SECTION 635 TRAFFIC SIGNALS AND ROADWAY LIGHTING

635.1 DESCRIPTION

This work consists of furnishing and installing all material and equipment necessary for the operation of traffic signals and roadway lighting.

635.2 MATERIALS

Materials for traffic signals and roadway lighting shall conform to Section 985.

635.3 CONSTRUCTION REQUIREMENTS

Installations shall comply with applicable sections of the NEC, State regulations, and local ordinances. Licenses or permits required shall be obtained by and at the expense of the Contractor.

Equipment and materials furnished shall be new.

The Contractor shall contact all utility companies to determine their involvement within the project limits and to notify them of the date that work is to begin. The Contractor shall contact the One Call Center in accordance with Section 5.6.

The Contractor shall arrange for necessary electrical services at locations specified, which have previously been agreed to by the Department and the utility company.

Upon completion of a roadway lighting project an operating test shall be conducted. The equipment shall be demonstrated to operate in a safe and proper manner. The Contractor shall provide required equipment to make the following tests:

A. Temporary power for the purpose of testing shall be provided by and at the expense of the Contractor.

B. Resistance to ground on nongrounded conductors shall be at least 5 megohm at 60EF (16EC) measured with a 1000 volt megger. The ground resistance shall not be more than 25 ohms.

C. Voltage readings shall be made at each service pole in the load contactor with load and without load, and at each fixture with load.

D. Current readings shall be made on the load side of each load contactor phase and neutral. Readings shall be made at nighttime with lighting systems in normal operation.

E. Photoelectric control units shall be positioned northward, except where light sources other than sunlight interfere with normal operation.

F. Data obtained from the tests shall be furnished in writing.

After the traffic signals or the lighting system have been turned on and found to be operating satisfactorily, the Engineer shall notify the Contractor of acceptance. Upon acceptance, the Contractor shall be relieved of routine maintenance responsibility. The Contractor is not relieved of responsibility for failures due to workmanship, materials, or equipment that occur during a six month period following the date of acceptance. The Contractor shall warrant and guarantee materials, electrical and mechanical equipment furnished and installed to be free from defects in materials and workmanship in accordance with the following:

Warranties and guarantees offered by electrical and mechanical equipment manufacturers shall be turned over to the maintaining authority at the time of acceptance of the project. The maintaining authority shall be named as the obligee on all manufacturer warranties and guarantees.

The Contractor shall warrant and guarantee satisfactory in-service operations of electrical and mechanical equipment, and related components, and replace or correct parts, except signal lamps, found to be defective within a six month period. Compensation will not be made for replacements and corrections. The warranty and guarantee requirements shall not apply to parts of electrical and mechanical equipment which have been subjected to misuse, negligence, or accident by other parties.

Cables shall be identified as shown on the field wiring diagram in hand holes, junction boxes, pedestal bases, electrical service cabinets, and controller cabinets. Labels to identify cables shall be plastic or cloth adhesive tape which is embossed or printed with numerals and letters and wrapped around the cable.

G. Electrical Bonding and Grounding: Grounding and bonding shall be in strict compliance with the National Electrical Code (NEC), local ordinances, and local utility company rules.

H. Electrical Conduit: Use and installation shall conform to NEC and the following requirements:

1. The size of the conduits installed shall not be less than the electrical trade size specified.

2. The location and direction of conduit runs is diagrammatic and may be shifted to meet field conditions.

3. Underground conduit shall be placed by trenching, jacking, or drilling methods. The use of the trenching method for placement under existing roadway pavements will be permitted only after jacking or drilling attempts have failed.

Trenches shall be backfilled and compacted to the same density as the adjoining ground. Roadway surfaces, sidewalks, curb and gutters, sod, etc., which are removed by trenching operations shall be replaced. The cost of removing and replacing these materials shall be incidental to the unit price bid for the conduit.

4. Where trenching operations require the removal of concrete pavement or sidewalk, the concrete shall be sawed full depth along the removal lines or the concrete shall be removed to existing joints.

5. Conduit entering through junction or pull box walls shall terminate approximately two inches (50 mm) in from the inside wall and not less than two inches (50 mm) above the bottom.

6. Conduit entering the traffic signal cabinet shall be sealed with paraffin or other approved sealing compounds to prevent the entrance of gases.

7. Metal conduit open ends in junction boxes or above concrete foundations shall be provided with an approved threaded conduit grounding bushing.

Nonmetallic conduit open ends shall have an approved bell end or bushing installed to prevent damage to cable or conductors.

8. Metal conduit ends shall be reamed to remove sharp edges and burrs. Threads on threaded conduit shall be painted with a good quality lead or rust preventive paint as the couplings are made up. Couplings shall be tightened until the ends of the conduit are brought together.

I. Junction Boxes: The top of the junction box shall be flush with surfaced areas and approximately one inch (25 mm) above earth or sodded areas.

J. Concrete Footings: The bottom of concrete footings shall rest on firm ground. The sides of the footings shall be formed by using an auger and then placing the concrete against the natural soil. A suitable form shall be used above existing ground line and all exposed portions shall be formed to present a neat appearance. The above ground portion of the footing shall be formed of sufficient size and shape so no part of the pole base, including transformer type bases, shall overhang or protrude beyond the footing. An acceptable form shall be used if the excavation is larger than the standard footing dimensions. Backfill must be replaced to a density equal to or greater than adjacent undisturbed natural soil.

A ½ inch (13 mm) conduit for grounding wire raceway shall be installed through the footing. Ground rods shall be a minimum of two feet (600 mm) from the footing.

K. Anchor Bolts: Anchor bolts shall be installed as specified by the manufacturer of the item for which they are intended.

L. Electrical Power Cables: Cables shall be installed using methods that will not injure the jacket, insulation, or conductors. All cables within a single conduit shall be placed at the same time. When powder or compound is required to ease pulling, the powder or compound shall be used according to manufacturer recommendations and the use shall not injure the cable.

The Contractor may substitute a multiple conductor cable having more conductors than specified if conduit fill requirements are not exceeded, subject to approval by the Engineer.

The Contractor may provide cables with conductor AWG size larger than specified where conduit fill requirements are not exceeded. When larger cables are substituted, they must extend from terminal to terminal for circuits used. Splicing to a conductor of a different size is not permitted.

1. **Underground Cable (Direct Burial):** Cables shall be installed using the trenching or plowing method at a 24 inches (600 mm) depth. At locations where a conflict exists, the depth may be altered as approved by the Engineer. Splices or connections will not be allowed in the earth. Splices and connections shall be made in hand holes, junction boxes, or pole bases.

   Backfill shall be kept free of stones, boulders, and other materials which might damage the cables.

2. **Pole and Bracket Cable:** A strain relief shall be utilized to support the weight of the cable on the "J" Hook in the pole.

M. Traffic Signal Control Cables: Conductor splices shall be made electrically secure, protected with vinyl plastic tape of an approved type, and insulated equal to the rest of the conductor. Insulated cables may be spliced only in pole bases, junction boxes, or cabinets.

Cables shall be installed using methods that will not injure the jacket, insulation, or conductors. All cables within a single conduit shall be placed at the same time. When powder or compound is required to ease pulling, the powder or compound shall be used according to manufacturer recommendations and the use shall not injure the cable.

The Contractor may substitute a multiple conductor cable having more conductors than specified if conduit fill requirements are not exceeded, subject to approval by the Engineer.

N. Electrical Service Cabinet: Electrical service cabinets shall be installed in accordance with the plans and the manufacturer's recommendations. A lock and two keys shall be provided.

O. Traffic Signal Poles: The following shall apply to traffic signal poles:

1. Poles shall be plumb when the bracket arms, signal heads, fittings, and fixtures have been installed and connections have been made. Nuts shall be firmly tightened.

2. Field repair of damaged galvanizing shall be done in accordance with AASHTO M36.

P. Roadway Lighting Poles: The following shall apply to roadway lighting poles:

1. Poles shall be plumb when the installation is complete and nuts are firmly tightened.

2. The mast arm shall be set perpendicular to the project center line.

3. Field repair of damaged galvanizing shall be done in accordance with AASHTO M36.

Q. Luminaries: Luminaries shall be adjusted on the support so the laminar sets level as indicated by a small bubble level. Bolts shall be firmly tightened.

R. Photoelectric Control Units: The photoelectric cell shall normally be positioned so that the light sensor is to the north. If light sources other than sunlight interfere with normal operation of the control, then it shall be adjusted in an attempt to obtain proper operation.

S. Controller Cabinet:

1. The controller cabinet shall be installed according to the directions supplied by the manufacturer.

2. Wiring and connections in the controller cabinet shall be neat, firm, and in accordance with industry standards and Section 985.1 N.

3. Three sets of wiring diagrams and three maintenance and operation manuals shall be supplied for each controller that is required. The Contractor shall place one set in the controller cabinet, give one set to the maintaining authority, and one set to the Engineer.

T. Controller: The installation of the controller and location in the cabinet shall be accordance with directions supplied by the manufacturer.

U. Detector Unit: Induction loop vehicle detectors shall be installed in accordance with the directions supplied by the manufacturer.

V. Detector Loops:

1. Clearance Between Loops and Metallic Objects: The Contractor shall provide sufficient clearance between detector loops and metallic objects such as manhole covers, drop inlets, etc., to avoid interference with the operation of the loop.

2. Sawed-in Loops:

a. Lead-in saw cuts shall clear each other by one foot (300 mm).

b. Backer rod material shall be cut into one inch by two inch (25 mm to 50

mm) lengths and spaced not farther apart than two feet (600 mm).

c. Saw slots in the pavement shall be blown out with compressed air and shall be clean and free of loose grit and moisture when wires are placed and sealer is applied.

d. The loop wires shall be pushed into the sawed slots with a blunt wood stick (not with a screwdriver). The wires shall be laid in the slots so there are no kinks or curls and without straining or stretching the insulation.

e. The flexible embedding sealer shall completely surround the ¼ inch (6 mm) tube, displace all the air within the sawed slot, and fill the area of the sawed slot except for that area which is taken up by the backer rod and the wires.

3. Preformed Loops:

a. If installation is on a grading project, each set of wires shall be tagged to identify loops and shall be taped together for future series splices.

b. If installation is on a signal project, tagging shall be done and wires connected in series.

4. Lead-ins: Lead-ins shall be twisted at least one turn per foot (300 mm). Splices shall not be made in the loop or lead-in conductors except in the junction box.

5. Splices in Junction Boxes: Splices shall be by one of the following methods:

a. Crimped with a crimper which insures a cold flow weld.

b. Twisted and soldered by a soldering iron (not a torch) with sufficient heat applied to the splice ("cold" soldered joints are not acceptable).

Splices shall be insulated with electrical tape or a "shrink sleeve" and waterproofed by one of the following methods:

c. A splice kit such as Scotchcast, Hysol, Hyseal, or approved equal.

d. By immersing the splice in silicone rubber sealer.

6. Connections in the Controller: Terminal board screws shall be turned down tightly on the lug. Shielding shall be grounded at the controller only.

7. Loop Testing: After installation, each loop shall be tested by the Contractor. Necessary equipment shall be furnished by the Contractor and test results recorded and furnished to the Engineer. Each detector loop shall conform to the following:

Continuity:	5 ohms maximum
Resistance, loop to ground:	10 megohms minimum
Inductance:	100-500 micro henries

W. Vehicular and Pedestrian Traffic Signal Heads:

1. Signal heads are to be rigidly attached to signal poles and shall appear vertical from the street approach which they control.

2. Signals heads which are mounted in place, but are not in operation shall be hooded or positioned so the lenses are not visible to any approach.

635.4 METHOD OF MEASUREMENT

A. Electrical Grounding and Bonding: No field measurement will be made.

B. Electrical Conduit: The plan shown quantity, of each type and size specified, will be the measured quantity unless changes are ordered by the Engineer.

C. Junction Boxes: Measurement will be by actual count of the various types and sizes of junction boxes furnished and installed.

D. Concrete Footings: Concrete footings of the various diameters will be measured to the nearest 0.1 linear foot (0.10 meter).

E. Anchor Bolts: No field measurement will be made.

F. Electrical Power Cable: The plan shown quantity, of each type, number of conductors, and size specified, will be the measured quantity unless changes are ordered by the Engineer.

G. Traffic Signal Control Cable: The plan shown quantity, of each type, number of conductors, and size specified, will be the measured quantity unless changes are ordered by the Engineer.

H. Electrical Service Cabinets: Measurement will be by actual count of cabinets furnished and installed.

I. Traffic Signal Poles: Measurement will be by actual count of the various types and sizes furnished and installed.

J. Roadway Lighting Poles: Measurement will be by actual count of the various types and sizes furnished and installed.

K. Luminaries: Measurement will be by actual count of the various types and sizes of luminaries furnished and installed.

L. **Photoelectric Control Units:** No field measurement will be made.

M. **Controller Cabinet:** No field measurement will be made.

N. **Traffic Signal Controller:** Measurement will be by actual count of controllers furnished and installed.

O. **Detector Units:** Measurement will be by actual count of detector units furnished and installed.

P. **Detector Loops:** Measurement will be actual count of detector loops installed.

Q. **Traffic Signal Heads:** Measurement will be by actual count of the various types and sizes of signal heads furnished and installed.

635.5 BASIS OF PAYMENT

A. **Electrical Grounding and Bonding:** The cost of furnishing and installing conduits for grounding will be incidental to the cost of footing, electrical service cabinet, or controller cabinet to be grounded.

B. **Electrical Conduit:** Conduit of each type and size specified will be paid for at the contract unit price per linear foot (meter). Payment will be full compensation for required materials, labor, equipment, and incidentals.

C. **Junction Boxes:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.

D. **Concrete Footings:** Payment for concrete footings of the various diameters will be at their respective contract unit prices per linear foot (meter). Payment will be full compensation for materials and labor necessary to satisfactorily install the footings.

E. **Anchor Bolts:** Cost for anchor bolts shall be included in the contract unit price for the item for which they are incorporated with.

F. **Electrical Power Cable:** Electrical power cable, of each type, number of conductors, and size specified, will be paid for at the contract unit price per linear foot (meter). Payment will be full compensation for required materials, labor, equipment, and incidentals.

G. **Traffic Signal Control Cable:** Traffic signal control cable, of each type, number of conductors, and size specified, will be paid for at the contract unit price per linear foot (meter). Payment will be full compensation for required materials, labor, equipment, and incidentals.

H. **Electrical Service Cabinet:** Payment for this item will be at the contract unit price per

each. Payment will be full compensation for furnishing and installing electrical service cabinets, including circuit breakers, fuses, contactor, photoelectric control, manual on/off switch, mounting pole, pad, and other materials and fixtures required. It shall also include any fees associated with hookup.

I. **Traffic Signal Poles:** Payment for traffic signal poles of the various types will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.

J. **Roadway Lighting Poles:** Payment for roadway lighting poles will be at the contract unit price per each. Payment will be full compensation for furnishing and installing roadway lighting poles.

K. **Luminaries:** Payment for luminaries of the various types and sizes will be at their respective contract unit prices per each. Payment will be full compensation for furnishing and installing luminaries.

L. **Photoelectric Control Units:** Cost of photoelectric controls shall be included in the contract unit price for other related contract items.

M. **Controller Cabinet:** The cost of controller cabinets is to be included in the contract unit price for traffic signal controllers.

N. **Controller:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing the controller cabinet and all required items included in the cabinet.

O. **Detector Unit:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing detector units.

P. **Detector Loop:** Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing detector loops.

Q. **Traffic Signal Heads:** Payment for this item for the various sizes will be at the contract unit price per each. Payment will be full compensation for furnishing and installing traffic signal heads, including mounting hardware, required bracketing, and backplates.