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 must be constructed or installed as shown or specified in the Contract, these Specifications, the applicable State Plans, and the applicable provisions of the State Specifications.

49-1.01 Definitions

Definitions for signals, lighting and electrical systems must be as specified in 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 that supports signal head(s).

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

49-1.02 Abbreviations

Abbreviations for signals, lighting and electrical systems must be as specified on State Plans, and the following:

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 must 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 State Specifications.

49-1.04 Equipment List and Drawings

If requested by the Agency, the Contractor must submit for review sample articles of the material proposed for use. After review, said sample articles will be returned. The Contractor must include on the equipment list and on the equipment itself the installation location of material supplied. This must 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 must conform to the State Specifications.

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

In conformance with the requirements in Section 11-3, “Record Drawings”, of these Specifications, the Contractor must maintain record drawings that must show in detail the construction changes of all traffic signal and streetlight wiring, conduits, standards, and associated equipment. In particular, the record drawings must 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 must place the order for long lead-time signal and lighting equipment not provided by the Agency within 5 Calendar Days after the date of the Notice to Proceed or within 5 Calendar Days after the start of the Contract Time, whichever comes first. The Contractor must 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, 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 must 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 the vendor(s). The statement must be furnished within 10 Calendar Days after receiving notice that the Contract has been executed for the Agency. The statement must give the date that the electrical equipment will be shipped.

49-1.06 Maintaining Existing and Temporary Electrical Systems

Existing electrical systems, including traffic signals, traffic signal vehicle and pedestrian detection facilities, traffic signal/Intelligent Transportation System (ITS) 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 ascertain the exact location and depth of existing detectors, conduits, pull boxes and other electrical facilities before using any tools or equipment that may damage those facilities or interfere with any electrical system.

The Contractor must notify the Agency at least 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 must notify the Agency at least 2 Working Days prior to any operational shutdown of traffic signals, traffic signal/ITS communications, street lighting or other electrical systems or facilities.

Traffic control to direct traffic during the shutdown of a traffic signal system must be provided by the Contractor at the Contractor's expense. The Contractor must submit a traffic control plan to the Agency for review and approval in accordance with Section 12-4, "Traffic Control Plans (TCP)," of these Specifications prior to a shutdown of a traffic signal. Traffic signal shutdowns are limited to Monday through Thursday, excluding holidays, from 9:00 a.m. to 3:00 p.m., or as specified in the Special Provisions.

The Contractor shall notify the local traffic enforcement agency prior to any operational shutdown of a traffic signal.

The Contractor shall cover signal faces when the system is shutdown overnight.

Where a facility requires continuous lighting, the shutdown time must 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 must not interfere with the regular lighting schedule, unless otherwise permitted by the Agency.

Where roadways are to remain open to traffic and existing lighting systems are to be modified, the Contractor shall ensure the lighting systems are in operation by nightfall.

Work performed on an existing system considered by the Agency necessary to keep all or part of the existing system in effective operation and not described on the Plans, in the Special Provisions, or herein is change order work.

The Agency will:

1. Continue the operation and maintenance of existing electrical facilities.
2. Continue to provide for electrical energy for the operation of existing electrical facilities.
3. Repair or replace existing facilities damaged by public traffic.

Until full completion of installation and operation verification of a video or hybrid video/radar detection system (detection system), the Contractor shall not cut any existing loop so as to break circuit.

Metal objects (such as manhole frames and lids, valve boxes, bore casings, etc.) must not be

installed within 72 inches of a traffic loop.

Temporary electrical installations shall be kept in effective operation until the temporary installations are no longer required for the traveling public.

Traffic signal equipment, including, vehicle detectors, bicycle detectors, pedestrian push buttons, ITS equipment, traffic signal/ITS communications, and other existing actuated electrical systems shall remain in operation at all times during the progress of work, except as specified in the Special Provisions or as provided herein.

Traffic signal equipment, including, vehicle detectors, bicycle detectors, pedestrian push buttons, ITS equipment, traffic signal/ITS communications, and other existing actuated electrical systems damaged, taken out of service, or when vehicular traffic is rerouted and the traffic signal system is not able to properly detect approaching vehicles shall be repaired or replaced within twenty-four (24) hours, except as otherwise specified in the Special Provisions or as provided herein.

If an existing detection system is damaged, the Contractor shall immediately notify the Agency. When an existing detection system is damaged or vehicular traffic is rerouted and the traffic signal system is not able to properly detect approaching vehicles, the Contractor shall repair and/or replace as necessary with a video or hybrid video/radar detection system conforming to Section 49-5.02, "Video or Hybrid Video/Radar Detection System," of these Specifications, even if the existing system utilizes in-pavement loop detectors, unless otherwise approved by the Agency to repair/replace with loop detectors as a permanent repair. If repair/replacement with loop detectors is approved by the Agency, loop detectors and associated work shall conform to Section 49-5.01, "Loop Detectors," of these Specifications. Temporary loop detectors conforming to Section 49-5.01, "Loop Detectors," of these Specifications may be used in locations where the detector loop will not be part of the final work product, and the location of the temporary detector loop will receive an asphalt overlay as part of the final work product. For conditions other than stated above, the Agency will provide a detection system for immediate Contractor use for which the equipment provided shall be replaced in kind with new equipment to the Agency as soon as it is available to the Contractor. If the existing detection system utilizes a video or hybrid video/radar detection system, the Contractor shall replace or, if possible, adjust the video or hybrid video/radar detection system. Detection system adjustments shall be made by a factory certified representative. If the existing traffic signal detection system is damaged by the Contractor during construction, the Contractor shall repair/replace the system with a video detector system (or, if directed by the Agency, with detector loops), at their expense.

Where work site conditions do not permit the installation of permanent vehicle detectors within twenty-four (24) hours, temporary vehicle detection providing actuation for every lane of every approach shall be installed in accordance with the previous paragraph, at the Contractor's expense, as directed by the Agency, within the same twenty-four (24) hour period. Permanent vehicle detection shall be installed as soon as work site conditions permit.

Unplanned disruptions to a traffic signal system result in negative impacts to the traveling public: increased fuel consumption, increased vehicle operating cost, increased pollution, and other inconveniences and costs. In the event the Contractor fails to maintain an existing traffic signal system in accordance with the contract specifications or these Standard Construction Specifications within the time specified, the Agency reserves the right to perform the necessary maintenance and emergency service to ensure continuous traffic signal operation. All expenses incurred by the Agency for maintenance and emergency service will be deducted from payment due the Contractor, plus $2,500 liquidated damage per occasion, per day or any portion thereof, until corrected.

Except as noted, all Work in this section shall be included in the price paid for the various items of work and no additional compensation will be paid.

49-1.07 Scheduling of Work

Work shall be so scheduled that each traffic signal and lighting system shall be completed and ready for operation prior to opening the corresponding section of the roadway to traffic.

Traffic signals shall not be placed in operation for use by public traffic without the energizing of street lighting at the intersection to be controlled if street lighting exists or is being installed in conjunction with the traffic signals.

Traffic signals shall not be placed in operation until the roadways to be controlled are open to

public traffic, unless otherwise directed by the Engineer.

Conductors shall not be pulled into conduit until pull boxes are set to grade, crushed rock sumps installed, mortar placed around conduit, concrete bottom of pull boxes placed, and metallic conduit bonded.

In vehicular under crossings, soffit lights shall be placed in operation as soon as practicable after falsework has been removed from the structure. Lighting for pedestrian structures shall be placed in operation prior to opening the structure to pedestrian traffic.

If the Engineer orders soffit lights or lighting for pedestrian structures placed in operation before permanent power service is available, the cost of installing and removing temporary power service will be paid for as extra work.

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 must obtain daily a safety circuit clearance from SMUD. By-pass switch plugs must 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 must notify the Agency and request inspection of all conduits and foundation forms.

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

The Contractor must 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 must be exposed by the Contractor, at the Contractor's expense, for such inspection or testing.

49-1.10 Signal Turn-On

Prior to the day of turn-on, all equipment as shown on the plans shall be installed and operable including vehicle signal heads, backplates, pedestrian signals, pedestrian push buttons, vehicle detection, lighting, signs, and pavement delineation, with the exception of crosswalks which shall be installed the day of turn-on. All signal faces, visors, and louvers shall be directed to provide maximum visibility. The Contractor must give written notice of intentions of signal turn-on at least 3 Working Days prior to actual turn-on time so that Agency forces can accomplish the proper signing. The written notice must be given to both the Traffic Signal and Street Light Manager and the Signs and Markings Manager and is to allow for a review of the signal prior to turn-on. Agency personnel may request, and must be granted, a new turn-on date and review, pending the results of their initial review.

Prior to actual turn-on time, the Contractor must uncover all Agency-installed signs that have been installed prior to signal turn-on and are covered. Turn-ons must take place between 11:00 a.m. and 2:00 p.m., Monday through Thursday, except that signal turn-ons are not to be scheduled for the day before a holiday and no two-signal turn-ons on the same Contract are to 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.

49-1.11 Contractor Supplied Equipment

The Contractor shall supply all traffic signal poles, the service can, including battery backup if identified on the plans, all detector equipment, and all other material and equipment not specifically identified as "County Supplied" on the contract plans or in the Special Provisions. The Contractor shall supply all of the equipment specified in Section 49-5.03, "Emergency Vehicle Detector Cable, Detectors, and Phase Selectors," of these Specifications.

49-2 MATERIALS AND INSTALLATION

49-2.01 Trench Excavation and Backfill

Unless otherwise shown or specified in the Contract, trench excavation and backfill must conform to Section 19, "Trench Excavation, Bedding, and Backfill", of these Specifications, and restoration of surfaces must 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, "Trenching and Boring", of these Specifications.

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

The Contractor must contact Underground Service Alert a minimum of 48 hours before any excavation work begins. The Contractor must outline the excavation area in white.

49-2.02 Trenching and Boring

Conduit for signals, lighting, and electrical systems may be installed by earth saw trenching and conduit for traffic signal interconnect, lighting, and electrical systems may also be installed by directional bore and shall conform to these Specifications.

49-2.02.A Earth Saw Trenching

Trenches to be made by this method must be cut by a machine that will produce smooth edge cuts in the pavement and will move at a speed in excess of 4 feet per minute while cutting pavement. The trenching machine must 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 14" minimum cover between the top of the conduit and the finished pavement grade. A trench depth greater than 18" will require prior approval from the Engineer. The maximum trench width shall be 18". The trench section shall conform to Standard Drawing 4-64.

Loose material deposited on the pavement behind the cutting machine must 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 can be closed and they must 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 Minor Concrete to match the existing pavement surface. In areas that are not to receive an asphalt concrete overlay as part of the same Contract, pavement restoration shall be in accordance with Standard Drawing 4-64.

The concrete shall be, at a minimum, minor concrete conforming to Section 90-2, "Minor Concrete," of the State Specifications.

The sides of the trench above the concrete backfill must be coated with an asphaltic emulsion and the remaining depth of the trench must be backfilled with asphalt concrete placed in one layer. The asphalt concrete must conform to Section 23, "Asphalt Concrete", of these Specifications, and must be manufactured with 1/2 inch maximum-sized rock. The asphalt concrete must 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 2 inches permanent asphalt concrete surfacing, must be completed 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 two inch (2") asphalt concrete pavement replacement over the concrete trench backfill shall be completed no later than one (1) Working Day following placement of the concrete backfill.

Final pavement restoration shall conform to Section 14-3.01, "Trench Restoration," of these

Specifications.

Trenching in the medians must be as specified above, except that the requirement to complete the trench on the same day does 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.

49-2.02.B Directional Bore

Prior to beginning work, the Contractor shall submit to the Agency a general work plan. Prior to drilling, the Contractor shall prepare a directional bore profile showing all verified utility depths with utility required clearances and the projected bore path (elevation). The Contractor shall submit the proposed bore profile to the Agency for review and shall also request approval for any deviation from the required bore depth.

A directional bore profile, log of boring operations, and a guidance system log shall be kept on site and up to date during boring operations. The profile must be included with the record drawings, as required by Section 11-3, "Record Drawings," of the Standard Construction Specifications.

Conduit for traffic signal interconnect and/or street lights installed by directional bore shall be installed to a depth of 30-42" measured from the top of the conduit to finish grade. Approval from the Engineer shall be required if a depth greater than 42" is proposed, such as during the directional bore profile review and/or if unfavorable subsurface soil conditions are encountered during drilling operations. In no case shall the conduit depth be less than 30".

Unless otherwise approved by the Agency, the Contractor shall not install traffic signal conduit using directional bore, with the exception of traffic signal interconnect conduit installed from traffic signal to traffic signal.

Any other electrical conduit installed by directional bore shall be installed to a minimum depth of 42" measured from the top of the conduit to finish grade.

Bore pits shall be kept at least 2' clear of the edge of any type of pavement wherever possible. Excessive use of water, such that pavement might be undermined, or subgrade softened, will not be permitted.

The directional boring equipment shall consist of a directional boring rig of sufficient capacity to perform the bore and pull back the pipe, a boring fluid mixing, delivery, and recovery system of sufficient capacity to successfully complete the installation, a guidance system to accurately guide boring operations and trained and competent personnel to operate the system. The directional boring equipment shall have directional control of the boring tool and have an electronic boring tool location detection system. During operation, the directional boring equipment shall be able to determine the location of the tool both horizontally and vertically. The directional boring equipment shall be equipped with a tension measuring device that indicates the amount of tension exerted on conduit during conduit pulling operations.

Boring fluid shall be composed of bentonite clay, potable water, and appropriate additives. No hazardous additives may be used. Used boring fluid and boring fluid spilled during boring operations shall be contained and properly disposed of. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey excess boring fluid from containment areas to appropriate disposal facilities.

A pilot hole shall be drilled on the bore path. Upon successful completion of pilot hole, contractor will ream bore hole to a minimum of 25% and maximum of 50% greater than the outside diameter of the conduit using the appropriate tools. Contractor will not attempt to ream at one time more than the boring equipment and mud system are designed to safely handle.

After successfully reaming bore hole to the required diameter, contractor will pull the conduit through the bore hole. In front of the conduit will be a swivel. Once pull-back operations have commenced, operations shall continue without interruption until conduit is completely pulled into the bore hole. During pull-back operations, at no time shall the pull force exerted on the conduit exceed the manufacturer rated maximum pull force for the specific conduit being installed.

All excavated areas shall be backfilled to the top of the surface or trench plated by the end of each work period. Final restoration shall conform to Standard Drawing 4-64.

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, must be replaced or reconstructed with the same kind of material as found on the Work or with materials of equal quality. The new work must 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 must 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 must be cut to a minimum depth of 2 inches with an abrasive type saw prior to removing the material. Cuts must be neat and true along score lines or constructed joints, with no shatter outside the removal area. Cuts must not extend beyond the limits of the removal area.

49-2.04 Foundations

Contractor shall verify all existing underground and overhead utilities within the project site prior to constructing foundations for street lighting or traffic signals.

Foundations must conform to the State Specifications, and these Specifications. Foundations must conform to the sizes and shapes shown on the Plans, the Standard Drawings, or the State Plans, or as otherwise detailed in the Contract, as applicable. The Contractor must provide anchor bolts for all foundations unless otherwise specified in the Special Provisions. Anchor bolts must be positioned so that between 2 and 4 threads will be visible above the top nuts after the pole has been erected and plumbed. Rigid non-metallic conduit is allowed in traffic signal and street light foundations.

All traffic signal poles and street light poles and pull boxes must be located outside the limits of sidewalk ramps, unless shown on the plans to be located on a wider than standard curb incorporated into the rear portion of the sidewalk ramp. All traffic signal pole and street light foundations must be located so that no existing conduit, pipe or other underground utility facility conflicts with the entire volume of the pole foundation. If a conflict with an existing street light conduit or an existing traffic signal conduit exists, the Contractor must relocate the existing conduit out of the area of conflict. If a potential conflict with any underground utility facility other than street light or traffic signal conduit exists, the Contractor must bring the potential conflict to the attention of the Agency. The Agency may direct the adjustment of the signal foundation location in accordance with Section 49-2.05 of these Specifications. Conformance with these provisions as required to complete the Work, including relocation of existing street light and/or traffic signal conduits, is considered incidental to and included in the payment for traffic signal or street light installation and no additional compensation will be made.

All traffic signal poles with pedestrian push buttons must be located in sidewalk or pedestrian pad areas. Poles located in sidewalk areas must be located such that the back of the pole’s base flange must be within the sidewalk area and within one inch of the back of the sidewalk.

All traffic signal and street light poles and pull boxes must be located outside the limits of sidewalk ramps.

49-2.05 Standards, Steel Pedestals and Posts

Standards, steel pedestals, and posts must conform to the State Specifications, and these Specifications. Standards with an outside diameter greater than 12 inches must be round. Street light standards shall be galvanized steel and shall conform to Standard Drawing 5-3. The type of street light standard will be indicated in the Contract. All 1-B poles shall be installed with coupling nuts per the State Standard Plan ES-7B.

49-2.05.A NOT USED

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 must be field adjusted to conform to the following rules:

1. Pedestrian heads and crosswalks must be located such that pedestrian heads are not located behind the respective stop bar.
2. Pedestrian push buttons must be located within 5 feet of their respective crosswalks, measured perpendicular to the crosswalk lines.
3. Sidewalk ramps and crosswalks must 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 must be located to leave a minimum of 4 feet of clear sidewalk width.
5. High (mast arm mounted) signal heads with all-left arrow indications must be located at least 2 feet 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 is incidental and no additional payment will be made. All field adjustments must be coordinated with the Agency in the field.

49-2.05.C Final Location of Traffic Signal Poles

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

49-2.06 Conduit

Conduit shall conform to the State Specifications and these Specifications. Unless otherwise shown or specified in the Contract, conduit shall be rigid non-metallic.

Conduit installed in existing or proposed paved areas of streets shall be installed by earth saw trenching or directional boring conforming to these Specifications.

Conduit installed for traffic signal, lighting, or electrical, by trenching, including earth saw trenching, shall be electrical grade Schedule 40 or better.

Conduit installed for traffic signal interconnect and/or street lighting by directional boring, shall be High Density Polyethylene (HDPE). HDPE conduits shall be Type IPS SDR 11 and comply with ASTM F2160 and NEMA TC7 specifications.

The need for splicing HDPE conduit shall be minimized. Where splicing is necessary, HDPE conduit shall be spliced with mechanical joint couplings manufactured for use on HDPE conduit. The couplings shall provide an airtight and watertight connection. Conduits may also be joined by heat fusion. Heat fusion (includes electrofusion) of HDPE conduit shall be by methods recommended by the conduit manufacturer, and with equipment approved for such purpose. Equipment shall not expose conduit to direct flame. Heat fusion shall be performed by conduit manufacturer certified or other authorized personnel. A minimum of two test fusions, by each fusion operator, shall be demonstrated to the Engineer prior to performing fusion operations on any HDPE conduit to be installed.

All proposed conduits shall be a minimum of three inches (3”) in diameter.

Traffic signal conduits, including traffic interconnect conduits, are shown on the Contract Plans to scale, unless otherwise noted on said Plans. Conduit shown to be installed out of paved areas must be installed out of paved areas. Any conduit shown on the plans to be placed

at a specific location, either by dimensions, offsets, or by other means, must be installed at the specified location. Conduits shown to be installed across any street, or across any portion of any street, must be installed such that the alignment of the conduit between the pull boxes and/or cabinets at either end of the conduit run must be a straight line.

Pole risers shall be 3-inch Schedule 80 rigid non-metallic conduit unless otherwise specified.

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

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

Conduits terminating in standards or enclosures must emerge from the foundation vertically, ± 5 degrees in any direction.

A solid No. 10 THW copper wire with green insulation must be installed in all conduits that 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 must be spliced to be electrically continuous.

All rigid non-metallic conduit must 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 must be sealed with an approved sealing compound.

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

Conduit trenches shall be approximately 2” wider than the outside diameter of the conduit to be installed.

Conduit installed by trenching outside of existing or proposed pavement shall have 18” minimum cover from the top of the conduit to the finished grade. The trench shall be backfilled with compacted Class 2 aggregate base. Conduit shall not be placed under median curbing. In landscaped medians, the conduit shall be placed below the maintenance band between the inside face of the median curb and the root control barrier.

49-2.07 Pull Boxes

Pull boxes shall conform to the State Specifications, these Specifications, and the Standard Drawings.

Covers shall be factory-marked to indicate the contents of the pull box. Metal covers shall be marked by method “c” as described in the State Specifications.

Pull boxes for use in street lighting shall have covers with theft deterrent penta bolts. The penta-bolt shank size shall be 3/8” – 16UNC x 3-1/2”.

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 200 feet, pull boxes shall be spaced at maximum 200-foot intervals unless indicated otherwise. The Contractor, at the Contractor’s expense, may install additional pull boxes to facilitate the Work.

Each individual street light shall have its own pull box.

The bottom of pull boxes installed in unimproved areas or in sidewalk areas shall be bedded on 6 inch minimum layer of ¾ inch crushed rock.

All pull boxes that will or could potentially be exposed to vehicular traffic shall be traffic rated.

49-2.08 Conductors

Conductors shall conform to Section 86-1.02F, “Conductors and Cables,” of the State Specifications and these Specifications. Section 86-1.02F(1), “General,” 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 last paragraph of said Section 86-1.02F(1) is replaced with “All conductors must be copper. Aluminum conductors are not allowed.” The “Conductor Identification” table of Section 86-

1.02F(2)(a), "General," of the State Specifications is amended to include the following:

CONDUCTOR IDENTIFICATION

Circuit	Signal Phase or Function	Identification			Copper Size
		Insulation Color		Band Symbols	
		Base	Stripe		
Irrigation Control	Underground-Line 1	Black	None	IR1	As Required
	Neutral	White	None	IRN	As Required
Neutral	Traffic Signals	White	None	TSN	As Required
Neutral	Street Lighting	White	None	None	As Required
Traffic Signal Communications	As Required	As Required	As Required	None	As Required
Highway (Street) Lighting Pull Box to Luminaire	As Required	As Required	As Required	None	As Required
Multiple Highway (Street) Lighting	As Required	As Required	As Required	None	As Required
Emergency Vehicle Preemption	As Required	Black or As Required	As Required	Per Special Provisions	As Required
Inductive Loop Detector Circuits	Vehicle Detection	As Required	None	Per Section 87-1.03V(2) of State Specifications	As Required

49-2.08.A <u>Traffic Signal Interconnect</u>

Traffic Signal Interconnect shall be a fiber optic cable system including, but not limited to, conduit and accessories, fiber splice boxes, pull boxes, cables and locator wire, splice closures, patch panels, distribution units, and all appurtenances and accessories required for proper installation and operation of the fiber optic system.

Installation and testing of fiber optic cable, splice closures, patch panels, fiber distribution units, and splicing of the fiber optic cable system shall be performed by a contractor with a C-7 or C-10 Contractor license.

The Contractor's attention is directed to Section 11-3, "Record Drawings," of the Standard Construction Specifications. In addition to the requirements therein, the Contractor shall submit Fiber Optic System As-Builts to the Sacramento County Department of Transportation (PDF file format). The Fiber Optic System As-Builts shall include a cable route diagram and fiber strand termination schematic indicating the actual cable route, strand number termination point, and foot marks for all intersections, directional change points in the cable routing, and all termination points. The Contractor shall record these points during cable installation. Information such as the location of splices, patch points, cross connects, and slack cable and its quantity shall also be recorded in the cable route diagram.

Existing copper signal interconnect damaged during construction shall be replaced at the Contractor's expense from controller cabinet to controller cabinet on either end of the damage. Splicing of copper signal interconnect will not be allowed. Damaged copper signal interconnect shall be replaced with fiber optic signal interconnect, including cable, conduit, splices, terminations, patch panels, and pull boxes conforming to these Specifications. The Contractor shall also be responsible, at their expense, to make any additional repairs that may be needed to install the new cable from controller cabinet to controller cabinet.

49-2.08.A (1) Conduit

The minimum bend radius for all conduit shall be 36 inches.

The sum of the angles for all conduit bends between two consecutive fiber splice boxes or 6E pull boxes shall not exceed 270 degrees including the entrance/exit into the box. All non-HDPE conduit bends shall be made with factory bend fittings. Field bending of non-HDPE conduit will not be allowed. HDPE conduit shall enter/exit fiber splice boxes or 6E pull boxes without use of any fittings. HDPE conduit sweeps shall maintain a conduit bend radius of a minimum 10 times the outside diameter of the conduit.

Transition of conduit without bends shall not exceed more than 1 foot for every 10 feet in length.

If conduit is being installed above or below an existing utility, the conduit shall be laid no closer than 12 inches from existing utility.

Conduit shall enter/exit fiber splice boxes or 6E pull boxes on the short side of the box whenever possible and at a maximum angle of 45 degrees from horizontal as shown on Standard Drawings 5-22A and 5-22B. Conduit within the fiber splice box or pull box shall not protrude more than three inches, shall be installed no closer than three inches from any wall or the bottom of the box, and the top of the conduit shall be a minimum of twelve inches from the cover of the box.

Conduits entering fiber splice boxes or pull boxes shall be terminated with a manufacturer-produced terminator connector to seal the wall of the box against the entry of soil.

Where new conduit is being installed into an existing splice box or pull box, or in close proximity to existing conduit, the Contractor shall protect existing conduit from damage. Should the existing conduit become damaged, the Contractor shall repair and/or replace damaged conduit, as determined by the Engineer, at the sole cost of the Contractor. Prior to repair/replacement, the Contractor shall notify the Engineer of the exact location and contents of damaged conduit.

All conduits installed shall be proofed with a rigid mandrel sized approximately 90% of the inside diameter of the conduit.

Before installing fiber cable, the Contractor shall blow out all conduits with compressed air until all foreign material is removed.

49-2.08.A.(2) Existing Splice Boxes and Pull Boxes

Where the sump of an existing pull box or splice box is damaged by the Contractor's operations, the sump shall be reconstructed to match existing, and if the sump was grouted, the old grout shall be removed and new grout placed at the sole cost of the Contractor.

49-2.08.A.(3) Fiber Splice Boxes and Pull Boxes

Fiber Splice Boxes

Fiber splice boxes shall be in accordance with Standard Drawings 5-22A and 5-22B of these Specifications and as detailed in the Contract. Splice boxes and covers shall be Armorcast Products Company polymer concrete 20k ANSI/SCTE 77 for Tier 22 load rating or approved equal. Covers shall be two piece. Hold down bolts or cap screws and nuts shall be of brass, stainless steel, or other non-corroding material. Each cover portion shall have inset lifting pull slots. Cover markings shall be "TRAFFIC" and "COMMUNICATION".

Excavating and backfilling shall be per Section 49-2.01, "Trench Excavation and Backfill," of these Specifications.

Fiber splice boxes shall not be installed within driveways, sidewalk ramps, or curb aprons. Splice box installation spacing shall be adjusted accordingly to avoid these conditions.

Fiber splice boxes shall be installed a minimum distance of 12" from other utilities.

The preferred installation location for fiber splice boxes is in sidewalk or raised median. Fiber splice boxes installed at unimproved locations shall be a minimum of 3 feet from edge of pavement, away from traffic.

Fiber splice boxes shall be installed at 1" above grade in unpaved areas and at grade in paved areas, or as indicated on the Contract documents. Concrete to be placed around splice boxes shall be Minor Concrete per the State Specifications.

Fiber splice boxes shall be open bottom and bedded on a 6" minimum layer of ¾" crushed rock and shall be grouted prior to the installation of conductors. The grout shall be between ½-1" in depth and shall be sloped towards the drain hole. A layer of roofing paper shall be placed between the grout and the crushed rock sump. A 1" drain hole shall be provided in the center of the splice box through the grout and the roofing paper.

All ground connections shall be coated with oxidation prohibiting compound.

Pull Boxes

Pull boxes which contain 96 strand fiber optic backbone cable shall be No. 6E. Pull boxes which contain only 12 strand fiber optic drop cable shall be No. 5E. The use of pull boxes in the design of fiber optic signal interconnect cable systems shall be minimized.

Use of 6E pull boxes may be necessary for direction changes between fiber splice boxes. If used, 6E pull boxes shall be located within 500 feet of a fiber splice box. Any two or more consecutive 6E pull boxes shall be spaced no greater than 500 feet apart.

49-2.08.A.(4) Fiber Optic Cable, Splicing, and Closures

The Contractor shall be responsible for the installation, splicing, termination, and testing of the fiber optic cable and all related equipment/components.

Pre-approved fiber optic cables are:

1. Corning Optical Communications ALTOS All-Dielectric Gel-Free Cable order No. XXXEU4-T4101D20
2. Prysmian ExpressLTTM Dry order No. F-EDH1JKT-12-CE-XXX-E1

(XXX equals the total fiber strand count for the cable.)

The fiber count of the cables will be as indicated on the Contract documents. Default fiber count is 96 for backbone cable and 12 for drop cable to the signal controller cabinet.

Fiber optic cable shall have no splices, be shipped on a reel, and have 10 feet of length on each end of the cable accessible for testing. Both ends of the cable shall be sealed to prevent the ingress of moisture. All fibers in the cable shall be usable fibers and meet required specifications.

Each cable reel shall have a weatherproof label or tag with information specified in ANSI/ICEA S-87-640 including:

1. Contractor's name
2. Contract number
3. Number of fibers
4. Cable attenuation loss per fiber at 1310 and 1550 nm

The labeled or tagged information shall also be in a shipping record in a weatherproof envelope. The envelope shall be removed only by the Engineer.

The Contractor shall install the fiber optic cable in strict adherence to the manufacturer's recommended procedures. Care shall be taken to avoid cable damage during handling and placing. The minimum bending radius and maximum tension requirements for installing the fiber optic cables shall be according to the manufacturer's specifications and not exceeded at any time.

When installing the cable using the air blown method, the cable shall withstand a static air pressure of 110 psi.

Before installation, each end of the fiber cable segments shall be properly sealed against moisture intrusion and protected against damage during installation.

Cable lubricant shall be used for all fiber optic pulls. Cable lubricant shall be compatible with the fiber optic cable outer sheath and existing cable where fiber cable is installed in a

conduit with other existing cable. Lubricant shall be applied according to the manufacturer's recommendations.

Field installed pulling grips with a rotating type ball bearing swivel shall be used to pull the fiber optic cable. All pulling equipment and hardware, used by the Contractor during the cable installation, shall not cause the cable to exceed the manufacturer specified minimum bend radius of the cable. Such equipment includes sheaves, capstans, bending shoes, and quadrant blocks designed for use with fiber optic.

Where the fiber optic cable is installed in existing conduit, the Contractor shall be responsible for replacing any cables damaged during installation at the sole cost of the Contractor.

At fiber splice boxes, the slack fiber optic cable, as indicated on Standard Drawing 5-22A, shall be neatly coiled on the bottom of the box in a figure 8 fashion. At 6E pull boxes, 2 loops of fiber optic cable slack shall be coiled in the box. At no time will the minimum bending radius of the fiber optic cable be violated.

If necessary, splicing of fiber optic cable shall be allowed only at fiber splice boxes as indicated in the Contract documents.

A #10 green solid copper tracer wire shall be installed with all fiber optic cable. The Contractor shall provide a minimum 4-feet of slack tracer wire in each fiber splice vault or 6E pull box from each direction. Tracer wire may be spliced at intervals of not less than 500 feet and only inside fiber splice vaults or 6E pull boxes. All tracer wires in all fiber splice vaults and 6E pull boxes shall be spliced if not continuous.

After all fiber optic cables and tracer wires have been installed, the exposed end of conduits in fiber splice boxes and 6E pull boxes shall be sealed with a watertight seal installed around the cables.

Fiber optic cable terminated in signal controller cabinets shall be supported and strain relieved within 6” of the fiber patch panel and supported every 2 feet within the cabinet.

The Contractor shall identify fibers and cables by direct labeling, metal tags, or bands fastened in such a way that they will not move and shall use mechanical methods for labeling.

The Contractor shall provide identification on each fiber optic cable in each fiber splice box and at the end of terminated fibers.

Labels shall be placed on the cables at the following points:

1. Fiber splice box entrances and exits
2. Splice closure entrance and exit
3. Fiber distribution unit entrance

Fiber Optic Cable Splicing

Fiber optic cable splicing shall not be permitted in cable runs or pull boxes. Splicing shall be done only in Fiber Splice Boxes with splice closures, or at fiber termination points, as shown on the Contract documents.

All splices shall be of the fusion type and made with equipment certified for a typical loss of less than 0.2 dB. The Contractor shall test each splice and any splice with greater than 0.2 dB loss shall be rejected and re-spliced until the acceptable dB loss is obtained.

Splice Closures and Splices

For field splices, the Contractor shall furnish and install fiber optic splice closures meeting the latest requirements of GR-771-CORE, containing individual multiple fiber strand splice trays, and capable of accommodating 144 splices. Splice closures shall be able to accommodate up to six (6) cable entries. When all six cable entry holes are not required, the remaining unused entry holes will be closed or caulked such that moisture does not enter the splice closure. Splice closures shall have sleeves to size the cable entry to the appropriate cable diameter.

Splice closures shall be made of thermoplastic material and suitable for either direct burial or fiber splice box application. Splice closures shall be waterproof, chemical and UV resistant, rodent proof, and re-sealable.

Splice closures shall be complete with splice organizer trays, brackets, plugs, clips, cable ties, seals, sealant, and a dry encapsulate.

Splice closures shall have means to anchor the dielectric member of the fiber optic cable and include grounding hardware.

Install splice closures in accordance with manufacturer's instructions.

Each splice tray shall be designed specifically for housing single mode fusion splices protected by heat shrink sleeves and appropriately sized to fit inside the splice closure. The splice trays shall be of injection-molded plastic type with a clear plastic cover to allow visibility of fibers without opening the tray.

Each splice shall be individually restrained in a splice tray and protected with a splice protector. The optical fiber shall not be bent less than a 2" radius during installation or after final assembly in the splice tray. The optical fibers in buffer tubes and the placement of the optical fibers in the splice tray shall be such that there is no discernible tensile force on the optical fiber.

The Contractor shall refer to the Contract documents for a list of the number of field splices required by location. All other fibers in the cable shall remain uncut and pass through the splice closure. During project construction, detailed splice diagrams will be supplied by the County Traffic Signal Maintenance Shop to the Contractor.

The Contractor shall determine where full cable splices are needed for constructability; however, the location of full cable splices shall be at one of the fiber splice boxes indicated on the Plans. If the fiber splice box chosen by the Contractor does not indicate on the Plans that a splice closure is to be installed, the Contractor shall supply and install an additional splice closure. All of the fibers in the cable shall be spliced.

The Contractor shall not seal fiber splice closures until authorized and the power meter and light source test has been performed. Seal closures shall be per manufacturer's instructions.

The Contractor shall flash test the outer closure per manufacturer's instructions in the presence of the Engineer and shall visually inspect the closure. The Contractor shall identify the locations where bubbles are present, take corrective actions, and repeat the flash test until no bubbles are present.

49-2.08.A.(5) Fiber Patch Panels

The Contractor shall furnish and install a fiber patch panel (FPP) at the locations indicated on the Plans. All connectors for a pigtail shall be factory installed and tested. Pigtails shall have a minimum 80 N pull out strength. The fiber patch panels shall be Corning Single-Panel Housing (SPH-01P) with a Corning Closet Connector Housing Pigtail Panel with single mode MIC pigtail cable or approved equal. Connector type shall be LC duplex single mode UPC.

All 12 fibers entering the signal cabinet at each location shall be terminated on the FPP. All fibers shall be fusion spliced to the MIC pigtail cables. Each splice shall be covered with a Corning Splice Pak Single Fiber Splice Protector or approved equal. All splices shall be mounted in the splice holder within the FPP housing. The optical fiber shall not be bent less than a 2" radius during installation or after final assembly in the FPP. Protective dust caps shall be supplied on all 12 ports.

Placement and mounting of the FPP's in the signal cabinets shall be coordinated with and approved by the County Traffic Signal Maintenance Shop.

49-2.08.A.(6) Fiber Distribution Units

If shown on the Plans, the Contractor shall furnish and install fiber distribution units (FDU) and a 332 cabinet. The 332 cabinet shall include the cabinet housing 1B, cabinet cage, service panel assembly, and two each duplex NEMA 5-15R receptacles (one with GFCI). Each FDU shall be a 19-inch rack mountable modular metal enclosure for installation into the 332 cabinet and accommodate the termination of a 96 strand fiber cable. One FDU shall be supplied for each separate fiber cable entering the 332 cabinet. Termination of fibers in the FDU shall utilize coupling plates with adapters and pigtailed connectors. The connector type shall be LC duplex single mode UPC and the connectors shall be factory installed and tested on the pigtails. The

pigtails shall be fusion spliced onto the incoming fibers and housed in a splice tray.

The Contractor shall supply and install splice trays to accommodate terminations of all fibers entering the 332 cabinet. Each splice tray shall be designed specifically for housing single mode fusion splices protected by heat shrink sleeves and appropriately sized to fit inside the FDU. The splice trays shall be of injection-molded plastic type with a clear plastic cover to allow visibility of fibers without opening the tray.

Each splice shall be individually restrained in a splice tray and protected with a splice protector. The optical fiber shall not be bent less than a 2" radius during installation or after final assembly in the splice tray. The optical fibers in buffer tubes and the placement of the optical fibers in the splice tray shall be such that there is no discernible tensile force on the optical fiber.

All fibers in each fiber cable entering the 332 cabinet shall be terminated on its respective FDU. Protective dust caps shall be supplied on all ports.

Placement of the FDU's in the 332 cabinets shall be coordinated with and approved by the County Traffic Signal Maintenance Shop.

49-2.08.B <u>Traffic Signal Interconnect Cable and System Testing</u>

The fiber optic cable and system shall be tested for compliance with the transmission requirements of this specification, the cable and hardware manufacturer's specifications, and prescribed industry standards. Testing and test equipment shall be in accordance with prescribed industry standards and practices. The Contractor shall provide all personnel, equipment, instrumentation, and materials necessary to perform all testing herein.

The Contractor shall submit proof of calibration for the test equipment including:

1. Name of calibration facility
2. Date of calibration
3. Type of equipment, model number and serial number
4. Calibration result

The format for test results shall be as shown in the Link Loss Budget Worksheet (CEM-5819C). The worksheet is available at the State Division of Construction website. Test results shall be submitted in Microsoft Excel files.

Test results in a different format than indicated above, such as output from commercial fiber optic testing equipment, is acceptable as long as all of the data in the State test result form is included and is presented in a logical easy to follow format. Results are to be submitted in PDF files.

All test results shall be submitted to the Engineer within 4 working days of testing.

The Contractor shall notify the Engineer at least 4 working days before performing field tests and include exact location of the system or components to be tested. The Contractor shall not proceed with the testing until authorized and shall perform each test in the presence of the Engineer.

Two types of testing are required as follows:

1. Attenuation using an optical time-domain reflectometer (OTDR). This test consists of measuring the attenuation for wavelengths of 1310 nm and 1550 nm in both directions for each fiber in each cable link using the optical time-domain reflectometer

2. Continuity using a power meter and light source. This test consists of testing each fiber in a link using a light source at one end of the link and a power meter at the other end and measuring and recording the power loss for wavelengths of 1310 nm and 1550 nm in both directions.

Index matching gel is not allowed.

Cable and system testing shall be performed after splicing, breakout, and termination and the complete passive fiber optic system has been installed and is ready for activation. The

attenuation and continuity shall be measured for 100% of the fibers in each link, in both directions. The Contractor shall complete the Link Loss Budget Worksheets. If any measured individual fusion splice loss exceeds -0.20 dB, the Contractor shall re-splice and retest. If the measured link loss exceeds the calculated link loss, the Contractor shall replace the unsatisfactory cable segments at the sole cost of the Contractor and retest. Test results shall be submitted to the Engineer.

49-2.09 Wiring

Wiring must conform to Division X, "Electrical Work," of the State Specifications, except that the third paragraph of Section 86-1.02N, "Fused Splice Connectors," and the first two paragraphs of Section 87-1.03N, "Fused Splice Connectors," do not apply, and these Specifications.

Conductors must 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 must consist of a zinc-coated free expanding steel spring enclosed in a steel shell, with an outer jacket of polyvinyl chloride. The outer jacket must have a flared skirt, be flexible, and be able to withstand 105 degree C temperature continuously. Each splice must have the spring connector sized in accordance with the manufacturer's recommendations for the number of conductors and gages being spliced. Wire strip lengths must be in accordance with the manufacturer's recommendations. After the spring connector has been applied to the connection, the splice must 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 must 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", of these Specifications.

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

Luminaire fuse shall be 15 amp midget ferrule type, slow blowing. The Contractor shall use Cooper Bussman 13/32" x 1 ½" Time-Delay Fuse or approved equal.

49-2.10 Bonding and Grounding

Bonding and grounding must conform to Division X, "Electrical Work," of the State Specifications, and these Specifications.

For bonding purposes in all non-metallic type conduits, a No. 6 copper wire must be run continuously in circuits used for series lighting, and a No. 10 copper wire must 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 must be installed in these conduits. Equipment bonding and grounding conductors are not required in conduits that contain only loop lead-in cable or signal interconnect cable or both.

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

49-2.11 Service

Electrical service installation and materials must conform to these Specifications.

Each service enclosure must be fabricated from a 1/8" minimum thickness 5052-H32 aluminum sheet complying with ASTM B209 and must conform to the requirements for cabinets

fabricated from aluminum as specified in the State Specifications, and these Specifications.

All welds must be of highest quality and ground smooth and finished so that grind marks are not visible.

The enclosure must be rain-tight and dust-tight. For new construction, anchor bolts must be inside the service enclosure. For modification construction, anchor bolts must 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 must be provided. A hinged outside door equipped with a heavy duty draw latch and 2 heavy duty hasps suitable for padlocking must be provided for the service section. The dead front panel on the service enclosure must have a continuous stainless steel piano hinge.

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

No surface of the enclosure can be deflected inward or outward more than 1/16 inch, measured from the intended plane of the surface.

Service enclosures must be factory wired and conform to NEMA Standards. All control wiring must be stranded copper, No. 14 AWG THHN/THWN rated for 600 volts. Wiring must 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 must 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 must be enclosed in plastic and mounted on the inside of the front door.

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

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

The service enclosure must have provisions for the installation of up to a total of 16 single-pole circuit breakers, including brass links and mounting hardware. Branch circuit panel must use loop wiring rated for 125 amperes with THHN/THWN insulation. All copper wiring used for main bussing must be No. 2 AWG THHN/THWN and rated for 125 amperes.

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

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

Complete shop drawings on all substitutions must 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 must be furnished.

The Contractor must protect and lock the service enclosure during construction. When the Work has been accepted for maintenance, each enclosure must 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 must be furnished and installed by the Contractor.

49-2.11.A <u>Metered Service (120/208 Volt, 120/240 Volt)</u>

Where shown on the Plans to install a new signal and lighting service enclosure, the Contractor shall supply and install a metered service enclosure (120/208V or 120/240V) in accordance with Standard Drawing 5-11 and as specified in this section.

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

The service enclosure must consist of a separate metering section and a service section.

The metering section must be complete with SMUD approved meter socket, steel socket

cover, and manual circuit closing device.

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

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

The following equipment must be mounted in each metered service enclosure:

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. Each main breaker must have an internal common trip. Each pole must have individual "ON-OFF" control and handle tie for common operation. Breakers must be Eaton 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 must be Eaton Quicklag C or approved equal.
3. Two single-pole, 120-volt alternating current branch circuit breakers for traffic signals, each with 20-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. Breakers must be Eaton 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 15-ampere trip), and with a rating of 10,000 amperes AIC at 120/240 volts. Breakers must be Eaton Quicklag C or approved equal.
5. Minimum two, 3-pole, normally open, 60-ampere contactors. Coil voltage must be 120 VAC, 60 cycle. Contactors must be Eaton Contactor, Model Number C25FNF360A, 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 <u>Metered Service with Encapsulated Step-Down Transformer (277/480 Volt to 120-240 Volt)</u>

Where shown on the Plans to install a new signal and lighting service enclosure with step down transformer, the Contractor shall supply and install a metered service enclosure (277/480V to 120/240V) in accordance with Standard Drawing 5-12 and as specified in this section.

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

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

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

The service enclosure must be fabricated in accordance with the dimensions shown on Standard Drawing 5-12.

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

1. One 3-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 must have an internal common trip. Each pole must have individual "ON-OFF" control and handle tie for common operation. Breaker must be Eaton 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 15-ampere trip), and with a rating of 14,000 amperes AIC at 277/480 volts. Breakers must be Eaton 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 must be Eaton Quicklag C or approved equal.
4. One single-pole, 120-volt alternating current branch circuit breaker for traffic signals, with 20-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. The breaker must be Eaton 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 must have an internal common trip. Each pole must have individual “ON-OFF” control and handle tie for common operation. The breaker must be Eaton Quicklag C or approved equal.
6. Minimum three, 3-pole, normally open, 60-ampere contactors. Coil voltage must be 120 VAC, 60 cycle. Contactors must be Eaton Contactor, Model Number C25FNF360A, 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 must be 277 volts and secondary must be 120volts. This transformer must supply the traffic signal power.
13. One single phase transformer rated at 2 KVA. Primary must be 480 volts and secondary must be 120/240 volts. This transformer must provide the power for intersection safety lighting and the control circuit.
14. Provide primary transformer protection per the NEC.

49-2.11.C <u>Metered Service with Battery Backup Unit (BBU)</u>

Where shown on the Plans to install a new signal and lighting service enclosure with battery backup, the Contractor shall supply and install a metered service enclosure (120/208V or 120/240V) in accordance with Standard Drawing 5-13 and as specified in this section.

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

The service enclosure must consist of a separate metering section and a service section.

The metering section must be complete with SMUD approved meter socket, steel socket cover, and manual circuit closing device.

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

The service enclosure must be fabricated in accordance with the dimensions shown on Standard Drawing 5-13.

The following equipment must be mounted in each metered service enclosure:

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. Each main breaker must have an internal common trip. Each pole must have individual "ON-OFF" control and

handle tie for common operation. Breakers must be Eaton 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 must be Eaton Quicklag C or approved equal.
3. One single-pole, 120-volt alternating current branch circuit breakers for traffic signals, with 20-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. Breakers must be Eaton Quicklag C or approved equal.
4. Minimum two, single-pole, 120-volt alternating current branch circuit breakers for street lighting, each sized per the Special Provisions and the Standard Drawings (minimum 15-ampere trip), and with a rating of 10,000 amperes AIC at 120/240 volts. Breakers must be Eaton Quicklag C or approved equal.
5. Minimum one, 3-pole, normally open, 60-ampere contactor. Coil voltage must be 120 VAC, 60 cycle. Contactor must be Eaton Contactor, Model Number C25FNF360A, 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.C.(1) <u>Enclosure Specifications:</u>

Anodized 1/8 inch aluminum, weatherproof enclosure must house Uninterrupted Power Supply (UPS) and batteries. Enclosure must be TIG welded construction with welding materials specifically designed for the material to be welded. Enclosure must have fully framed side hinged outer doors with swaged close tolerance sides for flush fit with drip lip and closed cell neoprene flange compressed gaskets. Front door must incorporate a full-length piano hinge, pad-lockable draw latch (center area on door-latch side), and two pad lockable welded-in place vandal-proof tabs (one upper area, one lower area on door-latch side, rated at 2000 lbs. each). There must be no exposed nut, bolts, screws, rivets or other fasteners on the exterior of the enclosure. Maximum cabinet dimensions 46 inches high by 20 inches wide by 9 inches deep. Weight 250 pounds with batteries. UPS must be mounted in an interior tilt out housing with 800 pound rated stops. Battery connectors must be Anderson Connectors with silver plated contacts. Batteries must be installed in fixed position framed trays for seismic safety and be readily accessible for maintenance. Batteries must be mounted allowing airflow front and back. Enclosure can include two transfer bypass switches, one for UPS bypass the second for auxiliary generator (optional). All switches must be panel mounted on interior dead front panel board. UV resistant plastic laminated nameplates must identify all controls and major components. A plastic covered wiring diagram will be attached to the inside of the front door. All components must be factory wired and conform to required NEMA, NEC, and UL standards. A chassis ground point must be provided. Panel must be UL 508 Industrial Control Panel rated.

49-2.11.C.(2) <u>UPS Panel Minimum Features:</u>

- The UPS system must be Tesco 27-000/22-000BBS1400XI-22UPS or approved equal.
- UPS bypass and UPS isolation switch.
- Deadfront safety panel board with all switches, indicating fuses, plugs, and isolation fuses for each battery pre-wired with phenolic nameplates.
- All nameplates must be screwed on phenolic engraved type.
- All wire terminating lugs must be full wrap around type.
- All batteries must be captive spaced from external captive sides in earthquake proof buckets.
- Cabinet ventilation must be by (qty. 4) 4 inch by 1/4 inch louvers top and bottom

with encapsulated bug screens, cleanable filters and a 100 cfm fan to completely exchange air 25 time minimum per minute.

- All DC terminals and connections must incorporate safety covers such that the safety covers are in place for every normal maintenance mode.
- Event Counters & Total Run Time Counter.

49-2.11.C.(3) UPS Unit Minimum Specifications:

UPS unit must provide a true sine-wave output with minimum 1400 Volt-Amp continuous capacity. UPS must provide for utility service isolation when in operation. The minimum rating for wattage output will be 950 watts. The UPS must be capable of running an intersection with LED lights (for Run Time consult manufacturer). The unit must operate off-line, with transfer time of 2 ms or less, with battery condition indicator, with automatic test provisions, and with hot-swappable batteries (all batteries in system). UPS will automatically recharge batteries from full discharge to 95% capacity within 6 hours. UPS will provide on-line operation for a minimum input of 92 to 145 VAC, provide full load output of 120VAC – 10% / +4% at 60 Hz +/- 0.05% over a temperature range of -37 degrees C (optional adder) to +74 degrees C and be a UL Approved Design. The UPS unit must be delivered with maintenance manuals and schematic diagrams.

49-2.11.C.(4) UPS Unit Minimum Features

- 1400VA 950 Watts
- Surge energy withstand 480 Joules, 6.5kA
- Common mode clamping 0 ns < 5ns typical UL 1449
- Conditioned power – Computer quality
- Transient lighting protection – 160 Joules
- Transfer to battery time – 2 ms
- Retransfer to utility – 2 ms
- Each battery must be 24 volts @ 18 AH with heavy duty Anderson plugs and isolated fused (deadfront panel mounted 30 amp) connections to the UPS for greater system reliability and ease of maintenance. Series wiring is unacceptable.
- Fan cooling must be fused for locked rotor current.
- Cooling air must be ducted to cool the front and back of each battery with air space on all four sides and top of battery.
- UPS covers must be 60% open on both sides to diminish the environmental effects of extreme temperatures.
- Includes a RS232, DB9 Computer Interface Port.
- Low voltage safety design at 24v DC. (Higher voltage DC systems are unacceptable).

49-2.11.C.(5) UPS Communications Module

Smart Slot Relay I/O Module:
Input #1 Turn the UPS on.
Input #2 Turn the UPS off.
Input #3 Start the UPS self-test.
Input #4 Shut down the UPS (when on battery).

Output #1 The UPS is on-battery (during a power failure, self-test or run time calibration).
Output #2 UPS has a low battery – Programmable.

Output #3 The protected load is not receiving power from the UPS. Output #4 Replace the UPS batteries.

Output #5 The UPS is overloaded.

Output #6 Any UPS fault or self-test failure.

49-2.11.C.(6) Batteries:

Batteries must be maintenance-free, type AGM/VRLA (Absorbed Glass Mat / Valve Regulated Lead Acid), such as APC Smart-UPS RMXL or approved equal. Batteries must be independently pre-wired and individually fused. Batteries must be furnished with heavy-duty 50- amp rated silver-plated Anderson connectors. Batteries must be equipped with a 100-amp internal fuse. Batteries must be lightweight for personnel safety and protection plus ease of installation and maintenance. Batteries with a weight of over 26lbs are not acceptable.

49-2.11.C.(7) Enclosure Temperature Compensation

Operating temperature must be between -37 and +74 degrees C.

49-2.11.C.(8) Power System Analyzer and Conflict Resolution Module

The UPS must incorporate an integrated Power System Analyzer and Conflict Resolution Module. The Analyzer must evaluate and make limited adjustments to the incoming utility power and will automatically transfer load to the UPS battery back-up power if utility power is lost. When utility power becomes available, the system must provide automatic UPS failure detection and automatically isolate the failed UPS and transfer the load back to utility power. Once the failure has been corrected, the system must return to the normal operation. At a minimum, the system must include the following:

Triple Bypass System for Offline UPS:

1. SPACT – Smart Power Analyzer with Conflict Monitor Isolation and Transfer Module.
2. PCM – Power Conflict Monitor
3. The PCM is a totally redundant failsafe system. The PCM monitors load bus power available continuously. If load bus power fails for 5ms the PCM will transfer and isolate the UPS and guarantee that commercial power will be locked on.
4. Watchdog Timer – Redundant 5 ms delay and hard transfer to utility power.
5. The outboard Smart Transfer Switch must not interrupt the normal controller function. Transfer time must be 2ms.
6. Onboard Smart I/O module will execute lockout of battery backup system upon Smart detection of any inverter UPS fault. If UPS resets itself, it will automatically be available for backup.

Smart Battery Charger:

Must charge from shut off discharge to 95% fully charged in less than 6 hours. Batteries must be ambient enclosure compensated to less than 120 degrees F. The battery charger must utilize Smart Cell Technology to extend battery life.

49-2.11.C.(9) Warranty

Manufacturers must provide a 2 year factory-replacement parts warranty on the Battery Backup System. Batteries must be warranted for full replacement for 2 years. The warranty is included in the total lump sum price paid for the traffic signal modification.

Supply and installation of service can with battery backup unit is included in the lump sum price paid for traffic signal installation and no additional payment will be made.

49-2.12 Testing

Testing must conform to Division X, “Electrical Work,” of the State Specifications, except that references to Functional Testing do not apply, and these Specifications.

Any fault in any material or in any part of the installation revealed by testing must be replaced or repaired by the Contractor, at the Contractor’s expense, in a manner approved by the Agency, and

the same test must be repeated until no fault appears.

Attention is directed to the additional requirements in the Contract regarding notifications, scheduling, and approval of testing for traffic signal and street lighting work.

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

49-2.13 Painting

Unless otherwise specified or shown in the Contract Documents, painting must conform to the State Specifications and these Specifications. Painting of existing steel street light poles, decorative street light poles, signal appurtenances, and bridges must conform to the Special Provisions.

Painting of newly installed decorative street lights consisting of a steel pole and cast iron decorative base cover must conform to the following specifications.

A. Painting must conform to Section 59, “Structural Steel Coatings”, of the State Specifications, with the following additions and modifications:
   1. Paint materials, unless otherwise specified, must conform to Section 91, “Structural Steel Coatings”, of the State Specifications.
   2. A Certificate of Compliance must be furnished in conformance with the provisions in Section 6-2.03C, “Certificates of Compliance”, of the State Specifications, certifying that the coating system furnished complies in all respects with the Contract. Coatings may be applied before Certificates of Compliance have been received. The Certificates of Compliance must accompany the order when shipped and be supplied to the Agency.
   3. The steel street light pole, cast iron base, and light fixture must be painted and fully cured at the time of manufacture and shipped to the job site ready for installation.
   4. Light fixtures must be powder coated. Surface preparation and coating application must be in conformance with both light fixture manufacturer’s specifications and coating manufacturer’s recommendations. Color will be a Federal Standard 595B color number as specified in the Contract
B. Surface Preparation (steel pole & cast iron base)
   1. All surfaces to be painted must be cleaned in conformance with the requirements in Surface Preparation Specification No. 6, “Commercial Blast Cleaning”, of the Steel Structures Painting Council (SSPC-SP6).
   2. Cleaning must leave all surfaces with a blast profile consisting of a dense, uniform, angular anchor pattern of 1.5 to 2.5 mils as measured in conformance with the requirements in ASTM D4417.
   3. All burrs and weld splatter must be completely removed.
   4. All surfaces must be clean, dry, and free of any dirt, chalk, dust, oil, grease, salts, curing compounds, release agents, preservatives and other detrimental foreign matter before coating application is performed.
C. Coating Application (steel pole & cast iron base)
   1. All paint must be applied in accordance with the manufacturer’s recommendations and these Specifications. Manufacturer’s recoat windows must be adhered to.
   2. Apply one prime coat of an epoxy coating. Coating manufacturer and product identification will be indicated in the Contract and approved by the Sacramento County Department of Transportation Street Light Operations Section. Dry film thickness must be between 4 and 8 mils.
   3. Apply one intermediate color coat of polyurethane. Coating manufacturer and product identification will be indicated in the Contract and approved by the Sacramento County Department of Transportation Street Light Operations Section. Dry film thickness must be between 2 and 3 mils.

4. Apply one finish clear coat of polyurethane. Coating manufacturer and product identification will be indicated in the Contract and approved by the Sacramento County Department of Transportation Street Light Operations Section. Dry film thickness must be between 2 and 3 mils.
5. Total system dry film thickness must be a minimum of 9 mils.
6. The bottom of the base plate and the interior of the steel street light pole up to the handhole must be coated with one coat of the epoxy primer (6 to 8 mils dry film thickness). The top and edges of the base plate and the exterior of the pole must be multi-coated as detailed above.
7. The interior of the cast iron base, including the access doors, must be coated with one coat of the epoxy primer (between 6 and 8 mils dry film thickness). The exterior and edges of the cast iron base, including the access doors, must be multi-coated as detailed above.
8. The access doors on the cast iron base must be removed during the painting process.
9. The color coat polyurethane will be a Federal Standard 595B color number as indicated in the Contract, or as directed by Agency.

D. All coatings must comply with Proposition 65 regarding cancer-causing agents.
E. All street light components must be packaged for shipping to prevent damage to the coatings during loading, transport, and unloading.
F. An appropriate quantity of touch–up paint (epoxy primer, color polyurethane, and clear polyurethane) must be supplied with each shipment.
G. After installation of the street light (pole, decorative base cover, and fixture), any damaged coatings must be repaired with the supplied touch-up paint. Clean and prepare the damaged area by abrading with 100 grit sandpaper.

49-3 CONTROLLER ASSEMBLIES

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

The controller assemblies must be installed complete by the Contractor. The Contractor must 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 must be sealed with an approved joint sealing compound. The Contractor must make all wire connections to the appropriate terminals in the cabinet. All detector equipment external to the wired cabinet must be furnished and installed by the Contractor. The Contractor must provide anchor bolts for each controller cabinet.

Upon the receipt of a written request to the Agency at least 2 Working Days in advance, equipment and materials will be made available to the Contractor for pick up. The Contractor is responsible for the safe pickup and delivery of the Traffic Controller Assemblies to the work site. Traffic Controller Assemblies must 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”, 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 must conform to the State Specifications, and these Specifications.

49-4.01 Vehicle Signal Faces

All vehicle signal sections, housings, and visors must be metal. The Contractor must remove all manufacturing labels from the traffic signal head lenses prior to installation.

All vehicle signal heads supplied by the Contractor must have 12-inch (300mm) signal faces. All vehicle signal heads must be illuminated by light emitting diode (LED) units that are Caltrans-approved. The LED modules must be Gelcore or Dialight or County approved equal.

All vehicle signal heads shall have a 15-year warranty.

49-4.02 Programmable Directional Louvers

Plastic programmable directional louvers are only permitted where shown or specified in the Contract. Plastic programmable directional louvers must be Pelco Brand GPL (Geometrically Programmed Louver) or approved equal.

49-4.03 Backplates

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

Backplates shall have a 2-inch retroreflective strip on the face around the perimeter per State Specification 86-1.02R(3).

49-4.04 Pedestrian Signal Faces

Pedestrian signal heads must be of the "countdown" variety and must conform to the following specifications:

1. The design of pedestrian signal heads must conform to Sections 4E.04, "Size, Design, and Illumination of Pedestrian Signal Head Indications" and 4E.07, "Countdown Pedestrian Signals", of the current edition of the Federal Highway Administration Manual on Uniform Traffic Control Devices (MUTCD), including approved errata, revisions, and California supplements, the State Specifications, and these Specifications.
2. The housing, finish, control, and terminal blocks of pedestrian signal heads must conform to the State Specifications, except that the housing must be metal.
3. The display of pedestrian signal heads must consist of integrated WALKING PERSON and UPRAISED HAND symbols on the left side and a countdown timer display on the right side. The integrated WALKING PERSON and UPRAISED HAND symbols portion of the display must conform to the documents listed in item 1 above. In addition, the WALKING PERSON and UPRAISED HAND symbols must be Caltrans-approved LED type and must be solid. Outline style symbols must not be used. The countdown timer portion of the display must conform to the documents listed in item 1 above and the specifications in item 4 below.
4. The countdown timer portion of the display must consist of Portland orange numbers that are 9 inches in height on a black opaque background. The display must be capable of indicating the numbers 0 through 99 inclusive. The numbers 0 through 9 inclusive must be displayed as a single digit (i.e. without a leading zero, the left digit dark). The display must be high-intensity LED type in conformance with Caltrans specifications for LED modules. The display must be legible, day or night, from a minimum distance of 120 feet from the signal. The timer must calculate and display the appropriate Flashing Don't Walk time, as programmed on the signal controller, after one cycle of Flashing Don't Walk operation. The timer must continuously recalculate Flashing Don't Walk time each cycle so that the unit will display the proper Flashing Don't Walk time after any change in the settings for that phase on the traffic signal controller. If the Flashing Don't Walk timing is interrupted or shortened (e.g. transition into a preemption sequence or transition to flashing mode), then the countdown timer portion of the display must be discontinued and go dark immediately.
5. Each pedestrian signal head must have an egg crate or Z-crate type screen as specified under number 2 of Section 86-1.02S(3)(d), "Front Screen", of the State Specifications, modified as follows:
   a. The screen must be fabricated from aluminum anodized flat black or finished with lusterless black exterior grade latex paint formulated for application to properly prepared metal surfaces or must be fabricated from flat black plastic.

b. The frame for the screen must be aluminum alloy; polycarbonate will not be allowed.
c. The only alternate method of screening allowed is to eliminate the screen completely and design the pedestrian signal head display, so the results are at least equal to those obtained with the use of the egg crate or Z-crate type screen as determined by the Agency.
d. Visors are not required for pedestrian signal faces.

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

The following meet the standards for Pedestrian Signal Heads and are approved for use on Sacramento County signals:

- Dialight countdown module
- GE countdown module
- Signal housing shall be painted olive green, manufactured by McCain or Peek.

49-5 DETECTORS

The Contractor shall call the Project Inspector, or the County's Construction Management and Inspection Division (CMID) at (916) 875-2700 if the Project Inspector is unavailable, to provide three (3) working days' notice for interruption of traffic signal detector function for each affected intersection.

Traffic signal loop detectors shall only be installed when existing loop detectors are damaged during construction and the Contractor has approval from the Agency to install loop detectors.

Detectors must conform to the State Specifications, and these Specifications.

49-5.01 Loop Detectors

At locations where existing loop detectors are damaged and the Agency has approved repair of the damage by replacing with new loop detectors, all work shall be in accordance with this section or as directed by the Engineer.

Traffic signal loop detectors shall be installed as detailed on Standard Drawings 5-18 and 5-19A.

At advanced detector locations, loop detectors that are more than 100 feet from the associated stop bar at the signalized intersection, the Contractor shall replace any damaged loop detector with a new Type A loop detector (one per lane). If there is no existing detector handhole in the vicinity of the new loop detector, a new detector handhole and conduit connecting to the associated pull box shall be supplied and installed. At presence detection locations, loop detectors that are less than 100 feet from the stop bar at the signalized intersection, the Contractor shall replace any damaged loop detector with one or more Type A loop detectors as needed so that there are 4 working loop detectors per lane, spaced as shown on Standard Drawings 5-18 and 5-19A. If there is no detector handhole in the same lane as the new loop detector(s), a new detector handhole and conduit connecting to the associated pull box shall be supplied and installed. Detector handholes shall be installed per State Specifications. All costs associated with the replacement of damaged loop detectors, including the supply and installation of detector handholes and connecting conduits, will be borne by the Contractor and no additional compensation will be allowed therefor.

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.

All induction detector loop and lead-in cable shall be tested in accordance with procedures outlined in Drawing 5-18, "Loop Detectors," of these Specifications. All test results and corrections of failures shall be documented and become a permanent record for future reference. The Contractor shall splice new detector loops connected to new or existing detector lead-in cable. All testing shall be done and approved prior to the County returning the traffic signal to normal function.

The Contractor shall be responsible for laying out all detector loops in conformance with these Specifications. Loops shall be marked, and their location approved by the Engineer prior to

pavement cutting. All costs associated with traffic control, measuring, and marking required to properly locate detector loops shall be borne by the Contractor and no additional compensation will be allowed therefor.

49-5.01.A Construction Materials

Either Type 1 or Type 2 loop detector conductor wire, as defined in Section 86-1.02F(2)(c)(iii), "Inductive Loop Conductors," of the State Specifications, may be used.

Loop detector lead-in cable must consist of 4 No. 18 AWG stranded copper conductors insulated with 9 mils minimum of polypropylene, color coded, parallel laid, twisted together with 4 to 6 turns per foot. An amorphous interior moisture penetration barrier must be provided to prevent hosing, siphoning, or capillary absorption of water along cable interstices. Aluminum polyester shielding must be applied around the conductors. The outer jacket must be 32 mils minimum thickness, high density polyethylene conforming to ASTM D1248, 65T for Dielectric Material, Type I, Class C, Grade 5, J3. The diameter of the lead-in cable must be approximately 1/4 inch.

49-5.01.B Installation Details

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

Unless otherwise indicated in the Contract, loop detectors must 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. Detector handholes must be centered in the associated vehicle lane and must be located approximately 4 feet clear of the nearest traffic signal loop detector. Loop detectors that are installed in the vehicle lane closes to the edge of pavement, either with or without curbs and gutters, must be constructed such that the wires connecting the loops to the associated detector handhole run on the side of the loops further from the edge of pavement.

Unless otherwise shown or specified in the Contract or directed by the Agency in the field, each new detector loop must be 5 feet by 5 feet and must be centered in the traveled lane. All detector loops must 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 must accurately mark the future lane lines prior to pavement cutting.

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

Unless specified otherwise, each loop must consist of the 3 turns of conductors for each detector loop. All detector loops located two hundred 250 feet or farther from the stop line must consist of 4 turns of conductors for each detector loop. In each traffic lane, the loop detector at the stop bar shall have four turns instead of three. Other loop detectors that are located within one hundred feet of the stop bar in each traffic lane shall have three turns each.

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

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

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

Each detector loop circuit must be tested for continuity, circuit resistance, and insulation resistance at the controller location. The loop circuit resistance must not exceed 0.50 ohms plus 0.35 ohms per 100 feet of lead-in cable. The insulation resistance must be performed between each

circuit conductor and ground. The megged insulation resistance must not be less than 200 megohms. The Contractor must replace any detector loop that fails this test at the Contractor's expense. All test results and corrections of failures must be documented. Test documentation must be provided to the Agency to become a permanent record for future reference. All testing must 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 continuous without splices from the pullbox, adjacent to the loop detector, to the detection termination panel in the controller cabinet. All splices between loops and the lead-in cable shall be soldered. For presence detection loop detectors, those loop detectors that are located within one hundred feet of a stop bar, the loops in each traffic lane shall be spliced to two detector lead in cables. For any traffic lane approaching a traffic signal for which loop detection is shown to be installed, the loop detector that is closest to the stop bar shall be spliced to one detector lead in cable and the other presence loop detectors in that lane shall be spliced to a second detector lead in cable.

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

The Contractor may use any of the sealants described in Section 86-1.02W, “Loop Detector Sealants,” of the State Specifications; however, the top portion of any slot to be sealed (from a depth of approximately one half inch from the roadway surface to approximately one-eighth of an inch from the roadway surface) shall be sealed with elastomeric sealant.

Where indicated, detector lead-in cable (DLC) shall be installed from the pull box to the controller cabinet at the locations indicated on the Plans or as directed by the Engineer. DLC is to be installed into an existing conduit system using the following procedures:

1. Disconnect loop wires from DLC.
2. County Traffic Operations to place the signal controller on “Recall”.
3. Remove the DLC to the controller cabinet.
4. Install DLC as shown in these Specifications or as directed by the Engineer.

The Contractor shall splice to loop wires and test detector functionality.

Detector handholes must be type “B.” Detector handholes must 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 join the ABS sweep “Y” to the PVC conduit must be capable of providing a solvent type weld between the two materials.

49-5.01.C <u>Splicing Details</u>

All splicing must be made in a dry environment. The splice between the lead-in cable and the loop conductors in the adjacent pull box must be a soldered waterproof type. This must 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 must not be damaged while soldering. The soldered splice must be protected with an electrical spring connector of 3-part construction.

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

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

The Contractor must then apply heat-shrink tubing over the splice. Heat shrink tubing must be medium or heavy wall thickness irradiated polyolefin tubing containing an adhesive mastic inner wall. Minimum wall thickness prior to contraction must be 0.04 inch. When heated, the inner wall must 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 must, after contraction, overlap the conductor insulation at least 1-1/2. Heat shrink tubing must conform to the requirements of UL Standard 468D and ANSI C119.1, for extended insulated tubing at 600 volts. The Contractor must 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 must 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^{14} 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 3 or more conductors are to be enclosed within a single splice using heat-shrink tubing, mastic must be placed around each conductor, prior to being placed inside the heat- shrink tubing. The mastic must be the type recommended by the manufacturer of the heat- shrink tubing.

Heat-shrink tubing must 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 must be clamped together until the sealant dries.

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

Where shown on the Plans, detector loops must be sawcut into detector handholes. Detector handholes must be installed in accordance with these Specifications and as shown on the Standard Drawings unless otherwise specified or directed by the Agency. Splicing in the detector handholes is not permitted.

Conduit from the detector handhole to the adjacent pull box must 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 Video or Hybrid Video/Radar Detection System

A video or hybrid video/radar detection system (detection system) shall be supplied and installed for those locations indicated in the Contract. Detection system shall be video or hybrid video/radar per these Specifications unless otherwise approved by the Agency. The detection system shall consist of:

- Detection units
- Shelf mount CCU (shall be 4 sensor capable even if less are used at initial install)
- Riser pole for video cameras: Pelco AG-0175, 74” tube, no color, or approved equal.
- Riser pole for hybrid video/radar units: Pelco AG-0169, 74” tube, no color, or approved equal.
- Cabling
- Surge protection device
- 10.4” diagonal color LCD video monitor with integral stand
- Industry standard 3-button USB mouse
- Appropriate SDLC connection hardware as necessary when not installed in a TS-2 Type

1 signal controller cabinet

Detection units and CCU shall be of the manufacturer's official product line. Other hardware listed shall be as recommended and approved by the detection unit manufacturer.

Unless there is a bid item for a detection system, the detection system, including but not limited to specified hardware, software, warranty, maintenance, and support, is included in the lump sum price paid for the traffic signal installation, and no additional compensation will be allowed therefor.

Where indicated on the Plans for signalized intersection approaches when the vehicle detection area is more than one hundred feet from the associated stop bar, the Contractor shall supply and install a hybrid video/radar detector that can detect and differentiate vehicles and bicycles, in daylight and nighttime. The hybrid video/radar detector shall be "Iteris Vantage Vector on the Next Platform with shelf mount CCU" or approved equal.

Where indicated on the plans for signalized intersection approaches where the vehicle detection area is less than one hundred feet from the associated stop bar, the Contractor shall supply and install a video detector or hybrid video/radar detector that can detect and differentiate vehicles and bicycles, in daylight and nighttime. The video detector or hybrid video/radar detector shall be "Iteris Vantage Next Camera with shelf mount CCU" or "Iteris Vantage Vector on the Next Platform with shelf mount CCU" or approved equal.

49-5.02.A Installation

After the signal poles and arms have been erected, and before any holes are drilled, the Contractor shall notify the Engineer or Inspector and the area Signal Maintenance Supervisor at least five (5) working days in advance to request approval for mounting locations of the detection units. The Signal Maintenance Supervisor, or assigned signal technician, will meet with the Contractor and finalize/approve the exact mounting locations. If the Contractor installs detection units before receiving approval, the Contractor will need to relocate the detection unit or units as determined by the County at no cost to the Agency. The locations determined could be different from those indicated on the Plans.

The detection units shall be mounted per manufacturer's recommendations using 1" heavy stainless steel banding material. Video camera detection units shall be mounted on the signal mast arm using a six foot riser pole. Hybrid video/radar detection units shall normally be mounted directly on the signal mast arm but may require installation on a six foot rise pole in cases with a shorter signal mast arm to avoid conflict with signs or EVP detector.

The Contractor shall supply and install continuous cabling without splices from each detection unit to the signal controller cabinet. Cabling shall be as recommended and approved by the detection system manufacturer.

Each cable shall have 10 feet of slack at the detection unit (stored inside the pull box closest to the pole) and 20 feet of slack at the signal cabinet (stored in the signal cabinet pull box) when connected and terminated in the final configuration.

The cable shall be physically supported, strain relieved, protected from chafing, and water sealed where the cable enters the mast arm, provided by a rubber grommet. The rubber grommet shall be located on the side of the mast arm facing away from the intersection and 45 degrees down.

The Contractor shall install all equipment and cables (including cable terminations) external to the signal controller cabinet. The Contractor shall provide to the Agency all equipment for inside the controller cabinet at least two (2) weeks prior to signal turn on. The Agency shall install all equipment and make all cable terminations inside the signal controller cabinet and perform initial programming and testing.

49-5.02.B Warranty

The supplier shall provide a three-year warranty of the detection system. During this period technical support shall be available from factory-certified personnel via telephone within 4 hours of receipt of request.

49-5.03 Emergency Vehicle Detector Cable, Detectors, and Phase Selectors

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

The Contractor must 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 GTT Opticom 721 Detector, or approved equal. EVD's must 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 must be continuous and unspliced from the detector to the controller cabinet. The Contractor must provide for 5 feet of conductor slack in the pull box at the base of each pole with an EVD installation.

The Contractor shall supply one (1) EVD phase selector for each new traffic signal controller cabinet that is being installed under this Contract. EVD phase selector shall be GTT Opticom Model 764 Multimode Phase Selector or approve equal. The Contractor shall supply the phase selector to the County a minimum of two weeks prior to the date of traffic signal controller cabinet installation.

49-5.04 Pedestrian Push Buttons

The Contractor must supply and install push buttons that provide accessible pedestrian signals to users. The push buttons must have the following features integrated into the devices:

1. an audible push button locator tone,
2. an audible walk signal and
3. a tactile arrow.

Operation of the push button must activate both the "walk" interval and the accessible pedestrian signals. During the "walk" phase of signal operation the associated pedestrian push button must have both audible and vibrotactile indications. The vibrotactile indication must be provided by a tactile arrow on the push button that has high visual contrast (light on dark or dark on light), must be aligned parallel to the direction of travel on the associated crosswalk, and must vibrate during the "walk" interval.

The audible "walk" indication must be a tone that repeats at 8 to 10 ticks per second during the entire "walk" phase. The audible tone used as a "walk" indication must consist of multiple frequencies with a dominant component at 880 Hz.

The unit must be able to produce a speech message that can be used instead of the above described audible "walk" indication. The speech message must be customizable for the location where the device is installed. For example, a unit installed at a crosswalk that crosses Main Street must be able to produce a speech message that says, "Main Street. Walk sign is on to cross Main Street.".

The volume of the "walk" indication, the speech message, and of the locator tone, must be set to a maximum of 5dBA louder than ambient sound. The device must provide for automatic volume adjustment in response to changes in ambient traffic sound levels up to a maximum volume of 100dBA.

Following the audible walk indication, the accessible pedestrian signal must revert to the push button locator tone during the pedestrian change interval. The push button locator tone must have a duration of 0.15 seconds or less and must repeat at 1 second intervals. The locator tone must be deactivated when the traffic signal is operating in a flashing mode. The locator tone must be intensity responsive to ambient sound and must be audible six to twelve feet from the installed location of the push button.

The housing for the accessible pedestrian signal device must incorporate mounting space for the pedestrian push buttons signs described below.

The County has preapproved the use of the following accessible pedestrian push button signal devices:

- iDS3 Accessible Pedestrian Signal by Polara Enterprises (three wire system), iDS3-CA – Caltrans Prescribed Failsafe Mode.

Use of other devices that meet the requirements above might be allowed upon review and

approval by County of Sacramento's Department of Transportation. The Contractor may propose use of a device other than one of the ones listed above by supplying manufacture's information about the proposed device a minimum of 3 weeks prior to the date planned for ordering the equipment. The Agency may request submittal of a sample device for testing.

In addition to the pedestrian push buttons shown on the Plans, the Contractor must provide the Agency with one additional push button unit including control module. The push button unit must match the ones installed on the project and must meet all of the above requirements.

Pedestrian push button signs shall be sign R10-3j(CA) of the latest CAMUTCD. The signs shall be metal and have an anti-graffiti coating.

Each pedestrian push button unit must be mounted on traffic signal poles so the center of the portion of the unit that is intended to be pushed is located no lower than 42 inches above the surface of the sidewalk or walkway adjacent to the pole. At locations where installation of the pedestrian push button is not practical at 42 inches, the unit must be placed so the portion of the unit that is intended to be pushed is located between 42 and 48 inches above the surface of the sidewalk or walkway adjacent to the pole.

49-6 LIGHTING

Lighting must conform to the State Specifications, and these Specifications.

49-6.01 Street Lights

Street Lights shall be standard Type A in accordance with Standard Drawing 5-1, unless otherwise shown on the Plans or directed by the Engineer.

Type A street lights shall be wired so that the fuse is installed in the street light pole hand hole.

49-6.02 Photoelectric Controls

The control circuit wiring between the photoelectric unit and the contactor must be installed as shown on the Standard Drawings.

Unless otherwise shown or specified in the Contract, the photoelectric controls must be Type II as modified herein. Type II photoelectric control must 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 must be furnished with a nameplate reading "Hand-Off-Auto" and must be connected as specified in Section 49-2.11, "Service", of these Specifications and as shown on the Standard Drawings. Test switch must have an "OFF" position.

49-6.02.A Photoelectric Unit

The photoelectric unit will be supplied by the Contractor. The photoelectric unit must be compatible with Light Emitting Diode (LED) street light luminaires. Photoelectric units must be Dark to Light DLL Elite long life LED photocell – DLL127 F 1.5 or approved equal.

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

49-6.02.B Contactors

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

49-6.02.C Contactor and Test Switch Housing

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

49-6.02.D Wiring

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

49-6.03 Light Emitting Diode (LED) Luminaires

LED luminaires must be of the wattage and ANSI light distribution pattern shown on the plans and specified in the Special Provisions. Safety light luminaires for use at signalized intersections must be on the list prepared by the State of California Department of Transportation titled "Pre-Qualified Product List LED Luminaires", latest version.

The luminaire must consist of a housing, LED array, and electronic driver (Power supply). Each luminaire must be rated for a minimum operational life of 100,000 hours, and must be designed to operate at an average nighttime operating temperature of 70 degrees F. The individual LEDs must be connected so that a catastrophic loss or failure of one LED will not result in the loss of the entire luminaire. The luminaires must be listed with Underwriters Laboratory, Inc., under UL1598 for luminaires, or an equivalent standard from a recognized testing laboratory.

The luminaires must operate at 60 Hz AC line over a voltage range of 95 to 277 Volts AC and must have a power factor of 0.90 or greater. The on-board circuitry must include surge protection and must prevent perceptible flicker to the unaided eye. The luminaire shall be compatible with currently utilized lighting control systems and photocell controls as detailed in ANSI/IEEE C136.41.2.

The luminaire must have a correlated color temperature of 4,000K +300, and a color rendition index of 65 or greater. The luminaire must have a BUG (Backlight, Uplight and Glare) rating of B2 U0 G2.

The heat sink material must be aluminum, and thermal management must be passive by design. The luminaire must contain circuitry that will automatically reduce the power to the LEDs to 50% of normal operating power, or to a level that will ensure that the maximum junction temperature is not exceeded, when the ambient, outside air temperature is 100°F or greater.

The maximum weight of the LED luminaire must be 35 pounds, and the maximum effective projected area must be 1.4 square feet. The housing must be light grey in color. The housing must be constructed of materials that are designed to withstand a 1,000-hour salt spray test as defined in ASTM Designation B117. Each housing must be provided with a slip fitter, clamping bracket, and two or four bolts capable of mounting on mast arms from 1-5/8 to 2-3/8 inch outside diameter.

The optical assembly of the luminaire must be protected from dust and moisture intrusion per the requirements of IP-66. The electronics/power supply enclosure must be protected per the requirements of IP-43 (Minimum).

Each luminaire must be supplied with a photoelectric unit receptacle and rain tight shorting cap.

Field wires connected to the luminaire must terminate on a barrier type terminal block secured to the housing. When components are mounted on a down-opening door, the door must be hinged and secured to the housing. A safety cable must mechanically connect the door to the housing.

Luminaires must be vibration tested in conformance with California Test 611, or other internationally recognized vibration test standard.

Each luminaire must have the manufacturer's name, trademark, model number, serial number, and date of manufacture (Month-Year) permanently marked inside each luminaire and outside of each box. Each luminaire must be marked on the underside with a suitable decal visible from the ground that includes the fixture's system wattage and identifies the luminaire as an LED type.

The manufacturer must provide a warranty against loss of performance and defects in materials and workmanship for the luminaires for a period of 120 months after acceptance of the luminaires. The warranty must include language indicating that replacement luminaires must be provided promptly after receipt of luminaires that have failed, at no cost to the County.

Lighting fixtures used for street lighting shall be as required by the latest version of the County of Sacramento Improvement Standards or approved equal.

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 must inform the Agency and the Traffic Signal and Street Light Manager at least 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 is 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, must 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 must be tagged with a suitable waterproof tab and marking pen before removal from the work site. The tag must give the date, the intersection name, corner, and location from which the equipment was removed as shown on the Plans.

The Contractor must inform the County Traffic Signal Shop at least 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 must 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 is 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 become the property of the Contractor and must be removed from the right-of-way by the Contractor.

49-9 IP CAMERA

The Contractor shall furnish and install IP cameras on traffic signal poles and/or mast arms as indicated on the Plans. See Standard Drawing 5-21 for mounting and connection details.

The IP camera shall be AXIS Q6315-LE PTZ dome network camera or approved equal. Camera shall connect through the County's network and all camera functions shall be fully capable of working with the County's existing Genetec Inc. Security Center software. In addition, the Contractor shall provide training for both the camera setup, including connection to the network, and operation.

The camera system shall have following components, or approved equals:

Manufacturer	Model Number	Description
AXIS	Q6315-LE	PTZ dome network camera
AXIS	T91B67	Pole mount bracket
AXIS	TQ-6501-E	Parapet mount bracket
Pelco Products	AB-3034	Astro-Brac Clamp Kit, 1-1/2" NPS Cable Mount, stainless steel cable, no color
AXIS	T94A01D	Pendant kit
AXIS	5700-371	RJ45 PushPull connector
Primus Cable	C5CMXT	Outdoor rated Category 5e cable, black with water blocking layer
AXIS	T8154	60 W SFP Midspan PoE power injector
AXIS	TU8001	Ethernet surge protector

All firmware found in products shall be the latest provided by the manufacturer, or of a version as specified by the provider of the Video Management Application (VMA).

All equipment shall be tested and configured in accordance with instructions provided by the manufacturer.

Full compensation for IP Camera as specified herein shall be considered as included in the

LUMP SUM price paid for traffic signal installation and/or traffic signal modification and no additional compensation will be allowed therefor.

49-9.01 IP Camera Mounting

Mast arm mounted cameras shall be installed such that other equipment on the mast arm does not block the camera view.

The pole mount installation shall use stainless steel banding. For the parapet mount, discard mount base, retain and install lock nut and cable holder, and thread mount arm into mounting bracket. The cable holder in the mounting bracket shall hold the communication cable in place. The cable shall have enough slack for easy removal of the camera.

49-9.02 IP Camera Communication Cable and Connectors

The camera shall connect to the PoE midspan in the traffic signal cabinet using 4-pair Category 5e communication cable which is outdoor rated, UTP, and meets ANSI/TIA-568.2-D Category 5e, NEMA WC63.1 Category 5e, IEEE 802.3af, and IEEE 802.3at standards. The cable shall be as specified above.

Cables shall have 5 feet of slack at the camera (stored inside the pull box closest to the pole) and 20 feet of slack at the signal cabinet (stored in the signal cabinet pull box) when connected to the Ethernet surge protector in the final configuration. Cables shall be continuous without splices from the Ethernet surge protector to the camera.

Where the cable passes through holes drilled into poles or signal mast arms, a rubber grommet shall be installed to protect the cable from damage and provide a water seal and strain relief.

The camera end of the communication cable shall use the RJ45 push-pull connector specified above. The Ethernet surge protector end of the communication cable shall use a standard crimp type RJ45 connector suitable for outdoor use. The connector shall be rated for Category 5e connections, accept AWG 22-24 size wires, and be capable of T568A/B, UTP standards. The Contractor shall terminate all cables using manufacturer's guidelines. The jacket shall insert far enough into the connector to be crimped, providing strain relief.

49-9.03 Ethernet Surge Protector and Patch Cables

The Ethernet surge protector shall be installed between the camera and the midspan PoE injector and both the surge protector and PoE injector shall be located in the traffic signal controller cabinet.

Category 5e Ethernet patch cables are used to connect the Ethernet surge protector to the PoE midspan and the midspan to the County network device located inside the traffic signal controller cabinet. Cat 5e patch cables shall be factory made, outdoor rated, UTP, meet ANSI/TIA-568-C.2 Category 5e standard, have molded boots to protect the RJ45 connector, and be 3 feet in length.

49-10 APPROVED EQUALS

Contractors pursuing use of an approved equal for signals, lighting, and electrical systems shall contact the Chief of Engineering and Design Division or the Chief of Maintenance and Operations of the County of Sacramento Department of Transportation for the current approved equal requirements and specifications.

For alternative detection systems (approved equals), the Contractor shall submit a complete working detection system to the County for review and testing. A factory certified representative from the manufacturer shall be made available to the County, at the Contractor's expense, to install the detection system. The County shall have thirty calendar days to review, test, and determine acceptance. No extension of time or additional working days shall be allowed for the County's review and test period.

49-11 PAYMENT

The lump sum price or prices paid for signal, lighting, electrical system, traffic signal interconnect, 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 shall 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; 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.