

676.4.01

**676.4.01 Limits**

General Provisions 101 through 150.

**676.5 Payment**

All Items will be paid for at the Contract Unit prices.

Payment will be made under:

Item No. 676	Drinking fountain	Per each
Item No. 676	Wash hydrant	Per each
Item No. 676	Yard hydrant	Per each

**676.5.01 Adjustments**

General Provisions 101 through 150.

**Section 680—Highway Lighting**

**680.1 General Description**

This work includes furnishing and installing roadway and structure lighting systems according to the Specifications and Plan details.

**680.1.01 Definitions**

Conduit: Metallic or nonmetallic pipe, tube, or duct.

Rigid Conduit: Metallic conduit unless otherwise noted.

**680.1.02 Related References**

**A. Standard Specifications**

- Section 205—Roadway Excavation
- Section 500—Concrete Structures
- Section 681—Lighting Standards and Luminaires
- Section 682—Electrical Wire, Cable, and Conduit
- Section 683—High Level Lighting Systems
- Section 800—Coarse Aggregate
- Section 801—Fine Aggregate
- Section 832—Curing Agents
- Section 853—Reinforcement and Tensioning Steel
- Section 854—Castings and Forgings
- Section 870—Paint
- Section 920—Lighting Standards and Towers
- Section 921—Luminaires
- Section 922—Electrical Wire and Cable
- Section 923—Electrical Conduit
- Section 924—Miscellaneous Electrical Materials

**B. Related Documents**

GDT 7

GDT 59

GDT 67

**680.1.03 Submittals****A. Purchase List**

Before purchasing materials, submit 7 copies of the complete materials and structures list, including Shop Drawings, to the Engineer for approval. Include the manufacturer's name, catalog number(s), and other descriptive data needed to clearly define each Item.

**B. Manufacturer's Certifications**

## 1. Certification of Construction Items

Secure supplier or manufacturer certifications, including mill certificates, guaranteeing the construction items were manufactured according to the Specifications.

Ensure that the certificate shows that representative samples were tested and test results conform to the Specifications.

## 2. Certification of Quantity

Attach a copy of the bill of lading, sales order, or list showing the quantity of materials furnished for a specific project. Make this part of the certification by reference.

**C. Manufacturer's Guarantees**

After the work is complete and accepted, obtain manufacturer's guarantees for the mechanical and electrical equipment used.

Give these to the Engineer who will pass them to the agency responsible for continued equipment maintenance.

**680.2 Materials**

Furnish only new materials and equipment for this work. Ensure that materials meet the following requirements unless otherwise indicated:

<b>Material</b>	<b>Section</b>
Portland Cement Concrete, Class A	500
Coarse Aggregate	800
Fine Aggregate	801
Cement Concrete Curing Materials	832
Bar Reinforcement for Concrete Structures	853.2.01
Gray Iron Castings	854.2.01
Paints (Field Painting)	870
Lighting Standards and Towers	920
Luminaires	921
Electric Wire and Cable	922
Electric Conduit	923
Miscellaneous Electrical Materials	924

**A. Codes and Regulations**

Ensure that all materials and work performed meet the latest revisions of the following standard codes and regulations:

- National Electrical Code (NEC)
- National Electrical Safety Code

## 680.2.01

- Illuminating Engineering Society
- American National Standards Institute (ANSI)
- Power company regulations and standards
- Codes, regulations, and rules in the work area or municipality

In addition to the above, ensure that electrical materials meet the following standards, provided a standard exists for that material:

- Underwriter's Laboratories, Inc. (UL)
- American Institute of Electrical Engineers (AIEE)
- National Electrical Manufacturer's Association (NEMA)

### **680.2.01 Delivery, Storage, and Handling**

Dispose of excess or unsuitable material according to Section 205.

## **680.3 Construction Requirements**

### **680.3.01 Personnel**

#### **A. Approved Contractors**

Ensure that the Contractor performing this work is on the Department's list of approved electrical contractors or electrical subcontractors.

#### **B. Qualified Electrician**

Always have a qualified electrician on the job site when pulling electrical wiring or making electrical connections.

A qualified electrician is either of the following:

- An electrician with a Class II license issued by the Georgia State Construction Industry Licensing Board
- An electrician who has completed an approved four-year apprenticeship training program and is classified as a Journeyman Electrician

Have the qualified electrician show his or her classification to the Engineer in charge. For further definition, see Subsection 755.1.01.

### **680.3.02 Equipment**

Ensure that equipment is at the project site and approved before construction begins.

### **680.3.03 Preparation**

Before beginning work, pay applicable fees and obtain needed permits from power companies or governmental agencies.

### **680.3.04 Fabrication**

General Provisions 101 through 150.

### **680.3.05 Construction**

#### **A. Installing Conduit**

##### 1. General Requirements for Conduit

Install the specified size and type of conduit at the locations given on the Plans, or as directed.

##### a. Cut and ream conduit as follows:

- 1) Cut metallic conduit threads and then ream the ends.
- 2) Ream other conduit as necessary.
- 3) Cut conduit ends square.
- 4) Ensure that conduit ends butt solidly in the joints to form a smooth raceway for cables.

##### b. Ensure conduit joints form a watertight seal by doing the following:

- 1) Coat metallic conduit threads with red or white lead, pipe compound, or thermoplastic seal, and then securely connect them.

- 2) Form asbestos cement conduit joints with hot tar, asphalt, or bitumen paint, then drive tightly.
  - 3) Form plastic and bituminous fiber conduit joints as recommended by the conduit manufacturer and as approved by the Engineer.
  - c. Install bushings in conduit to protect the conductors.
  - d. Cap or plug conduit as follows:
    - 1) Thread and cap the ends of metallic conduit intended for future use.
    - 2) Plug the ends of nonmetallic conduit runs to keep water or other foreign matter out of the conduit.
  - e. Build conduit runs in straight lines where possible.  
If sweeps are necessary, use long sweep bends with a radius of at least 6 times the conduit's nominal diameter, unless otherwise specified.
2. Conduit on Structures
- Install conduits, condulets, hangers, expansion fittings, and accessories on structures according to the Plans and the following, unless otherwise specified:
- a. Run conduit parallel to beams, trusses, supports, pier caps, etc., as directly as possible.
  - b. Install horizontal runs in a slight grade without forming low spots that may prevent proper drainage.
  - c. Run conduits with smooth, easy bends.
  - d. Hold conduit in boxes with locknuts.
  - e. Do not clamp or attach conduit to beam flanges.
  - f. Use bushings to protect the conductors.
3. Underground Conduit Installation
- Use encased or direct burial conduit for underground installations. Install the conduit in a trench excavated according to Plan dimensions and lines. Follow the requirements for avoiding obstructions, described in Subsection 680.3.05.A.3.b, below.
- a. Trench Excavation
 

Unless specified on the Plans, do not excavate conduit trenches through existing pavement or surfaced shoulders. Install the conduit under the existing pavement by jacking, boring, or using other approved means. When the Plans specifically allow a trench through an existing pavement or surfaced shoulder, restore the pavement, surface, base, and subgrade to the Engineer's satisfaction. Include pavement surface, base, and subgrade removal, disposal, and restoration in the Contract Price for the Items to which they pertain.

Excavate trenches as follows:

    - 1) Unless otherwise specified, cut conduit trenches on a slight grade (0.25 percent minimum) for drainage.
    - 2) When the grade cannot be maintained all one way, grade the duct lines from the center in both directions, down to the ends. Avoid pockets or traps where moisture may accumulate.
    - 3) Make the trench walls vertical.
    - 4) Tamp the trench bottom as necessary for a firm conduit foundation.
    - 5) Sheet and brace the trenches when required.
    - 6) Adequately support pipe and other structures exposed in trenches if support is necessary to prevent damage. Include furnishing, installing, and removing sheeting, bracing, and supports in the Contract Prices for other items, as they pertain.
  - b. Obstructions to Excavation
 

Before excavating, determine the location of electrical lines, drainage, or utility facilities. Avoid damaging these while working. In addition, avoid conflict with proposed guardrail, sign posts, etc.

If necessary due to obstructions, slightly change the locations of conduit runs, pull boxes, etc., as approved by the Engineer.

Make the following allowances around obstructions:

    - 1) Where possible, provide at least 12 in (300 mm) between the finished conduit runs and utility facilities, such as gas lines, water mains, and other underground facilities not related to the electrical system.

- 2) Where the conduit run is adjacent to concrete walls, piers, footings, etc., maintain at least 4 in (100 mm) of undisturbed earth or firmly compacted soil between the conduit and the adjacent concrete.
- 3) When the conduit is encased, maintain at least 4 in (100 mm) of undisturbed earth or firmly compacted soil between the encasement and adjacent concrete.

c. Encased Conduit

Place encased conduit at the locations shown on the Plans.

Unless otherwise specified, follow these requirements for encased conduit:

- Use Class A concrete according to Section 500.
- Use precast concrete encasement only if approved by the Engineer.
- Run a mandrel test on completed installations.
- Ream duct openings to remove burrs or foreign matter.
- Immediately following testing, thoroughly clean conduit in a manner acceptable to the Engineer.
- After cleaning finished conduit that will not be wired until a future date, provide and install a weatherproof cap at each open end. Have the Engineer inspect and approve this work.

Install new underground concrete encasement as follows:

- 1) Construct encasement under pavements or surfaces so that it extends at least 12 in (300 mm) beyond the outside edges of pavement, paved shoulders, sidewalks, or curbs, when no shoulder or sidewalk is indicated.
- 2) Ensure that the end of installed conduit extends at least 6 in (150 mm) beyond the encasement.  
If using Type I nonmetallic conduit in the encasement, use Type II nonmetallic conduit for the 6 in (150 mm) beyond the encasement and for the last 24 in (600 mm) within the encasement.
- 3) Place 3 in (75 mm) of concrete in the trench bottom to support the conduit.
- 4) Plug the conduit ends temporarily to keep concrete or foreign material out, then place the conduit in the trench.
- 5) Pour concrete into the trench to at least 3 in (75 mm) above the conduit.
- 6) Do not encase conduit in concrete until tested, inspected, and approved by the Engineer. (See Subsection 680.3.05.A.5, below.)
- 7) Cure concrete encasement according to Subsection 500.3.05.Z, except reduce the curing period to 24 hours.

4. Direct Burial Conduit

Install direct burial conduit underground according to the Plans using the following conduit types:

- Rigid galvanized steel
- Rigid aluminum
- Bituminous fiber
- Asbestos cement
- Unplasticized polyvinyl chloride

When the trench bottom is rock, install direct burial conduit in a bed of well-compacted, fine-grained soil at least 4 in (100 mm) thick.

Ensure the trench is deep enough for the finish cover to be:

- At least 18 in (450 mm) from the top surface of raw ground
- At least 24 in (600 mm) from the bottom side of pavement

5. Backfill Over Underground Conduit

Do not backfill encased conduit until the concrete encasement has cured at least 24 hours.

- a. Once the Engineer has inspected and approved the direct burial conduit installation, promptly backfill it to the required grade. Use soil without rocks or other foreign matter.
- b. Backfill with approved material in layers no deeper than 6 in (150 mm) loose depth.
- c. Compact each layer to 100 percent of the maximum dry density as determined by test method GDT 7, GDT 59, or GDT 67.

## 6. Testing Conduit

After installing conduit, test it with a mandrel in the Engineer's presence as follows:

- a. Use a 2 in (50 mm) mandrel with a diameter 1/4 in (6 mm) smaller than the conduit diameter.
- b. Repair conduits that the mandrel will not pass through. If repairs cannot be made to the Engineer's satisfaction, remove and replace the conduit at no additional cost to the Department.

## B. Constructing Pull and Junction Boxes

Construct pull and junction boxes according to the design, dimensions, and locations shown on the Plans.

### 1. Box Construction

- a. Construct concrete boxes from Class A concrete according to Section 500. Ensure that precast concrete boxes follow the same requirements.
- b. Use manufactured units if the Engineer determines that they are equal to concrete boxes in design, quality, and structural strength.

### 2. Covers

Provide cast iron, steel, or reinforced concrete covers with each pull or junction box according to the Plans.

Ground the cast iron or steel covers to electrical junction or pull boxes according to NEC Section 370-18(c) and NEC Section 250-42.

### 3. Conduit Entrance Holes

After installing conduit, seal the conduit entrance holes in pull or junction boxes to the Engineer's satisfaction.

Blank off unused entrance holes and openings that will be used in the future to extend conduit. Use suitable plastic, bituminous fiber, or other approved plugs that keep foreign matter out.

### 4. Drainage

Provide pull and junction boxes with a drainage hole unless the application or the Engineer dictate otherwise.

Provide a drainage system for each ground-mounted box to ensure that no water accumulates inside the box.

## C. Installing Underground Cable for Lighting Circuits

For underground lighting circuits, use cable with or without conduit according to the Plans.

When installing cable under existing pavements or surfaced shoulders, install specified conduit according to Subsection 680.3.05.A.4.

### 1. Cable Slack

When cable is brought through the base of the lighting standard or junction box, leave enough slack to allow the connections to be made outside the standard or box.

### 2. Cable in Conduit

Carefully pull cables into place in conduits using approved methods so that the cable is installed without electrical or mechanical damage. Install as follows:

- a. Use powdered soapstone, talc, or other inert lubricants when placing conductors in conduit.
- b. Handle and install conductors carefully to prevent kinks, bends, or other distortions that could damage the conductor or outer covering.
- c. Pull all cables within a single conduit at the same time.

When pulling cables through hand holes in pole shafts, etc., place a pad of firm rubber or other suitable material between the cable and the opening edges to prevent cable damage.

### 3. Direct Burial Cable in Trenches

Do not unreel and pull cables into the trench from one end. Unreel and lay them alongside the trench, then lay them in the trench as follows:

- a. "Snake" the cables slightly in the trench to allow for settling of earth.
- b. Do not allow cable to crossover in the trench.

### 4. Splices

Splice conductors according to the National Electrical Code and the splice manufacturer's recommendations. Splices are subject to the Engineer's approval.

Follow these requirements for splicing conductors, including underground cable splices, if specified:

- Make splices watertight.
  - Make splices only in junction boxes and pole bases unless otherwise shown on the Plans.
  - When making straight or line splices in the same-sized conductors, use tin-plated copper compression tubular splices.
  - When making splices in different-sized conductors or conductors with different terminating directions:
    - a. Use tin-plated copper compression ring tongue terminals on each conductor.
    - b. Bolt the conductors/terminals together with stainless steel or high strength silicone bronze hardware.
      - Use locknuts, pal nuts, or lock washers to keep connections tight. Do not use split bolt connectors.
      - Use an oxidation inhibitor compound on aluminum conductor connections.
5. Heat-Shrinkable Tubing Around Splices

After making a conductor splice, insulate it with heat-shrinkable tubing, supplied by the manufacturer, with an adhesive coating on the inner wall.

Follow these requirements for heat-shrinkable tubing:

- Use shrink tubing with insulation thickness equal to or greater than the insulation thickness of the conductor.
- Use UL listed heat-shrinkable tubing that meets ANSI C119.1 (latest edition) requirements for submersible and direct buried splices.

Apply heat-shrinkable tubing as follows:

- a. When connections are bolted together, wrap the bolted connection with cloth tape before applying the heat-shrinkable tubing.
  - b. Pad sharp points and edges on splices to prevent the heat-shrinkable tubing from splitting during shrinking.
  - c. Place the shrink tubing to have at least 3 in (75 mm) of seal length on the conductor beyond the splice after the tube is fully recovered.
6. Grounding
- Ground underground cable as follows:
- a. Connect neutral/grounding conductors to the ground rod at all control points and to the ground wire cast in pole foundations. Use the type and size of continuous neutral/grounding conductors shown on the Plans. Connect according to Plan details.
  - b. Install ground rods adjacent to light standard bases at locations shown on the Plans. Install ground rods in one of the following ways:
    - 1) Driven Ground Rods
      - a) Drive single ground rods vertically until the top of the rod is at least 12 in (300 mm) below the finished ground.
      - b) Attach a length of No. 6 AWG, bare solid, soft drawn, or medium-hard drawn copper ground wire to the ground rod. Use suitable ground rod clamps.
      - c) Connect the wire to the standard base grounding nut.
    - 2) Laid Ground Rods
 

When sufficient penetration cannot be obtained in the above manner, place the following ground rod system:

      - a) Place 3 parallel ground rods at least 6 ft (2 m) center-to-center horizontally and at least 12 in (300 mm) below the finished ground.
      - b) Join and fasten these rods to the grounding nut of the standard base with No. 6 AWG, bare solid, soft drawn or medium hard drawn copper ground wire and suitable clamps.

#### **D. Installing Light Standard and Towers**

Install the specified design, kind, and size of light standards or towers at Plan-specified locations. Install these structures, complete with specified supporting assembly and luminaires, to the mounting heights shown on the Plans.

Consider transformer bases to be an integral part of the lighting standard unless otherwise specified.

Install light standards and towers as follows:

### 1. Installing Foundations

#### a. Foundations for Bolt-Down Base Standards with Anchor or Transformer Bases

Install these as follows:

- 1) Excavate a hole the size and depth shown on the Plans.  
Remove and dispose of excavated material as directed by the Engineer.
- 2) Place the specified type and size anchor bolts according to the pole manufacturer's recommendations. Hold these securely by a template to ensure proper position in the completed foundation.

**NOTE: Never attempt to realign the anchor bolts after pouring the foundation.**

- 3) Place conduits in foundations, orient them to accommodate service cables, and securely hold them to avoid displacement.
- 4) Pour Class A concrete into the excavated area to the following depths:
  - a) First pour against undisturbed earth up to 4 in (100 mm) below the finished ground line.
  - b) Then, using an approved form, continue to pour to the finished top of the foundation elevation, as specified.
- 5) Chamfer the top and formed portions of the foundation edges.
- 6) Give a Type III finish to all portions of the foundation above finished grade down to at least 2 in (50 mm) below finished grade, according to Subsection 500.3.05.AB.4, "Type III—Special Surface Coating Finish."
- 7) Where break-away bases are required, do not allow any portion of the base or anchor bolts to protrude more than 4 in (100 mm) above the ground line.

#### b. Tower Foundations and Pole Foundations on Structures

Construct these according to Plan details.

Where break-away bases are required, do not allow any portion of the base or anchor bolts to protrude more than 4 in (100 mm) above the ground line.

#### c. Foundations for Prestressed Concrete-Butt Base Standards

Excavate for prestressed concrete butt base lighting standard foundations either manually or mechanically.

When excavating:

- 1) Dig or drill holes to the depths and diameters shown on the Plans.
- 2) Place and compact 6 in (150 mm) of crushed stone in the bottom of the hole. Use crushed stone according to Subsection 800.2.01, with stone size 57.

### 2. Installing Light Standards and Towers on Foundations

Erect the standards or towers as recommended by the manufacturer and approved by the Engineer. Erect carefully to avoid marring the finish or damaging the standard.

Ground the lighting supports according to the Plans.

#### a. Installing Bolt-Down Base Standards with Anchor or Transformer Bases

After installing foundations according to Subsection 680.3.05.D.1, install lighting standards as follows:

- 1) When using bracket arm type, use metal shims or double nuts supplied with the poles to plumb the pole about its center axis.
- 2) When using the single arm type, unless otherwise specified, install the luminaire and hardware, then plumb the back side of the standard, providing a slight rake or lean away from the traveled way.

#### b. Installing Prestressed Concrete-Butt Base Standards

After installing foundations according to Subsection 680.3.05.D.1, install prestressed concrete-butt base standards as follows:

- 1) Position the pole in the center of the hole at grade and hold it in place, as follows.
  - a) Set two bracket arm lighting standards to plumb.
  - b) Rake single bracket arm lighting standards according to Subsection 680.3.05.D.2.a.(2).

- 2) Fill the space surrounding the pole butt base as follows:
    - Fill with crushed stone, applied in 6in (150mm) layers. Use crushed stone according to Subsection 800.2.01, with stone size 57.
    - Compact each layer with mechanical tamping equipment.
    - Moisten the stone backfill as necessary.
    - Fill the area to the bottom edge of the cable entrance in the butt base.
  - 3) Install the cable.
  - 4) Continue to fill and compact the area with 6in (150 mm) layers of crushed stone to 12 in (300 mm) below grade.
  - 5) Backfill the remaining 12 in (300 mm) with soil in 2 equal layers, thoroughly compacting each layer.
3. Installing Frangible or Break-Away Standards
- Ensure that frangible or break-away lighting standards meet the breakaway requirements according to Plan details and AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

#### **E. Bridge Lighting Installations**

When installing lighting on a bridge, examine the bridge plans or the completed structure, whichever applies, to determine the proposed or existing details that affect the lighting standards. Do this before ordering the standards.

Immediately report to the Engineer discrepancies between the highway lighting Plans, the existing bridge structure, or the proposed bridge Plans so that these differences can be reconciled.

#### **F. Bracket Arms**

Install the specified type, design, kind, dimensions, and number of bracket arms on the lighting standards according to the Plans.

#### **G. Luminaires**

Mount or install the specified design and size of luminaire shown on the Plans. Level according to the manufacturer's recommendations and Plan details, and as approved by the Engineer.

##### 1. Position the Luminaires

Position luminaires to illuminate the roadway as follows:

- a. Provide glare shields on luminaires if required by the Plans.
- b. Where a lighting unit illuminates a roadway portion on a grade, rotate the luminaire on its major axis to bring the minor axis parallel to the roadway.

##### 2. Install Pole and Bracket Cable

Install the pole and bracket cable as follows:

- a. Clamp cables into the proper terminals on the luminaire's terminal board.
- b. Splice cables to the proper phase and neutral conductors outside the handhole in the pole base.
- c. Ensure that cables contain specified size and type in-the-line fuses and waterproof holders within each phase conductor.
- d. Leave enough slack in cables to check or replace the fuse outside of the handhole.

##### 3. Finish the Installation

- a. After making the required circuit splices outside the handhole, place wires inside the handhole.
- b. Leave slack in cables for future maintenance.
- c. Attach a suitable identification tag to each phase cable, using white for the neutral grounding wire.
- d. Clean the light control surfaces and glassware after installation. Clean according to the luminaire manufacturer's recommendations.

#### **H. Miscellaneous Electrical Items**

Install the following according to Plan details:

Ground rods, fuses, arresters, circuit breakers, disconnect switches, photoelectric controls, magnetic contactors, assemblies, related components, and incidental hardware.

Consider these Items to be incidental to the lighting system and include their cost in the Contract Price for other Items.

**I. Power Source**

Make prior arrangements for furnishing power to operate the lighting system. Notify the power company at least 30 days before needing to connect to the power source.

Connect the lighting system to the secondaries of the local power supplier's overhead or underground distribution system at the locations indicated on the Plans.

Unless otherwise specified, install the service pole, metallic conduit riser, weatherproof circuit breaker, and weatherhead with enough wire to connect to the power source.

**J. Field Painting**

After erecting nongalvanized steel standards, thoroughly clean and touch up the standards, as required, with 1B Orange or original type primer.

Apply remaining coats according to System V (Heavy Exposure) in Section 535, unless otherwise indicated on the Plans.

**K. Seed and Sod Repair**

If areas previously seeded or sodded are disturbed during this work, sprig, reseed (with mulch), or resod those areas according to Section 700.

**L. Final Cleanup**

Do final clean-up according to Subsection 104.07 as it applies. Before final inspection, touch up finishes, clean surfaces, and perform other tasks as directed by the Engineer to ensure the work's effectiveness and neat appearance.

**680.3.06 Quality Acceptance****A. Field Painting**

If the finish on galvanized steel material is scratched, chipped, or otherwise damaged, the material will be rejected. Repair the finish only with the Engineer's approval, according to Section 645.

**B. Testing**

Complete and energize each lighting circuit as early as practicable. Before beginning testing, provide an electrician, with a megger, a voltmeter, and an ammeter to perform the following tests.

Perform the tests in the presence of the Department's Inspector(s) for each lighting circuit. Make test data part of the project records.

## 1. Megger Reading

Megger the circuit conductors to be certain that the phase conductors have no grounds before connecting them to the source breaker, sign structure, lighting standard wiring, or lightning arresters. Test as follows:

- a. Test 480-volt systems at 1,000 volts dc.
- b. Test systems under 480 volts at 500 volts dc.
- c. Apply the test voltage for 10 minutes.

The minimum acceptable megger reading is one megohm.

## 2. Service Voltage

Measure the service voltage as follows:

- a. Measure the service voltage between the phase conductors before turning the circuit breaker on at the service point. Also measure the service voltage between each phase conductor and the neutral or ground.
- b. After observing the proper voltage as indicated on the Plans, turn the circuit breaker on, wait 10 minutes for the luminaires to warm up, and repeat the voltage measurements.
- c. After the circuit has been energized for at least 10 minutes, measure the load current in each phase conductor and in the neutral at the service point. Ensure that the current in the phase conductors is balanced and that there is no current in the neutral.

**C. Final Acceptance**

Final Acceptance of the lighting system will be withheld for a 30-day testing period of continuous nightly automatic operation or until all other items have been accepted, whichever occurs later. The testing period begins after completion of the lighting work. The Contractor is responsible for energy costs during the testing period.

## 680.3.07

### 1. Test and Acceptance Time

Begin the test period after one of the following, whichever occurs later:

- Completion of the lighting work
- Acceptance of all other items in the Contract (except grassing)

Any portion of this test period that occurs after all other Work has been accepted will not be charged against the Contract time.

### 2. Correction of Defects

Correct defects in material or workmanship at no expense to the Department if they occur during one of the following periods, whichever occurs later:

- During the 30-day test period
- Before the Project is accepted

If defects are identified during the 30-day test, correct the defects, then continue the test for another 30 days. Run the test each time a defect is identified and corrected until achieving uninterrupted, continuous nightly automatic operation for 30 days.

### 3. Final Voltage Test

After the testing period and at Final Acceptance, provide an electrician, a voltmeter, and an ammeter to perform this test as in Subsection 680.3.06.B.2, above. Perform the test in the presence of the Department's Inspector(s) for each lighting circuit. Make this test data part of project records.

## **680.3.07 Contractor Warranty and Maintenance**

General Provisions 101 through 150.

## **680.4 Measurement**

Highway lighting Items complete in place and accepted are measured as follows:

### **A. Lump Sum**

When the Contract contains an Item for highway lighting on a Lump Sum basis, measurement is for the total of all Items installed.

### **B. Separate Items**

When the Contract contains Items for separate elements of highway lighting, measurement for each Item is as follows:

#### 1. Conduit

Encased conduit, direct burial, and conduit on structures are measured by the linear foot (meter) for the type and size installed.

#### 2. Accessory Items

- a. Electrical junction boxes are measured by the unit, complete, in place for all types unless separated by type on the Plans.
- b. Pull boxes, ground rods, fuses, arresters, circuit breakers, disconnect switches, photoelectric controls, and magnetic contractors are not measured for payment separately, but are included in the overall cost of the lighting installation.

#### 3. Cable

Cable is measured by the linear foot (meter) from center-to-center of pull boxes, light standards, etc., for each specified conductor type, number, and size.

No additional allowance is made for slack length, length inside equipment or standards, and similar instances where additional wire length is required.

Cable for lighting towers and the pole and bracket cable lighting standards is not measured separately for payment.

#### 4. Lighting Standards and Towers

Each lighting standard, with or without a base, or each lighting tower of the specified kind, design, and mounting height (M.H.) is measured by the unit, complete in place.

Foundations for towers are measured separately.

Appurtenances for lighting standards and towers are measured as follows:

- a. The service car of the specified type and design is measured by the unit, including the drive motor.

- b. Lowering device power supply units are not measured for payment separately unless shown on the Plans as a separate payment Item. Unless otherwise specified, furnish one power supply unit for each project.
  - c. Foundations for lighting standards are not measured separately for payment.  
For lighting tower foundations, only the Class A concrete, reinforcement steel, and piling are measured according to applicable sections.
5. Luminaires  
Luminaires of the specified size, type, and design are measured per each by the unit.
  6. Transformer Bases  
Transformer bases, if shown on the Plans as a separate Pay Item, are measured by the unit.
  7. Service Pole Risers  
Service pole risers are measured by the unit, complete in place.

#### **680.4.01 Limits**

General Provisions 101 through 150.

### **680.5 Payment**

Payment for highway lighting will be made as follows:

#### **A. Lump Sum**

When the Contract indicates that payment for highway lighting elements will be made on a Lump Sum basis, the Lump Sum payment is full compensation for materials, labor, equipment, and incidentals necessary to complete the Item according to Plan details.

#### **B. Separate Items**

When the Contract contains items for various highway lighting elements, payment will be made for each item as follows:

1. Conduit
  - a. Encased conduit will be paid for at the Contract Unit Price per linear foot (meter) complete in place for each type installed.  
Payment is full compensation for excavating; required sheeting; backfilling; disposing of excess or unsuitable material; furnishing and placing materials; installing concrete, conduit, and reinforcement, when specified; installing bends, joints, fittings, and appurtenances; and installing encased conduit complete.
  - b. Direct burial conduit will be paid for at the Contract Unit Price per linear foot (meter), complete in place.  
Payment is full compensation for all applicable work and materials noted under Subsection 680.5.B.1.a for required conduit jacking and bedding materials.
  - c. Conduit on structures will be paid for at the Contract Unit Price per linear foot (meter), complete in place.  
Payment is full compensation for furnishing and installing all materials, including condulets, hangers, expansion fittings, grounding materials, associated hardware and accessories, and installation of conduit complete.
2. Accessory Items
  - a. Electrical junction boxes will be paid for at the Contract unit price per each.
  - b. Pull boxes, ground rods, fuses, arresters, circuit breakers, disconnect switches, photoelectric controls, and magnetic contactors will not be paid for separately. They will be included in the overall cost of the lighting installation.
3. Cable  
Cable, including direct burial cable, will be paid for at the Contract Unit Price per linear foot (meter), complete in place.  
Payment is full compensation for furnishing and installing the cable and ground materials; making splices, joints, and connections; trenching, furnishing and placing cushion and backfill material; and disposing of excess or unsuitable excavated material.  
Cable for lighting towers and the pole and bracket cable for lighting standards will not be paid for separately, but will be considered as an integral part of the lighting tower or lighting standard.
4. Lighting Standards and Towers  
Each light standard or lighting tower will be paid for at the Contract Unit Price per each.

Payment is full compensation for furnishing and installing the complete lighting standard or tower, including the bracket arm(s) or high mast luminaire support and lowering assembly, and associated hardware and connections; furnishing grounding material; furnishing backfill materials; backfilling; reshaping to proper contours; and repairing seeded or sodded areas.

Appurtenances for lighting standards and towers will be paid for as follows:

- a. When lighting towers are designed for the use of a service car, normally one unit is required for each project and will be paid for at the Contract Unit Price per each. Payment is full compensation for furnishing the complete service car, including the drive motor and required accessories.
- b. If specified as a separate payment Item, the power supply unit will be paid for at the Contract Unit Price per each. Payment is full compensation for furnishing the complete power supply unit, including transformer, if required, and required accessories.
- c. Foundations for lighting standards are considered an integral part of the lighting standard and will not be paid for separately.

For lighting tower foundations only, the Class A concrete, reinforcement steel, and piling will be paid for separately according to the applicable sections.

5. Luminaires

Luminaires will be paid for at the Contract Unit Price per each. Payment is full compensation for furnishing and installing the complete luminaire. Installation includes ballast(s), lamp(s), glare shields where required, and associated hardware and wiring.

6. Transformer Bases

When shown on the Plans as a separate payment Item, transformer bases will be paid for by the Unit for each specific size shown on the Plans.

7. Service Pole Risers

These will be paid for at the Contract Unit Price per each. Payment is full compensation for furnishing and installing the complete service pole riser as shown on the Plans. Installation includes the wood pole, metallic conduit riser, weatherproof circuit breaker(s), weatherhead, enough wire to connect to the power source, and other required accessories.

Payment will be made under Sections 681, 682, and 683.

8. Seed and Sod Repair

Include the costs incurred in reseeding, resodding, and otherwise restoring the areas to their original condition in the Contract Price for other Items. These will not be paid for separately.

9. Energy Cost During Testing

The Contractor is responsible for the energy cost of each circuit or part of a circuit during the test period.

The cost of energy consumed after the successful completion of the 30-day test period will be borne by others.

Payment Items related to this section are described in the following sections:

Lighting standards and luminaires	Section 681
Electrical wire, cable, and conduit	Section 682
High level lighting systems	Section 683

**680.5.01 Adjustments**

General Provisions 101 through 150.

**Section 681—Lighting Standards and Luminaires**

**681.1 General Description**

This work includes furnishing and installing lighting standards and luminaires for roadway and highway structure lighting systems, either complete or as indicated on the Plans.

**681.1.01 Definitions**

General Provisions 101 through 150.