground of 25 ohms or less, couple additional rods to the first, and drive to the full depth until the required resistance is obtained. If a maximum depth of 50 feet (15 m) is reached, or if obstacles to further driving are encountered, install additional ground rods until the required resistance to ground is obtained.

b. Permissible grounding installations are as follows:

1) Ensure that in no case is any portion of the ground rod closer than 18 inches (0.5 m) to the finished earth surface. Drive all rods as nearly vertical as possible. Whenever possible, drive a full length ground rod.

2) When rock or other obstructions prevent driving the rod to full depth, two half-length sections may be driven, with the Engineer's approval. The two half-length sections are considered as a minimum length rod when additional rods are required to obtain the specified resistance to ground.

3) Where two half-length rods can not be driven to the required depth, place full length rods horizontally at a depth of no less than the adjacent trench depth.

4) The minimum horizontal clearance between all rods in a multiple ground installation is to be 6 feet (2 m).

N. Electrical Ducts.

1. General Requirements.

a. Refer to the contract documents for details of duct installations. Ensure the completed duct systems are watertight. Use expansion fittings where duct runs cross structural expansion joints and elsewhere as direct by the Engineer.

b. Thread metal conduit joints. Treat the mating threads with pipe joint compound. Treat all other threads with an approved rustproofing compound. For plastic conduits, use solvent welded, socket type joints.

c. After the duct runs are installed, demonstrate that the runs are clear by pulling an approved brush or conduit swab through the entire length of each run. Ensure no deleterious material remains in the duct. Securely cap terminal ends until cable is installed. Before the wire and cable is installed, fit terminal ends of metal conduit with threaded insulating bushings. Fit terminal ends of plastic conduit with socket type, bell end fittings.

d. Do not embed aluminum conduit in concrete.

2. Underground Ducts.

a. Lighting Circuit Ducts.

Fabricate lighting circuit ducts using Schedule 40 plastic conduit. As field conditions permit, install the runs to avoid adding bends or total bend angle to the design layout. Limit the total bend angle between pulling points to no more than 360 degrees.

b. Crossing Ducts.

Unless shown otherwise in the contract documents, use Schedule 80 PVC conduit for crossing ducts. If crossings are to be placed

without disturbing the existing surface, install by jacking or boring methods approved by the Engineer. Do not use jetting.

c. Primary Service Ducts.
Apply installation requirements for lighting circuit and crossing circuit.

3. Exposed Exterior Ducts.

a. Unless shown otherwise in the contract documents, use rigid steel conduits for all ducts for exposed installations.

b. When not shown in the contract documents, support exposed ducts at intervals of 6 feet (1.8 m) or less. Anchor the hangers or clamps to be attached to concrete structures by means of expanding anchors in drilled holes. The use of driven or explosive set anchors will not be permitted.

O. Handholes.

1. Construct handholes of the size and type and at locations shown in the contract documents, unless the Engineer specifies otherwise. Do not construct handholes in the following areas:

- Ditch bottoms,
- Low areas where ponding of water may occur, or
- Where they will be subject to normal vehicular traffic.

2. Provide access ducts for each general direction of the circuit branch run. Position them for ease of cable installation.

3. Position handholes so that the top is at the same inclination as the adjacent grade.

P. Junction Boxes.

Furnish junction boxes of the type specified and install as indicated in the contract documents.

Q. Wire or Cable.

1. Furnish and install wire or cable of the size and type specified. When installing wire or cable in a conduit system, provide equipment to demonstrate to the Engineer that at no time will a pulling tension of 0.008 pound per circular mil (70 N/mm^2) of conductor be exceeded.

2. Ensure unreeled wire or cable is not left on the ground surface or exposed to mechanical abrasion. Replace all wire or cable that is stressed or damaged in any way at no additional cost to the Contracting Authority. Do not install wire or cable with dirt or any other abrasive material adhering to it.

3. Use a lubricant when pulling wire or cable. Use a UL listed lubricant designed for use with the specified cable and conduit. The use of graphite or petroleum lubricants will not be permitted. Ensure the pulling device is attached to each conductor and all wire or cable within a single duct is pulled simultaneously.

R. Connectors.
Furnish and install connectors of the type specified at the locations shown in the contract documents. Ensure connector assemblies are supplied with a disposable mounting pin, when required, and sufficient silicone compound to lubricate the metal parts and rubber housings. Ensure complete instructions are supplied with each connector.

S. Splices.
Use approved connector assemblies to make splices. Splices in the system will only be allowed in pole shafts, handholes, pull boxes, breakaway bases, and other specified locations.

T. Control Station.
Furnish the components specified and construct the control station as indicated in the contract documents.

U. Final Acceptance.

1. Perform electrical tests of all systems after the circuit installation work is complete, and at any other stage of construction when directed by the Engineer. Include the following tests:
- Insulation resistance measurement for all underground circuit cable,
- Voltage measurements, and
- Ground resistance test for each individual grounding installation.

2. Perform insulation resistance measurements with all lamps or ballasts disconnected from the circuit and all neutral lines properly grounded. Measure with a properly calibrated 500 volt megaohmmeter. Ensure insulation resistance is no less than 100 megaohms.

3. Measure and record the voltages in the cabinet from phase to phase and phase to neutral at no load and at full load. Measure and record the voltage readings at the last termination of each circuit.

4. Measure ground resistance with the ground rod, or system of ground rods as described in Article 2523.03, K, disconnected from the circuit neutral wire. Measure with a Wheatstone bridge type ground resistance tester according to the manufacturer's instructions. Ensure the ground resistance of each individual grounding installation is no greater than 25 ohms.

5. Perform electrical tests and demonstrate to the Engineer that the lighting system complies with requirements of the contract documents.

6. Provide the Engineer with a written report of all test results for a permanent record.

7. In the insulation resistance report, include measurements from each insulated line to ground, and between all combinations of lines in a given circuit or contained in a single duct.

8. In the voltage measurement report, include measurements for each cabinet and each circuit.

9. In the ground resistance report, include measurements for each grounding installation identified by a lighting unit number and at other grounding locations by a means approved by the Engineer.

10. All components of the lighting system shall be in satisfactory operation according to the ratings and requirements specified.

11. After satisfactory completion of required testing, the complete lighting system is to be placed in operation for a 30 calendar day trial period, and final approval of the installation will not be made until the trial period ends. During the trial period, service and maintain the installation and make all necessary adjustments or replacements as are required, at no additional cost to the Contracting Authority. The Contractor will not be required to pay for energy consumed by the system, and working days will not be charged, during this trial period.

12. Where the existing ground has been disturbed by the Contractor, reshape to original contours or as directed otherwise by the Engineer.

13. Final acceptance of all lighting installations will be based on:
- Satisfactory results of electrical tests the Contractor has performed, and
- Satisfactory completion of the 30 calendar day trial period.

2523.04 METHOD OF MEASUREMENT.

Measurement for the quantities of the various items involved in the construction of highway lighting will be as follows:

A. Lighting Poles.
By count.

B. Electrical Circuits.
Linear feet (meters) shown in the contract documents.

C. Handholes and Junction Boxes.
By count.

D. Control Cabinet.
By count.

E. Under Deck Lighting.
By count.

2523.05 BASIS OF PAYMENT.

Payment for the quantities of the various items involved in constructing highway lighting will be the contract unit price as follows:

A. Lighting Poles.

1. Each.

2. Payment is full compensation for materials, equipment, excavation, and installation of the pole, luminaire, mastarm, footing, base, ground rod, wiring within the pole, and connectors within the pole, according to the contract documents.

B. Electrical Circuits.

1. Per linear foot (meter).

2. Payment is full compensation for materials, equipment, excavation, and installation of the conduit and the wiring/cables between the connectors in the poles, including switches.

C. Handholes and Junction Boxes.

1. Each.

2. Payment is full compensation for materials, equipment, excavation, and installation of the handholes and junction boxes.

D. Control Cabinet.

1. Each.

2. Payment is full compensation for materials, equipment, excavation, meter socket, meter loop, control cabinet pole, and installation of control cabinet and all internal circuitry.

E. Under Deck Lighting.

1. Each.

2. Under Deck Lighting luminaires shall be complete including lamps, ballast, and mounting device.