

**SECTION 49 SIGNALS, LIGHTING AND ELECTRICAL SYSTEMS  
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## **SECTION 49 SIGNALS, LIGHTING AND ELECTRICAL SYSTEMS**

### **49-1 GENERAL**

Signals, lighting and electrical systems shall be constructed or installed as shown or specified in the Contract, these Specifications, the applicable State Plans, and the applicable provisions of Section 86, "Signals, Lighting and Electrical Systems", of the State Specifications.

#### **49-1.01 Definitions**

Definitions for signals, lighting and electrical systems shall be as specified in Section 86-1.015, "Definitions", of the State Specifications, and the following:

**Programmed Visibility Signal Head**—A type of signal head that can be optically programmed to restrict visibility of indication(s) to only those areas or lanes designated.

**Signal Standard**—Any pole which supports signal head(s).

**Street Light Standard**—The pole, and mast arm if required, which supports the luminaire.

#### **49-1.02 Abbreviations**

Abbreviations for signals, lighting and electrical systems shall be as specified on page ES-1A of the State Plans, and the following:

**EVD**—Emergency Vehicle Detector

**I/C**—Interconnect Cable

**L.C.**—Lower Case

**PG&E**—Pacific Gas & Electric Company

**SMUD**—Sacramento Municipal Utility District

**U.C.**—Upper Case

#### **49-1.03 Regulation and Code**

Electrical equipment shall conform to the following standards wherever applicable: the International Municipal Signal Association (IMSA) and The National Electrical Code (NEC), as amended by the County, and the standards cited in the first sentence of Section 86-1.02, "Regulations and Code", of the State Specifications.

#### **49-1.04 Equipment List and Drawings**

If requested by the Agency, the Contractor shall submit for review sample articles of the material proposed for use. After review, said sample articles will be returned. The Contractor shall include on the equipment list and on the equipment itself the installation location of material supplied. This shall be done by the use of street names, the alphabetical letter designation used on the Plans, or a location as otherwise noted on the Plans. Equipment lists and drawings shall conform to Section 86-1.04, "Equipment List and Drawings", of the State Specifications.

The equipment and materials proposed for use on any project shall be approved by the Agency before starting work.

In conformance with the requirements in Section 11-3, "Record Drawings", of these Specifications, the Contractor shall maintain record drawings that shall show in detail the construction changes of all traffic signal and streetlight wiring, conduits, standards, and associated equipment. In particular, the record drawings shall accurately depict the location and depth of conduits, location of standards, pull boxes, wiring changes, and all applicable manufacturer's operation and maintenance information.

**49-1.05 Ordering of Signal and Lighting Equipment**

The Contractor shall place the order for long lead-time signal and lighting equipment not provided by the Agency within five (5) days of receiving notice that they have been awarded the Contract. The Contractor shall submit a copy of the equipment order to the Agency. Liquidated damages, as set forth in Section 8-10, "Liquidated Damages for Delay", of these Specifications, shall apply in case of failure to comply. No extension of time will be allowed for delay in delivery of traffic signal poles, street light standards, luminaries, or traffic signal equipment. The Agency hereby guarantees payment for long lead-time equipment ordered prior to execution of the Contract.

The Contractor shall furnish the Agency with a statement from the vendor(s) that the order for the electrical material required for the contract has been received and accepted by said vendor(s). Said statement shall be furnished within ten (10) days after receiving notice that the Contract has been executed for the Agency. Said statement shall give the date that the electrical equipment will be shipped.

**49-1.06 Maintaining Existing and Temporary Electrical Systems**

Maintaining existing and temporary electrical systems shall conform to Section 86-1.06, "Maintaining Existing and Temporary Electrical Systems", of the State Specifications, except that paragraphs 11, 12, and 13 shall not apply.

Existing electrical systems, including traffic signals, traffic signal vehicle and pedestrian detection facilities, traffic signal communication and monitoring facilities, street lighting facilities, flashing beacons and sign illumination facilities, or approved temporary replacements thereof, shall be kept in effective operation for the benefit of the traveling public during the progress of the Work, except when shutdown is permitted to allow for alterations or final removal of the systems.

The Contractor shall notify the Agency at least two (2) Working Days prior to performing any work on existing systems, including any work that may take vehicle detectors out of service or may reroute traffic off of existing vehicle detectors.

The Contractor shall notify the Agency at least two (2) Working Days prior to any operational shutdown of traffic signals, street lighting or other electrical systems or facilities.

Traffic control to direct traffic during the shutdown of a traffic signal system shall be provided by the Contractor at the Contractor's expense. The Contractor shall submit a traffic control plan to the Agency for review and approval a minimum of five (5) Working Days prior to a shutdown of a traffic signal. Traffic signal shutdowns shall be limited to Monday through Thursday, excluding holidays, from 9:00 a.m. to 3:00 p.m., or as specified in the Special Provisions.

Where a facility requires continuous lighting, the shutdown time shall be limited to one-half (1/2) hour as scheduled by the Agency, unless otherwise specified in the Special Provisions or permitted by the Agency. The shutdown of lighting systems shall not interfere with the regular lighting schedule, unless otherwise permitted by the Agency.

Vehicle detectors and pedestrian push buttons shall remain in operation at all times during the progress of the Work on an existing actuated traffic signal system, except as otherwise specified in the Special Provisions or as provided herein.

Vehicle detectors taken out of service shall be repaired or replaced within seventy-two (72) hours. New vehicle detectors for rerouted traffic shall be installed within seventy-two (72) hours. Where work site conditions do not permit the installation of permanent vehicle detectors within seventy-two (72) hours, temporary vehicle detectors shall be installed, at the Contractor's expense, as directed by the Agency. Permanent vehicle detectors shall be installed as soon as work site conditions permit.

#### **49-1.07 Scheduling of Work**

Scheduling of work shall conform to Section 86-1.07, "Scheduling of Work", of the State Specifications, except that paragraph 9 shall not apply.

Functional tests shall start on any Working Day except Monday, Friday, or the day preceding or following a legal holiday.

#### **49-1.08 Safety Precautions**

Attention is directed to Section 6, "Legal Relations and Responsibilities", of these Specifications. Before starting work on existing series street-lighting circuits, the Contractor shall obtain daily a safety circuit clearance from SMUD. By-pass switch plugs shall be pulled, "Men at Work" and other required construction signs posted, and lockouts installed at switch boxes before any work is done.

#### **49-1.09 Inspection**

Prior to backfilling conduit trenches or placing concrete foundations, the Contractor shall notify the Agency and request inspection of all conduits and foundation forms.

All conduits, conduit couplings, conduit bends and ground bushings shall be in place and properly tightened and secured, and all anchor rods, anchor bolts and ground rods shall be in place in the foundation form prior to the request for inspection. Wire shall not be pulled in conduits until inspection, backfilling and foundation concrete placement are completed. Stub ends of all conduits shall have approved caps and ground bushings installed prior to backfilling or placing concrete for foundations.

The Contractor shall not backfill, enclose, or otherwise cover up any electrical work prior to inspection or testing. Should any of the work be backfilled, enclosed or covered up, the work shall be exposed by the Contractor, at the Contractor's expense, for such inspection or testing.

#### **49-1.10 Signal Turn-On**

Traffic signals shall not be turned on until all signal heads, pedestrian heads, backplates, luminaries, detectors, push buttons, signs, and striping have been installed. The Contractor shall give written notice of intentions of signal turn-on at least three (3) Working Days prior to actual turn-on time so that Agency forces can accomplish the proper signing. The written notice shall be given to both the Traffic Signal and Street Light Manager (875-5327) and the Signs and Markings Manager (875-5133), and is to allow for a review of the signal prior to turn-on. These Agency personnel may request, and shall be granted, a new turn-on date and review, pending the results of their initial review.

Prior to actual turn-on time, the Contractor shall uncover all Agency-installed signs that have been installed prior to signal turn-on and are covered. Turn-ons shall take place between 11:00 a.m. and 2:00 p.m., Monday through Thursday. No signal turn-on shall be scheduled for the day before a holiday. No two-signal turn-ons on the same Contract shall be scheduled for the same day. All work done by the Contractor to accomplish these objectives is included in the price paid for the intersection, and no additional compensation will be allowed.

### **49-2 MATERIALS AND INSTALLATION**

#### **49-2.01 Trench Excavation and Backfill**

Unless otherwise shown or specified in the Contract, trench excavation and backfill shall conform to Section 19, "Trench Excavation, Bedding, and Backfill", of these Specifications, and restoration of surfaces shall conform to Section 14, "Restoration of Surfaces", of these Specifications. Trenching for signals, lighting and electrical systems may be made by earth saw trenching in accordance with the provision of Section 49-2.02, "Earth Saw Trenching", in this Section of these Specifications.

Unless otherwise permitted in writing by the Agency, all surplus excavated material shall be removed and disposed of the same day the surplus material is excavated.

The Contractor must contact Underground Service Alert a minimum of forty-eight (48) hours before any excavation work begins. The Contractor shall outline the excavation area in white.

#### **49-2.02 Earth Saw Trenching**

Trenching for signals, lighting, and electrical systems may be made by earth saw trenching. Trenches to be made by this method shall be cut by a machine that will produce smooth edge cuts in the pavement and will move at a speed in excess of four feet (4') per minute while cutting pavement. The trenching machine shall be shielded to prevent loose material from being thrown away from the machine.

The minimum trench depth shall be that which is necessary to provide for nine inches (9") minimum cover between the top of the conduit and the finished pavement grade. The trench section shall conform to Standard Drawing 4-31.

Loose material deposited on the pavement behind the cutting machine shall be removed from the pavement immediately and the pavement cleared to allow the passage of traffic. Only those traffic lanes occupied by the cutting machine and the cleanup operation shall be closed and they shall be opened as soon as the work has moved sufficiently to clear them.

The conduit shall be placed in the bottom of the trench and the trench shall be backfilled with portland cement concrete to match the existing pavement surface within areas that are to receive an asphalt concrete overlay as part of the same contract, and to within one inch (1") of the pavement surface of existing pavements that are not to receive an asphalt concrete overlay as part of the same contract.

The concrete shall be Class "C" concrete conforming to Section 50-5, "Portland Cement Concrete", of these Specifications, with one-inch (1") maximum size aggregate and one-inch (1") slump, and shall contain calcium chloride in an amount not to exceed three percent (3%) of the cement content. For electrical work, concrete shall be Class "B" concrete conforming to said Section 50-5, "Portland Cement Concrete", of these Specifications. The concrete shall be tamped or vibrated to provide a dense material free from voids and rock pockets.

The sides of the trench above the concrete backfill shall be coated with an asphaltic emulsion and the remaining depth of the trench shall be backfilled with asphalt concrete placed in one layer. The asphalt concrete shall conform to Section 23, "Asphalt Concrete", of these Specifications, and shall be manufactured with one-half inch (1/2") maximum-sized rock. The asphalt concrete shall be compacted to produce a uniform dense mixture with a surface elevation slightly higher than the adjacent pavement.

Once work is started on a trench, all work necessary to complete that trench, with the exception of the one-inch (1") permanent asphalt concrete surfacing, shall be performed during the same day. This includes cutting, placing of conduit or cable, removing all spoils from work site, barricades, maintaining a clean road surface for the safety of vehicular and pedestrian traffic, and backfilling trench with concrete.

The permanent asphalt concrete pavement replacement shall be completed no later than one Working Day following placement of the concrete backfill. Seal coats in accordance with Section 14-3.03, "Seal Coats", of these Specifications shall be placed to the full width of the pavement replacement plus twelve inches (12") on each side of trench, except that seals shall not overlap concrete curb and gutter.

Trenching in the medians shall be as specified above, except that the requirement to complete the trench on the same day shall not apply. In addition, median trenches may be backfilled to the surface of the median with concrete colored to match the color of the median surface.

### **49-2.03 Removing and Replacing Improvements**

Sidewalks, sprinklers and irrigation systems, curbs, gutters, portland cement concrete and asphalt concrete pavement, underlying material, lawns and plants, and any other improvements removed, broken or damaged by the Contractor's operations, shall be replaced or reconstructed with the same kind of material as found on the Work or with materials of equal quality. The new work shall be left in a serviceable condition.

Whenever a part of a square or slab of existing concrete sidewalk, curb, gutter, or driveway is broken or damaged, the entire square, section, or slab shall be removed or as directed by the Agency and the concrete reconstructed as above specified or as directed by the Agency.

The outline of all areas to be removed in portland cement concrete sidewalks, curbing, and driveways shall be cut to a minimum depth of two inches (2") with an abrasive type saw prior to removing the material. Cuts shall be neat and true along score lines or constructed joints, with no shatter outside the removal area. Cuts shall not extend beyond the limits of the removal area.

### **49-2.04 Foundations**

Foundations shall conform to Section 86-2.03, "Foundations", of the State Specifications, and these Specifications. Foundations shall conform to the size(s) and shape(s) shown on the Plans, the Standard Drawings, or the State Plans, or as otherwise detailed in the Contract, as applicable. The Contractor shall provide anchor bolts for all foundations unless otherwise specified in the Special Provisions. Anchor bolts shall be positioned so that a minimum of two (2) to a maximum of four (4) threads will be visible above the top nuts after the pole has been erected and plumbed. Rigid non-metallic conduit shall be allowed in traffic signal and street light foundations.

### **49-2.05 Standards, Steel Pedestals and Posts**

Standards, steel pedestals, and posts shall conform to Section 86-2.04, "Standards, Steel Pedestals and Posts", of the State Specifications, and these Specifications. Standards with an outside diameter greater than twelve inches (12") shall be round. Street light standards shall be galvanized steel, aluminum, or concrete. Galvanized steel street light standards shall conform to Standard Drawing 5-16 (Type B) or 5-17 (Type A). The type of street light standard shall be as shown on the Plans or in the Special Provisions.

#### **49-2.05.A Aluminum and Concrete Street Light Standards**

Aluminum and concrete street light standards shall conform to the American Association of Highway and Transportation Officials (AASHTO) "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals", and these Specifications. Standards shall be round in cross-section and have continuous tapered shafts and arms of approximately one-fourth inch (1/4") per foot. A wind velocity of seventy (70) miles per hour and a projected area of three (3) square feet of luminaire shall be used for the design of the standard. Handholes for standards shall be reinforced in such a manner as to distribute the load. Handholes shall be provided on the street-side of the standard and have a tamper-proof handhole cover. Eight (8) nuts and flat washers shall be provided for installing and plumbing the standards.

Type A aluminum and concrete street light standards shall be equipped with a two-inch (2") diameter by seven-inch (7") long tenon. Arm-to-standard connections shall be a three (3) bolt simplex type with five-eighths inch (5/8") H.S. cap screws. Standards with arms shall be provided with a raintight metal cap. Base plates for aluminum standards shall be provided with eleven and one-half inch (11-1/2") bolt circles. Bolt circles for concrete standards shall be twelve and one-half inches (12-1/2").

Type B aluminum and concrete street light standards shall be equipped with a two and seven-eighths inch (2-7/8") diameter by three inch (3") long tenon. Base plates shall be



provided with nine and one-half inch (9-1/2") bolt circles for aluminum standards and twelve and one-half inch (12-1/2") bolt circles for concrete standards.

Shop drawings for aluminum and concrete street light standards shall be submitted for approval before any fabrication is begun.

#### **49-2.05.B Placement of Standards, Enclosures, Posts and Associated Devices**

The Contractor is advised that traffic signal and pedestrian facilities in corner rounding areas are difficult to describe accurately on the Plans. These traffic signal and pedestrian facilities shall be field adjusted to conform to the following rules:

1. Pedestrian heads and crosswalks shall be located such that pedestrian heads are **not** located behind the respective stop bar.
2. Pedestrian push buttons shall be located within five feet (5') of their respective crosswalks, measured perpendicular to the crosswalk lines.
3. Sidewalk ramps and crosswalks shall be located such that the ramp pan falls entirely within the crosswalk lines.
4. Poles, push button posts, controller cabinets, interconnect terminal cabinets, and service enclosures shall be located such as to leave a minimum of four feet (4') of clear sidewalk width.
5. High (mast arm mounted) signal heads with all-left arrow indications shall be located at least two feet (2') into the controlled left turn only lane. If field conditions make this impossible, a programmed visibility head may be used and the extra cost compensable.

Any field adjustment needed to meet the above described criteria of location of crosswalks, signal poles, ramps, and pull boxes shall be considered incidental and no additional payment will be made. All field adjustments shall be coordinated with the Agency in the field.

#### **49-2.05.C Final Location of Traffic Signal Poles**

The Contractor shall pothole the pole location area for utility conflicts. If the site is found to be unsuitable, the Contractor shall re-pothole in the vicinity, as approved by the Agency, until a suitable location is found. Unused pothole areas shall be restored to their original or better conditions. The pothole and restoration work shall be considered as included in the contract lump sum price paid for individual traffic signal and no additional compensation will be allowed therefor.

#### **49-2.06 Conduit**

Conduit shall conform to Section 86-2.05, "Conduit", of the State Specifications, and these Specifications. Unless otherwise shown or specified in the Contract, conduit shall be rigid non-metallic. Rigid non-metallic conduit shall be electrical grade and be Schedule 40 or better.

Pole risers shall be two-inch (2") Schedule 80 rigid non-metallic conduit unless otherwise specified.

Schedule 40 rigid non-metallic conduit shall be used in signal, street light, controller, and service enclosure foundations. Install end bell fittings on all non-metallic conduits of one inch (1") and larger trade size.

All conduit systems, new or existing, shall be blown out with compressed air.

Conduits terminating in standards or enclosures shall emerge from the foundation vertically,  $\pm 5^\circ$  in any direction.

A solid No. 10 THW copper wire with green insulation shall be installed in all conduits which are to receive future conductors. All wires placed in conduits for future use at any one traffic signal location and for any traffic signal interconnect system shall be spliced to be electrically continuous.

All rigid non-metallic conduit shall be connected with the appropriate adhesive.

After conductors have been installed, the ends of conduits terminating in pull boxes, interconnect cabinets, controller cabinets, and service enclosures shall be sealed with an approved type of sealing compound.

All empty conduits shall be identified with their destination/termination point, and sealed with plugs approved for the purpose.

Conduit placed under sidewalks may have six inches (6") of cover, if the conduit trench is backfilled with concrete.

Conduit may be installed in paved areas of streets as specified in Section 49-2.02, "Earth Saw Trenching", in this Section of these Specifications. Conduit placed in existing paved areas shall be placed in a trench approximately two inches (2") wider than the outside diameter of the conduit to be installed. The trench shall not exceed six inches (6") in width. Conduit depth shall not exceed fourteen inches (14") or conduit trade diameter plus ten inches (10"), whichever is greater, except that at pull boxes the trench may be hand dug to a required depth. The top of the installed conduit shall be a minimum of nine inches (9") below finish grade. Provide four-inch (4") minimum width warning tape at least six inches (6") above buried conduit.

#### **49-2.07 Pull Boxes**

Pull boxes shall conform to Section 86-2.06, "Pull Boxes", of the State Specifications (paragraph 8 of Section 86-2.06A shall not apply except to traffic-rated pull boxes with steel traffic lids), these Specifications, and the Standard Drawings.

As required on Standard Drawings 5-20A and 5-20B, covers shall be factory-marked to indicate the contents of the pull box. Metal covers shall be marked by method "c" as described in Section 86-2.06B, "Cover Marking", of the State Specifications

Pull boxes shall be installed at the locations shown on the Plans and as required by these Specifications. With the exception of traffic signal interconnect conduit for conduit runs exceeding two hundred feet (200'), pull boxes shall be spaced at not over two hundred-foot (200') intervals unless indicated otherwise. The maximum spacing of pull boxes for traffic signal interconnect conduit shall be five hundred feet (500'). The Contractor, at the Contractor's expense, may install additional pull boxes to facilitate the Work.

The bottom of pull boxes installed in unimproved areas or in sidewalk areas shall be bedded on six inches (6") minimum layer of three-quarter inch (3/4") crushed rock.

The maximum depth of pull boxes shall be twenty-six inches (26") as shown on Standard Drawings 5-20A and 5-20B.

#### **49-2.08 Conductors**

Conductors shall conform to Section 86-2.08, "Conductors", of the State Specifications, and these Specifications. Section 86-2.08A, "Conductor Identification", of the State Specifications is amended to require the Contractor to use a different color-coded wire for each street lighting circuit with continuous color maintained throughout each circuit. The "Conductor Table" of said Section 82-2.08A shall be amended to include the following:

<b>CONDUCTOR TABLE</b>					
<b>Conductor Use</b>	<b>Signal Phase Or Function</b>	<b>Identification</b>			
		<b>Insulation Color</b>		<b>Label Designation</b>	<b>Conductor Size</b>
		<b>Base</b>	<b>Stripe</b>		
Irrigation Control	Underground-Line 1	Black	None	IR1	As Req'd.
	Neutral	White	None	IRN	As Req'd.
Neutral	Traffic Signals	White	None	TSN	As Req'd.
Neutral	Street Lighting	White	None	None	As Req'd.
Traffic Signal Communications	As Required	As Req'd.	As Req'd.	Per Special Provisions	As Req'd.
Highway (Street) Lighting Pull Box to Luminaire	As Required	As Req'd.	As Req'd.	None	As Req'd.
Multiple Highway (Street) Lighting	As Required	As Req'd.	As Req'd.	None	As Req'd.
Emergency Vehicle Preemption	As Required	Black or As Req'd.	As Req'd.	Per Special Provisions	As Req'd.
Inductive Loop Detector Circuits	Vehicle Detection	As Req'd.	None	Per Section 86-5.01A of State Specifications	As Req'd.

#### **49-2.08.A Signal Interconnect Cable**

Signal interconnect cable shall conform to the "International Municipal Signal Association, Specification No. 20-2, Polyethylene-Insulated, Polyethylene Jacketed Communication Cable", except that the signal interconnect cable shall be supplied without electrical shielding. The cable shall consist of twenty (20) twisted pairs of No. 20 AWG solid copper conductors.

Prior to delivery of the cable, the Contractor shall furnish the Agency with a certified report, in an Agency-approved form, of the tests made on the cable to show compliance with the Contract. In addition, the Agency may request samples for testing upon delivery of the cable to the work site, and, at Agency expense, test the samples for compliance with the Contract.

Cables shall only be installed under dry conditions. Each end of the cable shall be properly sealed against moisture intrusion and shall be protected against damage.

Cable shall be installed in conduit between termination points. Termination points are identified as controller cabinets, interconnect terminal cabinets, or master controller building. A minimum of five feet (5') of slack cable shall be left coiled at each termination point and in each pull box. The ends of all cables shall be taped and made waterproof by dipping in an approved sealer prior to being installed in conduit and prior to being left overnight. Unless otherwise specified or directed by the Agency, splicing of interconnect cable shall not be allowed.

After field testing of the cable by the Contractor, termination of cable will be made by Agency forces unless otherwise specified.

**49-2.08.B Interconnect Cable Testing After Installation**

Signal interconnect cable shall be tested in accordance with these Specifications.

The interconnect cable shall be installed and ready for cable testing twenty (20) Working Days prior to anticipated use of said cable.

Each insulated conductor in each length of completed cable, with all other insulated conductors grounded, shall have an insulation resistance of not less than the following:

<b>Cable Lengths, feet</b>	500	1000	1500	2000
<b>Megohms</b>	500	250	160	125

The tests shall be made using a 500-volt megohm meter applied for one (1) minute. The test may be terminated as soon as the measurement demonstrates that the specified value has been met or exceeded for a period of one (1) minute.

The direct current (D.C.) resistance of each pair shall be measured by connecting each pair together at one end of the cable and measuring loop resistance at the other end. The maximum resistance shall be 0.01012 OHMS per linear foot  $\pm 10$  percent for a single #20 AWG conductor.

If the cable being tested fails any one or more of the above tests, the Contractor shall replace the defective cable. No extension of time or compensation will be allowed for replacement of cable. All tests and corrections of failures shall be documented and shall be available for future reference.

All electrical tests shall be made after the cable has been installed in the conduit. The conduit shall also be filled with water.

**49-2.09 Wiring**

Wiring shall conform to Section 86-2.09, "Wiring", of the State Specifications, except that the first sentence of the last paragraph of Section 86-2.09D, "Splicing", and the first paragraph of Section 86-2.095, "Fused Splice Connectors", shall not apply, and these Specifications.

Conductors shall not be pulled into and through conduits until after pull boxes are set to grade, drain rock sumps installed, and the conduits bonded and cleaned out with the appropriate size swab or blown out with compressed air.

On 600-volt conductor splices of solid or stranded conductor sizes #14 AWG to #6 AWG, the Contractor has the option to use either crimp-type connectors or spring-type connectors of three-part construction. The three-part construction shall consist of a zinc-coated free expanding steel spring enclosed in a steel shell, with an outer jacket of polyvinyl chloride. The outer jacket shall have a flared skirt, be flexible, and be able to withstand 105°C temperature continuously. Each splice shall have the spring connector sized in accordance with the manufacturer's recommendations for the number of conductors and gages being spliced. Wire strip lengths shall also be in accordance with the manufacturer's recommendations. After the spring connector has been applied to the connection, the splice shall be coated by submersion with a corrosive-resistant, solvent-resistant, sealing, bonding and flexible electrical coating, having at least 100-volt/mil electrical strength. Upon coating of the splice, the flared skirt end shall be positioned in an upright alignment and maintained in place until the electrical coating is dry.

The use of heat shrinkable tubing will only be permitted for splicing of detector loop conductors and detector lead-in cables in accordance with Section 49-5.01.C, "Splicing Details", in this Section of these Specifications.

In the handhole section of each luminaire pole, a fused disconnect splice connector shall be installed in each ungrounded conductor between the line and the ballast.

Luminaires with up to 200-watt bulbs shall have six-amp (6A) fuses installed. Luminaires with 250 to 400 watt bulbs shall have ten-amp (10A) fuses installed. All fuses shall be midget ferrule type, rated at 600 volts, and fast blowing.

#### **49-2.10 Bonding and Grounding**

Bonding and grounding shall conform to Section 86-2.10, "Bonding and Grounding", of the State Specifications, except that paragraph 6 shall not apply, and these Specifications.

For bonding purposes in all non-metallic type conduits, a No. 6 copper wire shall be run continuously in circuits used for series lighting, and a No. 10 copper wire shall be run continuously in all other circuits. Where non-metallic conduit is to be installed for future conductors, a green No. 10 THW copper wire shall be installed in these conduits. Equipment bonding and grounding conductors are not required in conduits which contain only loop lead-in cable or signal interconnect cable or both.

Grounding jumper shall be attached by a three-sixteenths inch (3/16") or larger brass bolt in the standard or pedestal and shall be run to the metallic conduit, ground rod, or bonding wire in the adjacent pull box. The grounding jumper shall be visible and accessible after the cap has been poured on the foundation.

#### **49-2.11 Service**

Electrical service installation and materials shall conform to these Specifications.

Each service enclosure (or "can") shall be fabricated from 14 gauge Type 304D stainless steel and shall conform to the requirements for cabinets fabricated from stainless steel as specified in Section 86-3.07A, "Cabinet Construction", of the State Specifications, and these Specifications.

The mounting brackets shall be 10 gauge Type 304D stainless steel. All welds shall be of highest quality and ground smooth and finished so that grind marks are not visible.

The enclosure shall be rain-tight and dust-tight. For new construction, anchor bolts shall be inside the service enclosure. For modification construction, anchor bolts shall be inside or outside the service enclosure as shown on the Plans.

A hinged dead front plate with cutouts for the handles of the breakers and the switch shall be provided. A hinged outside door equipped with a heavy duty draw latch and two (2) heavy duty hasps suitable for padlocking shall be provided for the service section. The dead front panel on the service enclosure shall have a continuous stainless steel piano hinge.

The enclosure shall have no screws, nuts, or bolts on the exterior, except utility sealing screws. All screws, nuts, bolts, and washers shall be stainless steel. All hinges and hinge pins shall be stainless steel.

No surface of the enclosure shall be deflected inward or outward more than one-sixteenth inch (1/16"), measured from the intended plane of the surface.

Service enclosures shall be factory wired and conform to NEMA Standards. All control wiring shall be stranded copper, No. 14 AWG THHN/THWN rated for 600 volts. Wiring shall be arranged so that any piece of equipment can be removed without disconnecting any wiring other than the leads to the equipment being removed. All wiring shall be marked with permanent clip sleeve wire markers. Felt, pencil, or stick back markers will not be acceptable. A copy of the wiring diagram for the service enclosure and a typewritten circuit directory shall be enclosed in plastic and mounted on the inside of the front door.

All circuit breakers, contactors, and wire shall be listed by UL or ETL. The enclosure shall conform to the NEMA 3-R standard.

The terminal lugs or strips shall be copper or alloyed aluminum. All terminals shall be compatible with either aluminum or copper conductors.

The service enclosure shall have provisions for the installation of up to a total of sixteen (16) single-pole circuit breakers, including brass links and mounting hardware. Branch circuit panel

shall use loop wiring rated for 125 amperes with THHN/THWN insulation. All copper wiring used for main bussing shall be No. 2 AWG THHN/THWN and rated for 125 amperes.

Nameplates of a reasonable size identifying the control unit therein shall be installed on the dead front panel. Nameplates shall be black laminated plastic with white characters, and shall be fastened by screws.

The entire service enclosure shall be constructed with the highest quality workmanship and shall meet all applicable codes, and shall bear a factory applied label of approval by a recognized testing laboratory.

Complete shop drawings on all substitutions shall be submitted to the Agency for approval prior to fabrication. If the proposed substitute is rejected or if the submittal is not made within a reasonable time, the specified equipment shall be furnished.

The Contractor shall protect and lock the service enclosure during construction. When the Work has been accepted for maintenance, each enclosure shall be locked with a Contractor-supplied master lock that will accept a Type 2214 key.

Street light "ON" and "OFF" control will be by photoelectric cell. All conduits and wires shall be furnished and installed by the Contractor.

#### **49-2.11.A Metered Service (120/208 Volt, 120/240 Volt)**

The metered electrical service will be served from SMUD facilities as shown on the Plans. Unless otherwise specified, service shall be wired for 120/208 volts or 120/240 volts, three-wire and single phase as shown on the Plans.

New service enclosures shall be supplied and installed as shown on the Plans.

The service enclosure shall consist of a separate metering section and a service section. The metering section shall be complete with SMUD approved meter socket, steel socket cover, and manual circuit closing device.

The meter section shall have a removable cover with the top and front sections welded together so that it is rain-tight and padlockable. The meter section shall include provisions to allow SMUD to lock and seal the meter section.

The service enclosure shall be fabricated in accordance with the dimensions shown on Standard Drawing 5-8.

Mounted in each metered service enclosure shall be the following equipment:

1. Two 2-pole, 120-volt alternating current main breakers with 100-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. Each main breaker shall have an internal common trip. Each pole shall have individual "ON-OFF" control and handle tie for common operation. Breakers shall be Westinghouse Quicklag C or approved equal.
2. One single-pole, 120-volt alternating current branch circuit breaker for control circuit with 15-ampere trip and a rating of 10,000-amperes AIC at 120/240 volts. Breaker shall be Westinghouse Quicklag C or approved equal.
3. Two single-pole, 120-volt alternating current branch circuit breakers for traffic signals, each with 60-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. Breakers shall be Westinghouse Quicklag C or approved equal.
4. Minimum six, single-pole, 120-volt alternating current branch circuit breakers for street lighting, each sized per the Special Provisions and the Standard Drawings (minimum 30-ampere trip), and with a rating of 10,000 amperes AIC at 120/240 volts. Breakers shall be Westinghouse Quicklag C or approved equal.
5. Minimum two, 3-pole, normally open, 60-ampere mercury displacement lighting contactors. Coil voltage shall be 120 VAC, 60 cycle. Mercury displacement lighting contactors shall be Dayton Electric Manufacturing Co., Model Number 3X753E, or approved equal.
6. One oil tight "Hand-Off-Auto" selector switch.

7. One solid copper neutral bus.
8. Incoming terminals (landing lugs).
9. Solid neutral terminal strip.
10. Terminal strips for conductors within the cabinet.

**49-2.11.B Metered Service with Encapsulated Step-Down Transformer (277/480 Volt to 120-240 Volt)**

The metered electrical service will be served from SMUD facilities as shown on the Plans. Unless otherwise specified, service shall be wired for 277/480 volts, four-wire and three phase as shown on the Plans.

New service enclosures shall be supplied and installed as shown on the Plans.

The service enclosures shall consist of a separate metering section and a service section. The metering section shall be complete with SMUD-approved three-phase meter socket, steel socket cover and manual circuit closing device.

The meter section shall have a removeable cover with the top and front sections welded together so that it is rain tight and padlockable. The meter section shall include provisions to allow SMUD to lock and seal the meter section.

The service enclosure shall be fabricated in accordance with the dimensions shown on Standard Drawing 5-9.

Mounted in each metered service enclosure shall be the following equipment:

1. One 2-pole, 277/480-volt alternating current main breaker with 100-ampere trip and a rating of 14,000 amperes AIC at 277/480 volts. The main breaker shall have an internal common trip. Each pole shall have individual "ON-OFF" control and handle tie for common operation. Breaker shall be Westinghouse Quicklag GHC or approved equal.
2. Minimum six, single-pole, 277/480-volt alternating current branch circuit breakers for street lighting, each sized per the Special Provisions and the Standard Drawings (minimum 30-ampere trip), and with a rating of 14,000 amperes AIC at 277/480 volts. Breakers shall be Westinghouse Quicklag GHC or approved equal.
3. One single-pole, 120-volt alternating current branch circuit breaker for control circuit with 15-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. Breaker shall be Westinghouse Quicklag C or approved equal.
4. One single-pole, 120-volt alternating current branch circuit breaker for traffic signals, with 50-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. The breaker shall be Westinghouse Quicklag C or approved equal.
5. One 2-pole, 120-volt alternating current branch circuit breaker for intersection safety lighting, with 15-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. The breaker shall have an internal common trip. Each pole shall have individual "ON-OFF" control and handle tie for common operation. The breaker shall be Westinghouse Quicklag C or approved equal.
6. Minimum three, 3-pole, normally open, 60-ampere mercury displacement lighting contactors. Coil voltage shall be 120 VAC, 60 cycle. Mercury displacement lighting contactors shall be Dayton Electric Manufacturing Co., Model Number 3X753E, or approved equal.
7. One oil tight "Hand-Off-Auto" selector switch.
8. One solid copper neutral bus.
9. Incoming terminals (landing lugs).
10. Solid neutral terminal strip.
11. Terminal strips for conductors within the cabinet.

12. One single-phase transformer rated at 5KVA. Primary shall be 277 volts and secondary shall be 120volts. This transformer to be metered and shall supply the traffic signal power.
13. One single phase transformer rated at 2 KVA. Primary shall be 480 volts and secondary shall be 120/240 volts. This transformer to be unmetered and shall provide the power for intersection safety lighting and the control circuit.
14. Provide primary transformer protection per the NEC.

**49-2.11.C Unmetered Service (120/208 Volt, 120/240 Volt)**

The unmetered electrical service will be served from SMUD facilities as shown on the Plans. Service shall be wired for 120/208 volts or 120/240 volts, three-wire and single phase as shown on the Plans. The Contractor shall connect the luminaires to the circuits shown on the Plans.

New service enclosures shall be supplied and installed as shown on the Plans.

The service enclosures shall be fabricated in accordance with the dimensions shown on Standard Drawing 5-10.

Mounted in each unmetered service enclosure shall be the following equipment:

1. One, 2-pole, 120-volt alternating current main breaker with 100-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. The main breaker shall have an internal common trip. Each pole shall have individual "ON-OFF" control and handle tie for common operation. Breaker shall be Westinghouse Quicklag C or approved equal.
2. One single-pole, 120-volt alternating current branch circuit breaker for control circuit with 15-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. Breaker shall be Westinghouse Quicklag C or approved equal.
3. Minimum six single-pole, 120-volt alternating current branch circuit breakers for street lighting, each sized per the Special Provisions and the Standard Drawings (minimum 30-ampere trip), and with a rating of 10,000 amperes AIC at 120/240 volts. Breakers shall be Westinghouse Quicklag C or approved equal.
4. Minimum two 3-pole, normally open, 60-ampere mercury displacement lighting contactors. Coil voltage shall be 120 VAC, 60 cycle. Mercury displacement lighting contactors shall be Dayton Electric Manufacturing Co., Model Number 3X753E, or approved equal.
5. One oil tight "Hand-Off-Auto" selector switch.
6. One solid copper neutral bus.
7. Incoming terminals (landing lugs).
8. Solid neutral terminal strip.
9. Terminal strips for conductors within the cabinet.

**49-2.11.D Unmetered Service (277/480 Volt)**

The unmetered electrical service will be served from SMUD facilities as shown on the Plans. Service shall be wired for 277/480 volt, four-wire and three phase as shown on the Plans. The Contractor shall connect the luminaires to the circuits shown on the Plans.

New service enclosures shall be supplied and installed as shown on the Plans.

The service enclosures shall be fabricated in accordance with the dimensions shown on Standard Drawing 5-10.

Mounted in each unmetered service enclosure shall be the following equipment:

1. One 2-pole, 277/480-volt alternating current main breaker with 100-ampere trip and a rating of 14,000 amperes AIC at 277/480 volts. The breaker shall have an internal common trip. Each pole shall have individual "ON-OFF" control and handle tie for common operation. Breaker shall be Westinghouse Quicklag GHC or approved equal.



2. One single-pole, 277-volt alternating current branch circuit breaker for control circuit with 15-ampere trip and a rating of 14,000 amperes AIC at 277/480 volts. Breaker shall be Westinghouse Quicklag GHC or approved equal.
3. Minimum six single-pole, 277-volt alternating current branch circuit breakers for street lighting, each sized per the Special Provisions and the Standard Drawings (minimum 30-ampere trip), and with a rating of 14,000 amperes AIC at 277/480 volts. Breakers shall be Westinghouse Quicklag GHC or approved equal.
4. Minimum two 3-pole, normally open, 60-ampere mercury displacement lighting contactors. Coil voltage shall be 277 VAC, 60 cycle. Mercury displacement lighting contactors shall be Mercury Displacement Industries (MDI), Part Number 360NO-277V, or approved equal.
5. One oil tight "Hand-Off-Auto" selector switch.
6. One solid copper neutral bus.
7. Incoming terminals (landing lugs).
8. Solid neutral terminal strip.
9. Terminal strips for conductors within the cabinet.

**49-2.11.E Unmetered Service with Encapsulated Step-Down Transformer (277/480 Volt to 120/240 Volt)**

The unmetered electrical service will be served from SMUD facilities as shown on the Plans. Unless otherwise specified, service shall be wired for 277/480 volts, four-wire and three phase as shown on the Plans.

New service enclosures shall be supplied and installed as shown on the Plans.

The service enclosure shall be fabricated in accordance with the dimensions shown on Standard Drawing 5-11.

Mounted in each unmetered service enclosure shall be the following equipment:

1. One 2-pole, 277/480-volt alternating current main breaker with 100-ampere trip and a rating of 14,000 amperes AIC at 277/480 volts. The main breaker shall have an internal common trip. Each pole shall have individual "ON-OFF" control and handle tie for common operation. Breaker shall be Westinghouse Quicklag GHC or approved equal.
2. One single-pole, 120-volt alternating current branch circuit breaker for control circuit with 15-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. Breaker shall be Westinghouse Quicklag C or approved equal.
3. Minimum ten (10) single-pole, 120-volt alternating current branch circuit breakers for street lighting, each sized per the Special Provisions and the Standard Drawings (minimum 30-ampere trip) and with a rating of 10,000 amperes AIC at 120/240 volts. Breakers shall be Westinghouse Quicklag C or approved equal.
4. One single-pole, 120-volt alternating current branch circuit breaker for receptacle with 20-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. Breaker shall be Westinghouse Quicklag C or approved equal.
5. Minimum three, 3-pole, normally open, 60-ampere mercury displacement lighting contactors. Coil voltage shall be 120 VAC, 60 cycle. Mercury displacement lighting contactors shall be Dayton Electric Manufacturing Co., Model Number 3X753E, or approved equal.
6. One oil tight "Hand-Off-Auto" selector switch.
7. One solid copper neutral bus.
8. Incoming terminals (landing lugs).
9. Solid neutral terminal strip.
10. Terminal strips for conductors within the cabinet.

11. One single-phase transformer rated at 10KVA. Primary shall be 480 volts and secondary shall be 120/240 volts.
12. Provide primary and secondary transformer protection per the NEC.

#### **49-2.12 Testing**

Testing shall conform to Section 86-2.14, "Testing", of the State Specifications, except that the second sentence in paragraph one and all of paragraph four of Section 86-2.14A, "Materials Testing", and the third paragraph of Section 86-2.14C, "Functional Testing", shall not apply. Testing shall also conform to these Specifications.

Any fault in any material or in any part of the installation revealed by testing shall be replaced or repaired by the Contractor, at the Contractor's expense, in a manner approved by the Agency, and the same test shall be repeated until no fault appears.

Attention is directed to the additional requirements in the Special Provisions with regard to notifications, scheduling, and approval of testing for traffic signal and street lighting work.

New or modified street lighting work shall be tested with lamps being energized for 24 hours continuously. The tests of the street lighting shall be for the purpose of identifying the light distribution patterns, determining the acceptability of the ballasts, fixtures and lamps for electrical and noise standards, verifying that all connections are electrically and mechanically sufficient, and for other purposes as directed by the Agency or in the Special Provisions. The Contractor shall furnish all material and equipment for such testing at the Contractor's expense.

#### **49-2.13 Painting**

Painting shall conform to Section 86-2.16, "Painting", of the State Specifications, except that paragraphs 12 and 20 shall not apply and paragraph 7 shall be amended as noted below, and to these Specifications.

*Paragraph 7 (seven) of Section 86-2.16, "Painting", of the State Specifications shall be amended as follows:*

Existing equipment to be painted in the field, including Agency-furnished equipment, shall be washed with a stiff bristle brush using a solution of water containing two (2) tablespoons of heavy duty detergent powder per gallon. After rinsing, all surfaces higher than eight (8) feet above the ground shall be wire brushed with a coarse, cup shaped, power-driven brush to remove all poorly bonded paint, rust, scale, corrosion, grease or dirt. All surfaces between the ground level and eight (8) feet in height shall have all paint, rust, scale, corrosion, grease and dirt removed to bare metal. Any dust or residue remaining after wire brushing or removing to bare metal shall also be removed prior to priming. Immediately after cleaning, all bare metal surfaces shall be coated with one application of unthinned zinc-rich paint conforming to the requirements of Military Specification DOD-P-21035A. After the application of zinc-rich paint to bare metal surfaces and immediately after the cleaning of all galvanized surfaces and all non-ferrous metal surfaces, these surfaces shall be coated with one application of wash primer as specified in the Contract or conforming to the requirements of Military Specification MIL-P-15328D. The wash primer shall be applied by hand brushing to produce a uniform wet film on the surface.

All primer and paint shall be applied by hand brushing only.

All paint for new installations shall be factory applied. Manufacturer shall provide an appropriate amount of color-matched material for field application to repair damaged areas.

### **49-3 CONTROLLER ASSEMBLIES**

All controller assemblies will be furnished by the Agency unless otherwise shown or specified in the Contract.

The controller assemblies shall be installed complete by the Contractor. The Contractor shall construct the foundation and install the controller cabinet on the constructed foundation as shown on the Plans and as designated by the Agency. Seams where the controller cabinet rests on the foundation shall be sealed with an approved joint sealing compound. The Contractor shall make all wire connections to the appropriate terminals in the cabinet. All detector equipment external to the wired cabinet shall be furnished and installed by the Contractor. The Contractor shall provide anchor bolts for each controller cabinet.

Upon the receipt of a written request to the Agency at least two (2) Working Days in advance, equipment and materials will be made available to the Contractor for pick up. The Contractor shall be responsible for the safe pickup and delivery of the Traffic Controller Assemblies to the work site. Traffic Controller Assemblies shall be delivered directly to the work site and installed the same day they are acquired by the Contractor. See Section 49-7, "Agency-Supplied Equipment", in this Section of these Specifications for time, place, and person to contact for pick up arrangements.

#### **49-4 TRAFFIC SIGNAL FACES AND FITTINGS**

Traffic signal faces and fittings shall conform to Section 86-4, "Traffic Signal Faces and Fittings", of the State Specifications, and these Specifications.

##### **49-4.01 Vehicle Signal Faces**

All vehicle signal sections, housings, and visors shall be metal.

All reflectors shall be made of specular aluminum with an anodic coating.

The Contractor shall remove all manufacturing labels from the traffic signal head lenses prior to installation.

All vehicle signal heads (red circle, yellow circle, green circle, red arrow, yellow arrow, and green arrow) shall be Caltrans-approved "L.E.D." type.

##### **49-4.02 Programmable Directional Louvers**

Plastic programmable directional louvers will be permitted where shown or specified in the Contract. When permitted, plastic programmable directional louvers shall be Pelco Brand GPL (Geometrically Programmed Louver) or approved equal.

##### **49-4.03 Backplates**

Backplates shall be furnished and installed on all vehicle signal faces. All backplates shall be metal.

##### **49-4.04 Pedestrian Signal Faces**

Pedestrian heads shall use Caltrans-approved red L.E.D. illumination in the "upraised hand" portion of the head and white L.E.D. illumination in the "walking person" portion of the head.

Unless otherwise specified, the egg crate or Z-crate type screen shall be the only front screen allowed as specified under number 2 of Section 86-4.06B, "Front Screen", of the State Specifications, *modified as follows*:

The screen shall be fabricated from aluminum with an anodized flat black finish or finished with lusterless black exterior grade latex paint formulated for application to properly prepared metal surfaces, or shall be fabricated from flat black plastic.

The frame for the screen shall be aluminum alloy; polycarbonate will not be allowed.

Alternate methods of screening will not be permitted.

The Contractor shall mount the framework for all pedestrian signals such that the terminal section is positioned on the back side of the associated traffic signal poles, i.e., the side furthest from the public roadway.

Visors will not be required for pedestrian signal faces.

#### **49-4.05 Audible Pedestrian Signals**

In addition to each standard pedestrian signal shown on the Plan, the Contractor shall supply and install audible pedestrian signals. One audible pedestrian signal unit shall be supplied and installed for each standard pedestrian signal head installed as shown on the Plans. Audible pedestrian signal units shall be model APS-10 by Indicator Controls Corporation, or approved equal. Unit output volume shall be field adjustable and shall be capable of output of not less than 90db at 1 watt / 1 meter. Units shall be capable of automatic self-adjustment of output volume depending on ambient noise conditions. The type of signal output shall be field-selectable, with each unit capable of emitting both a “cuckoo” signal and a “peep-peep” signal.

Audible pedestrian signal units shall be mounted on top of the standard pedestrian signal heads with the face of the units tipped downward such that they are directed toward a point five feet (5') above the roadway surface in the center of the crosswalk at the edge of pavement on the opposite side of the associated crosswalk. Mounting of audible pedestrian signal units shall conform to manufacturer's recommendations and as directed by the Agency in the field.

#### **49-5 DETECTORS**

Detectors shall conform to Section 86-5, “Detectors”, of the State Specifications, and to these Specifications.

##### **49-5.01 Vehicle Detectors**

Unless otherwise specified in the Special Provisions, all vehicle detector sensor units in the controller cabinet will be provided by the Agency.

Splices shall be insulated as specified in these Specifications.

Detector lead-in cables shall be continuous, without splices, from the controller cabinet detector panel terminal block to the loop termination pull box unless otherwise shown on the Plans.

##### **49-5.01.A Construction Materials**

Each inductive detector loop conductor shall be continuous, unspliced, Type RHW-USE neoprene-jacketed or Type USE crosslinked polyethylene insulated No. 12 stranded copper wire. Conductor insulation thickness shall be forty (40) mils minimum.

Loop detector lead-in cable shall consist of four (4) No. 18 AWG stranded copper conductors insulated with nine (9) mils minimum of polypropylene, color coded, parallel laid, twisted together with four (4) to six (6) turns per foot. An amorphous interior moisture penetration barrier shall be provided to prevent hosing, siphoning, or capillary absorption of water along cable interstices. Aluminum-polyester shielding shall be applied around the conductors. The outer jacket shall be thirty-two (32) mils minimum in thickness, high density polyethylene conforming to ASTM Designation: D 1248, 65T for Dielectric Material, Type I, Class C, Grade 5, J3. The diameter of the lead-in cable shall be approximately one-quarter inch (0.25”).

##### **49-5.01.B Installation Details**

Installation and testing shall conform to the details and notes shown in the Standard Drawings and these Specifications.

Unless otherwise shown on the plans or specified in the Special Provisions, loop detectors shall be installed after the construction of all lower lifts of paving and after construction of pavement leveling courses but prior to the placement of the final lift of asphalt concrete for the affected portion of the roadway.

Unless otherwise shown or specified in the Contract or directed by the Agency in the field, each new detector loop shall be five feet by five feet (5' x 5') and shall be centered in the

traveled lane. All detector loops shall be field marked by the Contractor and their location approved by the Agency prior to pavement cutting. For installations that will serve lanes that are not parallel or concentric to lane markings existing at the time of loop installation, the Contractor shall accurately mark the future lane lines prior to pavement cutting.

Sawcut slots shall be cut into the pavement to the depth and width shown on the Standard Drawings. Slots cut in the pavement shall be blown out with compressed air, then dried and inspected for any sharp objects or corners, which shall be removed prior to installation of loop conductors. All conductors and conductor loops installed in the traveled way shall be installed so that the top of the conductor is a minimum of five-eighths inch (5/8") below the surface grade of the street.

Unless specified otherwise, each loop shall consist of the three (3) turns of conductors for each detector loop. All detector loops located two hundred fifty feet (250') or farther from the stop line shall consist of four (4) turns of conductors for each detector loop.

The loop conductors shall be installed in the slots using a five-sixteenths inch (5/16") to one-quarter inch (1/4") wooden paddle. As it is installed, the wire shall be kept under slight tension and shall be kept in the slots with suitable cardboard wedges. The cardboard wedges shall not be removed until the loop sealant operation requires removal.

Loop conductors shall be installed without splices and shall terminate in the nearest pull box. Detector loops shall be joined, in series, in the nearest pull box. See the Standard Drawings for typical loop connection details.

Each detector loop shall be identified and tagged by loop number, start (S), and finish (F). Loop lead-ins shall be individually identified as shown on the Plans. Identification shall be by means of bands placed on the lead-in cable.

Each detector loop circuit shall be tested for continuity, circuit resistance, and insulation resistance at the controller location. The loop circuit resistance shall not exceed 0.50 ohms plus 0.35 ohms per one hundred feet (100') of lead-in cable. The insulation resistance shall be performed between each circuit conductor and ground. The megged insulation resistance shall not be less than two hundred (200) megohms. The Contractor shall replace any detector loop that fails this requirement at the Contractor's expense. All test results and corrections of failures shall be documented. Test documentation shall be provided to the Agency to become a permanent record for future reference. All testing shall be completed to the satisfaction of the Agency prior to traffic signal turn-on.

All loop conductors shall be spliced to a lead-in cable, which shall be run from the pull box adjacent to the loop detector to a sensor unit mounted in the controller cabinet. All splices between loops and the lead-in cable shall be soldered.

If the conduit is not dry, the ends of all lead-in cable shall be taped and waterproofed prior to installation. If splicing is not done immediately after installation, the ends of both the loop conductors and lead-in cable shall be taped and waterproofed with an electrical insulating coating. The insulating coating shall be fast drying, resistant to oils, acids, alkalis and corrosive atmospheric conditions and shall be compatible with the insulations used in the conductors and cables.

Sealant for inductive loop detectors shall be supplied and installed by the Contractor in accordance with Section 86-5.01A(5), "Installation Details", of the State Specifications, with these Specifications, and with the following:

Sealant for loop detectors shall be as specified for Elastomeric Sealant.

Epoxy sealant will not be permitted.

The Agency may allow the use of Asphaltic Emulsion Sealant in areas scheduled for asphalt concrete overlay.

Detector handholes shall be type "B." Detector handholes shall be installed at the locations shown on the Plans, in the center of the lanes and in conformance with the Standard Drawings.

The cement used to joint the ABS sweep “Y” to the PVC conduit shall be capable of providing a solvent type weld between the two materials.

#### **49-5.01.C Splicing Details**

All splicing shall be made in a dry environment. The splice between the lead-in cable and the loop conductors in the adjacent pull box shall be a soldered waterproof type. This shall be accomplished by stripping and cleaning ends of wires, twisting ends together, dipping twisted ends in flux, then soldering. Open flame soldering will not be permitted. Wire insulation shall not be damaged while soldering. The soldered splice shall then be protected with an electrical spring connector of three- (3) part construction.

The 3-part construction spring connector shall consist of a zinc-coated, free-expanding steel spring enclosed in a steel shell with a jacket of polyvinyl chloride. The outer jacket shall have a flared skirt, be flexible, and be able to withstand 105°C temperature continuously. Each splice shall have the spring connector sized in accordance with the manufacturer's recommendations for the number of conductors and gauges being spliced. Wire strip lengths shall also be in accordance with the manufacturer's recommendations.

After the spring connector has been applied to the splice, the Contractor shall apply tape sealant to the splice. The tape sealant shall be applied over the entire area of the splice and overlap the spring connector and detector lead-in cable at least one and one-half inches (1-1/2”). The tape sealant shall be Thomas and Betts Catalog No. HSTS25 or approved equal.

The Contractor shall then apply heat-shrink tubing over the splice. Heat shrink tubing shall be medium or heavy wall thickness irradiated polyolefin tubing containing an adhesive mastic inner wall. Minimum wall thickness prior to contraction shall be 0.04 inch. When heated, the inner wall shall melt and fill all crevices and interstices of the object being covered while the outer wall shrinks to form a waterproof insulation. Each end of the heat-shrink tube or the open end of the end cap of heat-shrink tubing shall, after contraction, overlap the conductor insulation at least one and one-half inches (1-1/2”). Heat shrink tubing shall conform to the requirements of UL Standard 468D and ANSI C119.1, for extended insulated tubing at 600 volts. The Contractor shall use the appropriate size heat-shrink tubing from the following Thomas and Betts Catalog Numbers HS6-1, HS6-1L, HS4-30, HS40-400 or equal product if approved by the Agency.

All heat shrink tubing shall meet the following requirements:

Shrinkage Ratio:	33 percent, maximum, of supplied diameter when heated to 125°C and allowed to cool to 25°C
Dielectric Strength:	350 kilovolts per inch, minimum
Resistivity:	10 <sup>14</sup> ohms - centimeter, minimum
Tensile Strength:	2,000 lbs. per square inch, minimum
Operating Temperature:	-40°C to 90°C (135°C Emergency)
Water Absorption:	0.5 percent, maximum

When three (3) or more conductors are to be enclosed within a single splice using heat-shrink tubing, mastic shall be placed around each conductor, prior to being placed inside the heat-shrink tubing. The mastic shall be the type recommended by the manufacturer of the heat-shrink tubing.

Heat-shrink tubing shall not be heated with an open flame. A heating device designed for the purpose is required. Immediately after heating the splice and while the internally-applied sealant is still liquid, the open end of the splice shall be clamped together until the sealant dries.

If any detector lead-in splice fails within one (1) year due to poor workmanship, the Contractor shall replace all detector lead-in splices made by the Contractor within said intersection.

Where shown on the Plans, detector loops shall be sawcut into detector handholes. Detector handholes shall be installed in accordance with these Specifications and as shown on the Standard Drawings unless otherwise specified or directed by the Agency. No splicing will be permitted in the detector handholes.

Conduit from the detector handhole to the adjacent pull box shall be sized as shown below:

Conduit Size	Loop Conductors
1-1/2" minimum	1-4 pairs
2" minimum	5 or more pairs

**49-5.02 Emergency Vehicle Detector Cable, Detectors, and Phase Selectors**

The Contractor shall supply and install 3M Opticom cable model 138, or approved equal, where emergency vehicle detector (EVD) conductors are shown on the Plans. Opticom cable shall be installed to the EVD installed on the traffic signal mast arms, as shown on the Plans.

The Contractor shall supply and install EVD’s for each mast arm signal installation and at locations shown on the Plans. Unless otherwise shown on the Plans, EVD’s shall be 3M Opticom model 721, or approved equal. EVD’s shall be installed on the top of the signal mast arm at the locations indicated on the Plans or at the location on the mast arm as directed by the Agency in the field. For each EVD installation, the associated cable shall be continuous and unspliced from the detector to the controller cabinet. The Contractor shall provide for five feet (5’) of conductor slack in the pull box at the base of each pole with an EVD installation.

Unless otherwise shown or specified in the Contract, the Contractor shall supply two (2) EVD phase selectors for each new traffic signal controller cabinet installed under the Contract. EVD phase selector(s) shall be 3M Opticom model 752 or approved equal. The Contractor shall supply the phase selector(s) to the Agency a minimum of two weeks prior to the date of traffic signal controller cabinet installation.

**49-5.03 Pedestrian Push Buttons**

Pedestrian push buttons shall be Type B. Types A and C shall not be used. All pedestrian push buttons shall be the large A.D.A. type with a two-inch (2”) diameter button by Synchronex IASY 2021-41 (green) or I.D.C. HS-7999 A.D.A. (olive), or approved equal. Pedestrian push buttons shall be mounted at a height of thirty-six inches (36”) from the walkway surface.

Pedestrian push button signs shall be Pelco series SF1017-SF1020 or approved equal. The signs shall be metal. Structural plastic signs shall not be used.

Pedestrian push button housings shall be either die-cast or permanent mold cast aluminum.

**49-6 LIGHTING**

Lighting shall conform to Section 86-6, “Lighting”, of the State Specifications, and these Specifications.

**49-6.01 High Pressure Sodium Luminaires**

High pressure sodium luminaires shall conform to Section 86-6.01, “High Pressure Sodium Luminaires”, of the State Specifications, and these Specifications. Isofootcandle diagrams are not required to be shown on the Plans. The light distribution pattern for each luminaire shall be ANSI Type III.

Type A street light luminaires, including those at signalized intersections, shall have internal ballasts. All luminaires over one hundred (100) watts shall have a multi-tap ballast with a voltage range from 120 to 277 VAC. The luminaires shall be cut-off type unless otherwise specified by the Agency.

Type B street light luminaires shall be high pressure sodium vertical burning type. The luminaire housing shall be die-cast aluminum with a removable access door providing direct exposure to all electrical components, and shall be equipped with a slipfitter mounting unit for attachment to a three inch (3") tenon with a 2-7/8 inch to 3 inch tenon diameter. The housing shall contain the ballast, capacitor assembly, a terminal block for the necessary wires, and a porcelain lamp socket. The hood shall be spun or formed aluminum, with a twenty-two inch (22") minimum diameter. The refractor shall be acrylic plastic. All gaskets shall be composed of material capable of withstanding the temperature involved and they shall be securely held in place. All parts of the luminaire shall be manufactured from corrosion-resistant materials. Ballasts shall be integral to the housing. Color shall be aluminum baked enamel finish and shall resist heat, abrasion and weathering.

#### **49-6.02 Lamps and Ballasts**

Lamps shall conform to Section 86-6.01B, "High Pressure Sodium Lamps", of the State Specifications, and these Specifications. Each high pressure sodium luminaire shall be furnished with a high pressure sodium lamp of wattage as shown on the Plans. In addition to the high pressure sodium lamps specified in the State Specifications, the following high pressure sodium lamps shall be used when shown on the Plans:

<b>Lamp ANSI Code No.</b>	<b>Lamp Wattage</b>
S68	50
S62	70
S54	100

The Contractor shall, as part of the guarantee, replace with the Contractor's forces at the Contractor's expense any and all lamps that fail within a one-year period following final job acceptance. If the Contractor fails to respond within two (2) Working Days after notification, the Agency reserves the right to replace the lamp and the Contractor shall pay the Agency fifty dollars (\$50) for each lamp replaced for such failure.

Ballasts shall conform to Section 86-6.01A, "High Pressure Sodium Lamp Ballasts", of the State Specifications, except that Section 86-6.01A(2), "Autotransformer or Reactor Type Ballasts", shall not apply, and to these Specifications. The ballast for one hundred (100) watt high pressure sodium luminaires shall be energy efficient as in the American Electric luminaires 1) model C245-014 with a photoelectric unit receptacle and 2) model S450-314 without a photoelectric receptacle unit, or approved equal.

#### **49-6.03 Internally Illuminated Street Name Signs**

Internally illuminated street name signs shall be Type "A", double faced in accordance with State Plan ES-33 and Section 86-6.065, "Internally Illuminated Street Name Signs," of the State Specifications. Signs shall have standard clamps and mounts per the State Specifications, with the following exceptions: a) the top nut will be a one-half inch (1/2") stainless steel hex nut, "Nylock" self locking or approved equal, and b) the cotter pin will be stainless steel, three-thirty secondths inch by one inch (3/32" x 1") per mount. The internally illuminated street name signs shall be mounted on a separate support arm between the signal mast arm and the street light arm, as shown on the Standard Drawings.

The sign faces shall be fabricated from flexible, colored, wide-angle prismatic retroreflective sheeting, tape and related processing materials designed to enhance the visibility of the street name signs. The retroreflective sheeting for sign faces/finished signs shall have a smooth surface with a distinctive interlocking diamond seal pattern and orientation marks visible from the face. The sheeting shall be precoated with a pressure sensitive adhesive backing protected



by a removable liner. The adhesive shall require no heat for proper bonding when applied in accordance with the manufacturer's recommendations to substrates sixty-five degrees (65°) F or above. The retroreflective sheeting shall be 3M, "Scotchlite", Diamond Grade Series 3970G or approved equal.

Internally illuminated street name sign conductors shall be terminated in a "condulet" on the mast arm, one-half inch (1/2") rain tight fitting, "Crouse-Hinds" or approved equal. Separate conductors shall be continued from the fitting to the sign panel. The street name sign circuit shall be spliced in the pull box at the pole base. A six-amp fuse shall be provided in the handhole access between the splice and the sign panel and shall be clearly labeled.

#### **49-6.04 Photoelectric Controls**

The control circuit wiring between the photoelectric unit and the contactor shall be installed as shown on the Standard Drawings. The photoelectric unit will be supplied by the Agency.

Unless otherwise shown or specified in the Contract, the photoelectric controls shall be Type II as modified herein. Type II photoelectric control shall consist of a luminaire mounted EEI-NEMA twist-lock type photoelectric unit in a weatherproof housing, a separate contactor and a test switch located in the service enclosure.

Switches shall be furnished with an indicating nameplate reading "Hand-Off-Auto" and shall be connected as specified in Section 49-2.11, "Service", in this Section of these Specifications and as shown on the Standard Drawings. Test switch shall have an "OFF" position.

##### **49-6.04.A Photoelectric Unit**

The photoelectric unit will be supplied by the Agency. The photoelectric unit receptacle shall be an EEI-NEMA twist-lock type and shall be provided on the luminaire(s) as shown on the Plans. If approved by the Agency, mounting brackets shall be used where luminaire mounting is not possible.

##### **49-6.04.B Contactors**

Contactors shall be as specified in Section 49-2.11, "Service", in this Section of these Specifications and as shown on the Standard Drawings.

##### **49-6.04.C Contactor and Test Switch Housing**

Contactor and test switch housing shall be as specified in Section 49-2.11, "Service", in this Section of these Specifications and as shown on the Standard Drawings.

##### **49-6.04.D Wiring**

Wiring shall be as specified in Section 49-2.11, "Service", in this Section of these Specifications and as shown on the Standard Drawings.

#### **49-7 AGENCY-SUPPLIED EQUIPMENT**

All equipment and materials supplied by the Agency will be available to the Contractor at the County Corporation Yard at 4135 Traffic Way near the intersection of Bradshaw Road and Kiefer Boulevard. The Contractor shall inform the Agency and the Traffic Signal and Street Light Manager (875-5327) at least two (2) Working Days in advance of date equipment pickup is required. The hours for pickup are 9:00 a.m. to 3:00 p.m. Monday through Thursday. Full compensation for pick-up and transport to the job site shall be considered as included in the lump sum price for the traffic signal work.

#### **49-8 REMOVING AND SALVAGING ELECTRICAL EQUIPMENT**

All traffic signal and street lighting equipment shown on the Plans as "Salvaged to the County", including but not limited to such items as controller units, cabinets, signal heads, luminaires, standards, mast arms, ballasts, service equipment, conduit, conductors, cables, and

detector contact items, shall be delivered, in the same condition as before removal, by the Contractor to the County Corporation Yard located at 4135 Traffic Way.

All poles, signal arms, luminaire arms, tie rods, and appurtenances shall be tagged with a suitable waterproof tab and marking pen before removal from the work site. The tag shall give the date, the intersection name, corner, and location from which the equipment was removed as shown on the Plans.

The Contractor shall inform the County Traffic Signal Shop (875-5327) at least two (2) Working Days in advance of the date equipment drop-off is required. The hours for drop-off are 9:00 a.m. to 3:00 p.m., Monday through Thursday. The Contractor shall be responsible for unloading the equipment at the County Corporation Yard, including providing any necessary cranes or other lifting devices. Full compensation for transport to and drop-off at the County yard shall be considered included in the lump sum price paid for the traffic signal work. All other traffic signal and street lighting equipment shown on the Plans as salvaged shall become the property of the Contractor and shall be removed from the right-of-way by the Contractor.

#### **49-9 PAYMENT**

The lump sum price or prices paid for signal, lighting, electrical system, or combinations thereof; for modifying or removing such systems; for temporary systems; or the lump sum or unit prices paid for various units of said systems include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in furnishing and installing, modifying, or removing the systems, combinations or units thereof, as shown or specified in the Contract, these Specifications, and directed by the Agency. The price also includes pull boxes; excavation and backfill; concrete foundations (except when shown as a separate contract item); pedestrian barricades; furnishing and installing illuminated street name signs; installing Agency-furnished sign panels and equipment; salvaging existing materials; and performing required tests.

Full compensation for all additional materials and labor, not shown or specified in the Contract or these Specifications, which are necessary to complete the installation of the various systems, is included in the prices paid for the systems, or units thereof, and no additional compensation will be paid.

Full compensation for pick up and safe and direct transport of controller assemblies and other Agency-furnished materials and equipment to the Work is included in the price paid for the various items of work and no additional compensation will be paid.

Full compensation for loading and transporting the salvaged equipment to the stockpile location is included in the price paid for the various items of work and no additional compensation will be paid.