

49-1 GENERAL

Traffic signals, intersection safety lighting and electrical systems shall be constructed or installed as shown or specified in the Contract, these Specifications, the applicable State Plans, and the applicable provisions of Section 86, “General” and Section 87, “Electrical Systems”, of the State Specifications.

The provisions of Section 7-19, “Substantial Completion”, of the City Standard Construction Specifications shall not apply.

49-1.01 Definitions

Definitions for signals, lighting and electrical systems shall be as specified in Section 86-1.01.B, “Definitions”, of the State Specifications, and the following:

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

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

49-1.02 Abbreviations

Abbreviations for signals, lighting and electrical systems shall be as specified on pages A3A through A3C of the State Standard Plans, and the following:

EVD - Emergency Vehicle Detector

I/C - Interconnect Cable

F.O. - Fiber Optic Cable

L.C. - Lower Case

PG&E - Pacific Gas & Electric Company

SMUD - Sacramento Municipal Utility District

U.C. - Upper Case

49-1.04 Equipment List and Drawings

The Contractor shall provide the City an Equipment List and Installation Drawings for all Signals, Lighting and Electric Systems to be constructed or installed. The Contractor shall include on the equipment list the installation location of material supplied. This shall be done by the use of street names, the alphabetical letter designation used on the Plans, or a location as otherwise noted on the Plans. Equipment lists and drawings shall conform to Section 86-1.01C4, “Submittals”, of the State Specifications. If requested by the City, the Contractor shall submit for review sample articles of the material proposed for use. After review, said sample articles will be returned.

The equipment and materials proposed for use on any project shall be listed on the City’s Authorized Materials List for Traffic Signal Cabinets and Components and approved by the Engineer before starting work.

In conformance with the requirements in Section 11-3, “As Built Drawings (As Builds)”, of these Specifications, the Contractor shall maintain “As Built” plans that shall show, in detail, the construction changes of all traffic signal and streetlight wiring, conduits,

standards, and associated equipment. In particular, the “As Built” plans shall accurately depict the location and depth of conduits, location of standards, pull boxes, wiring changes, and all applicable manufacturer’s operation and maintenance information.

49-1.05 Ordering of Signal and Lighting Equipment

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

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

49-1.06 Maintaining Existing and Temporary Electrical Systems

Maintaining existing and temporary electrical systems shall conform to Section 87-21.03B, “Maintaining Existing Electrical Systems”, of the State Specifications and these Specifications.

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

The Contractor shall notify the City at least two (2) working days prior to any operational shutdown of traffic signals, street lighting, loss of communications or other electrical systems or facilities.

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

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

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

Vehicle detectors taken out of service shall be repaired or replaced within forty-eight (48) hours. New vehicle detectors for rerouted traffic shall be installed within forty-eight

(48) hours. Where work site conditions do not permit the installation of permanent vehicle detectors within forty-eight (48) hours, temporary vehicle detectors shall be installed, at the Contractor's expense, as directed by the City. Permanent vehicle detectors shall be installed as soon as work site conditions permit.

49-1.07 Scheduling of Work

Scheduling of work shall conform to Section 8-1.02, "Schedule", of the State Specifications.

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

A traffic signal turn-on will not be scheduled until a pre-turn-on inspection has been completed and related issues have been resolved. The Contractor shall obtain City approval of the turn-on date at least five (5) working days in advance. The Contractor shall be responsible for notification and coordination with other personnel, agencies, and entities as appropriate, including coordination of related signing and striping work. Traffic signal turn-on shall take place between 11:00 AM and 2:00 PM.

49-1.08 Safety Precautions

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

49-1.09 Inspection

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

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

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

49-1.10 Signal Turn-on

Traffic signals shall not be turned on until all signalized intersection components including heads, pedestrian heads, backplates, luminaires, detectors, push buttons, signs, and striping have been installed, inspected and tested.

Contractor shall use the City's Traffic Signal Turn on Checklist. Contractor shall verify that all items on the traffic signal turn on checklist are provided and in working order.

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No two-signal turn-ons on the same Contract shall be scheduled for the same day.

At time of turn-on, the Contractor shall uncover all Contractor-installed signs and signal heads that have been installed.

49-2 MATERIALS AND INSTALLATION

49-2.01 Trench Excavation and Backfill

Unless otherwise permitted in writing by the City, all surplus excavated material shall be removed and disposed of the same day the surplus material is excavated outside the City right-of-way in accordance with the provisions in Section 18-7 “Surplus Material Disposal” of these Specifications.

Unless otherwise shown or specified in the Contract, trench excavation and backfill shall conform to Section 19, “Trench Excavation, Bedding, and Backfill”, of these Specifications, and restoration of surfaces shall conform to Section 14, “Restoration of Surfaces”, of these Specifications.

The Contractor must contact Underground Service Alert in accordance with the provisions in Section 6-16.04 “Underground Service Alert (USA)” of these Specifications.

49-2.02 Removing and Replacing Improvements

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

Traffic legends and striping shall be replaced in their entirety if any portion of the legend or marking was disturbed. This includes crosswalks, words, arrows, etc.

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

The outline of all areas to be removed in portland cement concrete sidewalks, curbing, and driveways shall be saw cut prior to removing the material to assure a clean edge. Cuts shall be neat and true along score lines or constructed joints, with no shatter outside the removal area. Cuts shall not extend beyond the limits of the removal area.

49-2.03 Foundations

Foundations shall conform to Section 87-1.03E(3), “Concrete Pads, Foundations, and Pedestals”, of the State Specifications, and these Specifications. Foundations shall conform to the size(s) and shape(s) shown on the Plans, the Standard Drawings, or the State Plans, or as otherwise detailed in the Contract, as applicable. The Contractor shall provide anchor bolts for all foundations unless otherwise specified in the Special Provisions. Anchor bolts shall be positioned so that a minimum of two (2) to a maximum of four (4) threads will be visible above the top nuts after the pole has been erected and plumbed. Rigid non-metallic conduit shall be allowed in traffic signal and street light foundations. All elbows are to be

Type 1 rigid galvanized steel.

All traffic signal pole foundations shall be located such that no existing conduit, pipe or other underground utility facility shall conflict with the entire volume of the pole foundation. If a conflict with an existing street light conduit or an existing traffic signal conduit is determined to exist, the Contractor shall modify the existing conduit such that it is removed from the area of conflict. If a conflict with any underground utility facility other than streetlight and traffic signal conduit is determined to exist, the Contractor shall bring the potential conflict to the attention of the Engineer. The signal foundation location may be adjusted as detailed in Section 49-2.04B & C of the City Standard Construction Specifications.

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

49-2.04 Standards, Steel Pedestals and Posts

Standards, steel pedestals, and posts shall conform to Section 87-1.03J, “Standards, Poles, Pedestals and Posts”, of the State Specifications, and these Specifications.

Powder Coating

All traffic signal poles, mast arms, luminaire arms and internally illuminated street name sign support arms at intersections in the Zone 2 area, which includes the areas noted in Section 5 of the Improvements Standard, shall be finished with a stock color black super-durable TGIC polyester powder coat prior to installation and a color sample shall be provided for City approval prior to powder coating. All pole, mast arm and support arm surfaces shall be recoatable with standard maintenance finishes.

Pretreatment

All surfaces to be powder coated shall first be swept to provide a better profile and remove oxidation. The sweeping process may consist of blasting with a light abrasive media such as glass beads or very fine sand. The sweeping shall not be so aggressive that it degrades the galvanized surface. The media shall then be blown off completely. Certification of pretreatment shall be provided by the powder coat finisher.

Primer

A coat of protective primer shall be applied with a minimum thickness of 2 mils. The primer shall be partially cured for 2 minutes at 400 degrees Fahrenheit at substrate.

Topcoat

A topcoat shall be applied with a minimum thickness of 3.5 mils. Curing time shall be a minimum of 15 minutes at 400 degrees at substrate.

Numbering

Identification number of each pole shall be labeled on the pole prior to acceptance by the City. Labels shall be two inch (2”) letters and numbers and shall be applied vertically on the pole top to bottom. The bottom of the lowest letter or number in the Identification Number shall be ten (10) feet from the ground surface. Pole Identification Numbers shall face forty-five (45) degrees to oncoming motor vehicle traffic. Letters and/or numbers shall be black on silver engineering grade reflective material. The City will assign the Pole Identification Numbers

Identification number of each Steel Pedestal shall be labeled on the enclosure prior to acceptance by the City. Labels shall be two inch (2") letters and numbers and shall be applied vertically on the top left corner of the front panel, from top to bottom. Letters and/or numbers shall be black on silver engineering grade reflective material. The City will assign the Service Pedestal Identification Number.

49-2.04.A Aluminum and Concrete Street Light Standards

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

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

Series B aluminum and concrete street light standards shall be equipped with a two and seven-eighths inch (2-7/8") diameter by three inch (3") long tenon. Base plates shall be provided with nine and one-half inch (9-1/2") bolt circles for aluminum standards and twelve and one-half inch (12-1/2") bolt circles for concrete standards.

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

49-2.04.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. Final placement of these facilities shall be determined by the Engineer at the time of their installation.

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

49-2.04.C Final Location of Traffic Signal Poles

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

compensation will be allowed.

49-2.05 Conduit

Conduit installation shall be as specified in Section 86-1.02 “Materials” and Section 87-1.03B, “Conduit Installation”, of the State Specifications, and the following:

Unless otherwise indicated all conduit shall be Type 3 at least two inches (2”) or larger in diameter. Conduit shall be at least Schedule 40 and pole risers shall be Schedule 80.

All elbows shall be Type 1 rigid galvanized steel. All bend radii shall be two feet (2’) or greater. Rigid galvanized steel elbows shall be grounded by grounding jumpers spliced to the ground wire in the conduit.

The conduit shall be free from defects including non-circularity, foreign inclusions, etc. It shall be nominally uniform (as commercially practical) in color, density, and physical properties. It shall be straight, and the ends shall be cut square to the inside diameter. The conduit system shall be designed so that straight sections and fittings will assemble without the need for lubricants. Conduits and fittings shall be fastened together with cement as recommended by the manufacturer or as approved by the Engineer.

Non-metallic conduit shall have an integral bell on each length, suitably designed to give a clearance fit on the outer diameter of the conduit. The conduit shall have a circumferential ring on the spigot end, which shall be used to ensure proper insertion depth when connecting conduit ends.

INTERCONNECT CONDUIT

Unless otherwise indicated, interconnect conduit shall consist of one (1) – two (2) inch Type 3 conduits and two (2) – four (4) inch Type 3 conduits. The conduits shall be Schedule Forty (40) or better. The following provisions shall apply:

A complete line of fittings and, adapters shall be provided by the conduit manufacturer. The complete system will allow for coupling kits, manhole terminator kits, lubrication fittings, repair kits, and installation accessories.

PVC conduit shall have system compatible bell and spigot ends.

The conduit shall be marked with data traceable to plant location, date, shift, and machine of manufacture.

Conduits entering splice vaults and pull boxes shall be capped with conduit plugs, terminated flush with the inside walls of each vault or pull box, and terminated with a manufacturer-produced terminator connector to tightly connect to and seal the wall of the splice vault.

PVC Conduit – PVC conduit shall conform to the requirements of NEMA TC-2, NFPA 70, and UL 651.

HDPE Conduit – High Density Polyethylene (HDPE) conduits shall conform to the following applicable standards: NEMA TC-7, UL 651B, NFPA 70, and ASTM F2160. Each conduit shall be a different color, which shall remain consistent throughout the project. The Contractor shall submit the color-coding scheme to the City for

approval.

Conduits shall normally be placed behind the curb. No trenching of a finish grade pavement is allowed unless otherwise approved by the Engineer. Base paving may be trenched to allow conduit installation if a final lift of asphalt will be placed by the same project.

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

Conduits terminating in standards or enclosures shall emerge from the foundation vertically, \pm five (5)° inches in any direction.

Conduit runs terminating in the controller cabinet shall consist of at least one (1) – two (2) inch conduit and two (2) four (4)-inch conduits with two (2)-foot minimum radii.

When multiple conduits are installed by trenching, they shall be installed together in a common trench. If the resulting trench size would exceed maximums required by these special provisions, the Contractor shall obtain the City’s approval for any modifications to standard trench requirements prior to beginning the work and shall be responsible for any additional traffic control, trench plating, or other work related to the trenching. To avoid modifying standard trench requirements, the City reserves the right to require conduit to be placed by boring instead of trenching.

Transition of the conduit without bends shall not exceed more than 1 foot (1’) for every ten feet (10’). Interconnect conduit bends shall comply with requirements stated elsewhere in these Standard Construction Specifications. .

The Contractor shall furnish and install end bushings.

To enable tracing the location of the conduit, a ten (10) AWG green wire shall be installed in conduits.

After conductors have been installed, the ends of conduits terminating in pull boxes, interconnect cabinets, splice vaults, controller cabinets, and service enclosures, conduit shall be sealed with Duct Seal or other approved sealing compound.

An orange warning tape or two (2)-sack red slurry cement backfill shall be placed in all trenches six (6) inches above the conduit.

Where conduit in unpaved areas is to be placed in a trench, the trench shall be approximately 2 inches (2”) wider than the outside diameter of the conduit to be installed. Trench shall not exceed 6 inches (6”) in width. At all pull boxes, the trench may be hand dug to required depth. The conduit shall be placed in the bottom of the trench and the trench shall be backfilled with commercial quality concrete, colored red and containing not less than two (2)-sack red slurry cement, to a point approximately eight (8)-inches below finished grade. The top eight inches (8”) shall be backfilled and compacted with native soil. The top of the installed conduit shall be a minimum of eighteen inches (18”)-inches below grade.

When “Trenching in Pavement Method” is specifically allowed or required in the special provisions, installation of conduit under pavement shall conform to the following:

Conduit shall be Type 3. Conduit shall be placed under existing pavement in a

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trench approximately two-inches (2") wider than the outside diameter of the conduit to be installed. Trench shall not exceed six inches (6") in width. Trench depth shall not exceed the greater of fourteen inches (14") or roadway structural section less two inches (2"), except that at pull boxes the trench may be hand dug to required depth. The top of the installed conduit shall be a minimum of nine inches (9") below finished grade.

Trenches to be made using this method shall be cut by a machine that will produce smooth edge cuts in the pavement and will move at a speed in excess of four feet per minute (4 ft/min.) while cutting pavement. The trenching machine shall be shielded to prevent loose material from being thrown away from the machine. Loose material deposited on the pavement behind the cutting machine shall be removed from the pavement immediately and the pavement cleared to allow the passage of traffic. Only those traffic lanes occupied by the cutting machine and the cleanup operation shall be closed and they shall be opened as soon as the work has moved sufficiently to clear them.

In areas where additional pavement is to be placed, trenching installation shall be completed prior to placing the final pavement layer.

The conduit shall be placed in the bottom of the trench and the trench shall be backfilled with commercial quality concrete, colored red and containing not less than five (5) sacks of cement per cubic yard. The concrete backfill shall extend to the existing pavement surface in areas that are to receive an asphalt overlay as part of the same contract, and to a point one and one half inches (1.5") from the surface of existing pavements that are not to receive an asphalt overlay as part of the same contract.

The pavement shall be cold-planed to a depth of one and one half inches (1.5") for a minimum of 6-inches (6") on each side of the trench. The cold-planed area shall extend to the lip of gutter if the trench is within twenty inches (20") of the gutter. The sides of the trench above the concrete backfill shall be coated with an asphaltic emulsion and the remaining depth of the trench shall be backfilled with asphalt concrete placed in one layer. The asphalt shall conform to Section 23 "Asphalt Concrete" of these Specifications, and shall be manufactured with half-inch (1/2") maximum-sized aggregate.

Once work is started on a trench, all work necessary to complete that trench, with the exception of the one and one half inch (1.5") permanent asphalt concrete surfacing, shall be performed during the same day. This includes cutting, placing of conduit or cable, removing all spoils from work site, barricades, maintaining a clean road surface for the safety of vehicular and pedestrian traffic, and backfilling trench with concrete. The permanent asphalt concrete pavement replacement shall be completed no later than one Working Day following placement of the concrete backfill.

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

Any trenching operation next to live traffic, deeper than five feet (5') shall be

protected by k-rail.

49-2.06 Pull Boxes

Pull Boxes shall be as specified in Section 86-1.02C “Pull Boxes”, of the State Specifications, and the following:

All new traffic signal interconnect pull boxes shall be P44 pull boxes with extensions (if required) or equal.

All new traffic signal pull boxes adjacent to traffic signal mast arm poles shall be No. 6.

All new traffic signal pull boxes adjacent to controller cabinets shall be No. 6E unless otherwise specified on the plans.

All new electrical service pull boxes shall comply with requirements of the serving utility.

Except for traffic-rated pull boxes, all lids for #5, #6, #6E, and P44 pull boxes shall be “Fibrelyte” or approved equal.

The requirement that pull box covers be secured with bolts, cap screws, or studs shall not apply except to traffic-rated pull boxes with steel traffic lids.

The cover marking for all traffic signal pull boxes shall read “TRAFFIC SIGNAL.”

The cover marking for all signal interconnect pull boxes shall read “SIGNAL INTERCONNECT ” or “FIBER OPTIC” for fiber optic interconnect pull boxes..

All fiber optic pull boxes shall be at five hundred (500) feet spacing and have fifty (50) feet of F.O. cable spooled inside.

Unless otherwise approved by the Engineer, no pull box shall be placed in the traveled way, on a driveway apron or within one foot (1') of any existing, proposed or future (as shown on the plans) curb ramp. Unless otherwise approved by the Engineer, no traffic signal interconnect pull box shall be placed within thirty inches (30")- of any pole foundation or other location which may interfere with the movement of people or vehicles.

Excavating and backfilling shall conform to the provision in Section 87.1.03C, “Excavating and Backfilling for Electrical Systems” of State Specifications.

The bottom of pull boxes installed in unimproved areas or in sidewalk areas shall be bedded on a six (6) inch minimum layer of three-quarter inch (3/4”) crushed rock. Grout will not be required.

The top portion of the conduit shall be not more than four inches (4”) nor less than two inches (2”) from the bottom of the pull box. The conduit shall be placed in a manner to allow the cable/wire to be pulled in a straight line.

If new pull boxes are replacing existing pull boxes, the Contractor shall protect existing conduit and cable from damage. Should the existing conduit or cable become damaged, the Contractor shall repair and/or replace damaged conduit or cable. Prior to repair/replacement, the Contractor shall notify the City of exact location, and provide a detailed description of damage.

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Pull boxes within unimproved areas shall have a Class 1 flexible post delineator, per State Standard Plans A73-C installed adjacent to the pull box.

49-2.07 Conductors and Cables

Conductors shall conform to Section 86-1.02F, “Conductors and Cables”, of the State Standard Specifications, and these Specifications.

The “Conductor Identification” table found in the State Standard Specifications shall be amended to include the following:

CONDUCTOR TABLE					
Conductor Use	Signal Phase or Function	Base	Stripe	Label Designation	Conductor Size
Irrigation Control	Underground-Line 1	Black	None	IR1	As Req'd.
	Neutral	White	None	IRN	As Req'd.
Neutral	Traffic Signals	White	None	TSN	As Req'd.
Neutral	Street Lighting	White	None	None	As Req'd.
Traffic Signal Communication	As Required	As Req'd.	As Req'd	Per Special Provisions	As Req'd.
Highway (street) Lighting Pull Box to Luminaire	As Required	As Req'd.	As Req'd.	None	As Req'd.
Multiple Highway (Street) Lighting	As Required	As Req'd	As Req'd	None	As Req'd.
Emergency Vehicle Preemption	As Required	Black or As Req'd.	As Req'd.	Per Special Provisions	As Req'd.
Inductive Loop Detector Circuits	Vehicle Detection	As Req'd.	None	Per Section 86-1.02F(2)(c)(iii) of State Specifications	As Req'd.

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

49-2.07.A Signal Interconnect Cable (Twisted Pair)

Signal Interconnect Cables shall conform to Section 86-1.02F(2)(d)(v), “Signal Interconnect Cables” and 87-1.03F(2)(c)(iv) “Signal Interconnect Cable”, of the State Specifications, and these Specifications.

All new traffic signals installed in the City shall be interconnected to an adjacent signal determined by the City.

The cable shall consist of either twenty (20) twisted pairs of No. 20 AWG solid copper conductors or 96 strand Single Mode Fiber Optic Cable (SMFO) as determined by the City.

Prior to delivery of the cable, the Contractor shall furnish the City with a certified report, in a City-approved form, of the tests made on the cable to show compliance with the Contract. In addition, the City may request samples for testing upon delivery of the cable to

the work site, and, at City expense, test the samples for compliance with the Contract.

Cables shall only be installed under dry conditions. Each end of the cable shall be properly sealed against moisture intrusion and shall be protected against damage. Interconnect cable having damaged insulation will not be accepted. If the Contractor damages the insulation during or after installation, the entire cabinet to cabinet run shall be replaced with new cable. Cable shall be installed in conduit between termination points. Termination points are identified as controller cabinets, interconnect terminal cabinets, master controller building, City Hall, or transportation management center. No splices shall be allowed between termination points. A minimum of eight feet (8') of slack cable shall be coiled in each pull box and a minimum of ten feet (10') at each controller/termination cabinet.

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

49-2.07.B Signal Interconnect Cable (Fiber Optic)

A. Fiber Optic Signal Interconnect Cable

General

The Contractor shall be responsible for the installation, splicing, termination and testing of the fiber optic cable and all related equipment/components. The plans require the installation of 96 strand and 12 strand single-mode fiber optic (SMFO) cable.

The fiber optic cable shall be single-mode with loose tube type construction, non-armored, all dielectric with central dielectric strength member consisting of gel-free buffer tubes.

The cable shall meet all requirements stated in this specification. The cable shall meet the requirements of the United States Department of Agriculture Rural Utilities Service (RUS) 7 CFR 1755.900 and the ANSI/CEA Standard for Fiber Optic Outside Plant Communications Cable, ANSI/ICEA S-87-640-1992.

Fiber Characteristics

All fibers in the cable must be usable fibers and meet required specifications.

Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding. The fiber shall be matched clad design.

The dispersion unshifted single mode fiber utilized in the cable specified herein shall conform to the following specifications:

1. Core Diameter 8.3 μm (nominal)
2. Cladding Diameter: 125.0 \pm 1.0 μm .
3. Core-to-Cladding Offset: \leq 0.8 μm .
4. Cladding Non-Circularity: \leq 1.0%.
5. Coating Diameter: 245 \pm 10 μm .
6. Colored Fiber Diameter: nominal 250 μm .
7. Attenuation Uniformity: No point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm.
8. Attenuation at the Water Peak: The attenuation at 1383 \pm 3 nm shall not exceed 2.1 dB/km.

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9. Cutoff Wavelength: The cabled fiber cutoff wavelength shall be < 1260 nm.
10. Mode-Field Diameter: 9.30 ± 0.50 μm at 1310 nm or 10.50 ± 1.00 μm at 1550 nm.
11. Zero Dispersion Wavelength (λ_0): $1301.5\text{nm} \leq \lambda_0 \leq 1321.5$ nm.
12. Zero Dispersion Slope (S_0): 0.092 ps/(nm².km).
13. Fiber Polarization Mode Dispersion (PMD): ≤ 0.5

The coating shall be dual layered, UV-cured acrylate applied by the fiber manufacturer.

The coating shall be mechanically strippable.

Fiber Specifications Parameters:

Required Fiber Grade – Maximum Individual Fiber Attenuation.

The maximum dispersion shall be ≤ 33.2 ps/(nm/km) from 1285 nm to 1330 nm and shall be < 18 ps/(nm/km) at 1550 nm.

All optical fibers shall be proof tested by the cable manufacturer to a minimum load of 0.7 GN/m² (100 kpsi).

Specifications for Cable Construction:

Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 2.5 mm.

The fibers shall not adhere to the inside of the buffer tube.

Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-A, "Optical Fiber Cable Color Coding."

The fibers shall be colored with ultraviolet (UV) curable inks.

Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-A, "Optical Fiber Cable Color Coding." Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.

In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrink back requirements of 7 CFR 1755.900.

Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cable, any fillers shall be placed in the inner layer. Fillers shall be nominally 2.5 mm in outer diameter.

The central anti-buckling member shall consist of dielectric, glass reinforced plastic (GRP) rod. The purpose of the central member is to prevent buckling of the cable. The GRP rod shall be overcoated with a black colored thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process. Water blocking yarn(s) shall be applied

longitudinally along the central member during stranding.

Two polyester yarn binders shall be applied contra helically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dielectric with low shrinkage.

Gel free cable shall include waterblocking technology.

For single layer cables, a water blocking tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The tape shall be held in place by a single polyester binder yarn. The water blocking tape shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter.

The cable shall contain at least one (1) ripcord under the sheath for easy sheath removal of all-dielectric cable. The cable shall contain at least one (1) ripcord under the inner sheath and under the steel armor for armored cable. The ripcord color shall be orange.

Tensile strength shall be provided by dielectric yarns.

The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.

All-dielectric cables (non-armored) shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water blocking tape. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus. The all-dielectric construction shall require no grounding or bonding.

The MDPE jacket material shall be defined by ASTM D1248, Type II, Class C and Grades J4, E7 and E8.

The jacket or sheath shall be free of holes, splits and blisters.

The cable jacket shall contain no metal elements and shall be of a consistent thickness. Cable jackets shall be marked with manufacturer's name, sequential foot marking, month and year, or quarter and year of manufacture, and a telecommunication handset symbol, as required by Section 350G of the National Electrical Safety Code (NESC). The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.

The maximum pulling tension shall be 2700 N (600 lbf) during installation (short term) and 890 N (200 lbf) long term installed.

The shipping, storage, and operating temperature range of the cable shall be -40° C to +70° C. The installation temperature range of the cable shall be -30° C to +70° C.

General Cable Performance Specifications

When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components", the change in attenuation at extreme operational temperatures (-40° -C and +70° -C) shall not exceed 0.2 dB/km at 1550 nm for single-mode fiber.

When tested in accordance with "Fluid Penetration Test for Fluid-Blocked Fiber Optic

Cable”, a one (1) meter length of unaged cable shall withstand a one (1) meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.

When tested in accordance with FOTP-41, “Compressive Loading Resistance of Fiber Optic Cables”, the cable shall withstand a minimum compressive load of 440 N/cm (250 lbf/in) for armored cables and 220 N/cm (125 lbf/in) for non-armored cables applied uniformly over the length of the sample. The load shall be applied at the rate of 3 mm to 20 mm per minute and maintained for ten minutes. The change in attenuation shall not exceed 0.4 dB during loading at 1550 nm for single-mode. The repeatability of the measurement system is typically 6 0.05 dB or less. No fibers shall exhibit a measurable change in attenuation after load removal.

When tested in accordance with FOTP-104, “Fiber Optic Cable Cyclic Flexing Test”, the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation shall not exceed 0.1 dB at 1550 nm for single-mode fiber.

When tested in accordance with FOTP-25, “Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies”, the cable shall withstand 25 impact cycles. The change in attenuation shall not exceed 0.2 dB at 1550 nm for single-mode fiber.

When tested in accordance with FOTP-33, “Fiber Optic Cable Tensile Loading and Bending Test”, using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a tensile load of 2700 N (600 lbf). The change in attenuation shall not exceed 0.2 dB during loading and 0.1 dB after loading at 1550 nm for single-mode fiber.

When tested in accordance with FOTP-85, “Fiber Optic Cable Twist Test”, a length of cable no greater than 4 meters shall withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.1 dB at 1550 nm for single-mode fiber.

When tested in accordance with FOTP-181, “Lightning Damage Susceptibility Test of Optic Cables with Metallic Components”, the cable shall withstand a simulated lightning strike with a peak value of the current pulse equal to 105 kA without loss of fiber continuity. A damped oscillatory test current shall be used with a maximum time-to-peak value of 15 μ s (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time to half-value of the waveform envelope shall be from 40 to 70 μ s.

When tested in accordance with FOTP-37, “Low or High Temperature Bend Test for Fiber Optic Cable”, the cable shall withstand four full turns around a mandrel of ≤ 10 times the cable diameter for non-armored cables and ≤ 20 times the cable diameter for armored cables after conditioning for four hours at test temperatures of -30 $^{\circ}$ C and +60 $^{\circ}$ C. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears or other openings. Optical continuity shall be maintained throughout the test.”

Quality Assurance Provision

All cabled optical fibers shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.

The cable manufacturer shall be ISO 9001 registered.

Packaging

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The completed cable shall be packaged for shipment on non-returnable wooden reels. Required cable lengths shall be stated in the purchase order.

Top and bottom ends of the cable shall be available for testing.

Both ends of the cable shall be sealed to prevent the ingress of moisture.

Each reel shall have a weather resistant reel tag attached identifying the reel and cable.

Fiber optic cable shall be clearly tagged and labeled as such at all pull box, vault, cabinet, splicing, and pole attachment locations and at all other locations where it is exposed or may be accessed. Labeling shall consist of a permanent plastic waterproof yellow tag or shrink wrap label printed with the words “City of Elk Grove Fiber Optic Cable” and the cable type and size/number of strands (SMFO or MMFO).

Example: City of Elk Grove Fiber Optic Cable – 96 SMFO – “direction” to “next intersection”

All labels shall be affixed to the cable per the manufacturer’s recommendations and shall not be affixed in a manner that will cause damage to the fiber. Handwritten labels shall not be allowed. The Contractor shall submit the proposed fiber cable label to the Engineer for review and approval prior to installation.

B. Fiber Termination Panels

The Contractor shall supply and install a fiber termination panel (FTP) at the locations indicated on the Plans.

The 12-fiber termination panels shall consist of a single-panel housing with a connector housing pigtail panel and single mode MIC pigtail cable. Connector type shall be LC duplex single mode UPC.

All 12 fibers entering the signal cabinet at each location shall be terminated on the FTP. 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 Engineer approved equal. All splices shall be mounted in the splice holder within the FTP housing. Protective dust caps shall be supplied on all 12 ports.

96-144 Fiber termination panels shall have 24 fibers from the Blue and Orange buffer tubes, from each direction (N,S,E,W), terminated in the FTP.

Approval of equals, if proposed by the Contractor, may require providing physical samples of the exact equipment proposed.

C. Fiber Optic Cable Installation

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. Fiber optic cable is sensitive to excessive pulling, bending and crush forces. The minimum bending and maximum tension requirements for installing the fiber optic cables shall be according to the manufacturer’s specifications.

If necessary, splicing of fiber optic cable shall be allowed only at splice vaults indicated on the Plans.

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At splice vaults, the fiber optic cable will be neatly coiled as indicated on the Plans. At no time will the minimum bending radius of the fiber optic cable be violated.

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 swivel shall be used to pull the fiber optic cable.

All pulling equipment and hardware, which will be used by the Contractor during the cable installation, must maintain 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.

Contractor shall coil fiber optic cable to provide slack as follows: 50 feet of trunk cable slack and 20 feet of branch cable slack on both sides of a new splice closures. 10 feet of branch cable slack in home run pull boxes. 20 feet of branch cable slack in base of controller cabinets. 10 feet of slack for all cables in pass-through pull boxes.

49-2.07.C Interconnect Cable Testing After Installation (Twisted Pair)

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

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

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

Cable Lengths, feet	500	1000	1500	2000
Megohms	500	250	160	125

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

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

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

All electrical tests shall be made after the cable has been installed in the conduit.

49-2.07.D Interconnect Cable Testing After Installation (Fiber Optic)

The Contractor shall perform various pre-installation and post-installation tests, as specified by the product manufacturer's specifications and as specified in these Special Provisions. The Contractor acknowledges that contractor-performed testing is a vital component of the work and required for acceptance of the fiber optic cables and all related assemblies.

The fiber optic testing shall be conducted at the following stages:

- Upon Cable Delivery Before Installation – Cable Reel Tests/Pre-Installation Tests
- After Installation and Before Splicing – Post Installation/Pre-Splicing Tests
- After Splicing and Connectorizing – End-to-End/Post-Splicing Tests

Contractor shall submit a sample of the Optical Time Domain Reflectometer (OTDR) and power meter/light source data printouts to the Engineer for review and approval prior to conducting any testing.

All testing shall be performed in a manner that provides the time, space, set up, tools, and equipment for the Engineer or his designee to inspect and verify that all test setups and tests, including review of fiber connections, test equipment, device displays, and all related documentation. The tests shall quantitatively demonstrate that the fiber optic cable meets or exceeds the minimum requirements and specifications provided in these special provisions and the contract plans.

All technicians testing cable shall be certified as an Advanced Fiber Optics Technician or Certified Fiber Optics Specialist by the Fiber Optic Association (FOA). Contractor shall submit to the Engineer for approval proof of FOA certification for each of the technicians performing testing.

LINK LOSS BUDGET WORKSHEET

Date: _____

Operator: _____

Link No.: _____

Fiber Color: _____

Buffer Color: _____

Cable No.: _____



Section 1: Total System Gain

Enter the measured Optical Transmitter Power _____ dBm [1A]

Enter the measured Optical Receiver Sensitivity
(This should be a negative value) _____ dBm [1B]

Subtract line [1B] from [1A] to obtain Maximum Permissible
Loss _____ dBm [1C]

Section 2: Fiber Losses

Enter the measured length of the link _____ km [2A]

Enter the measured loss per km of the fiber _____ dBm [2B]

Multiply line [2A] by [2B] to obtain the Total Fiber Loss _____ dBm [2C]

Enter the sum of all Connector Losses in the link _____ dBm [2D]

Enter the sum of all Splice Losses in the link _____ dBm [2E]

Enter the sum of all Other Losses from other components
(Couplers, splitters, routers, switches, etc.) _____ dBm [2F]

Add lines [2C], [2D], [2E], and [2F] to obtain Total System Loss _____ dBm [2G]

Section 3: Design System Gain Margin

Subtract Line [2G] from line [1C] (this number must be at least
6 dB) _____ dBm [3A]

49-2.08 Splices

49-2.08.A Conductor and Cable Splice Method

Splices shall conform to Section 86-1.02H “Splicing Materials” and 87-1.03H “Conductor and Cables Splices”, of the State Specifications, and these Specifications.

Unless otherwise noted all splices shall be by Method B.

In the handhole section of each luminaire pole, a fused disconnect splice connector shall be installed in each ungrounded conductor between the line and the ballast. Luminaires with up to 200-watt bulbs shall have six-amp (6A) fuses installed.

49-2.08.B Fiber Optic Cable Splicing Method

Fiber optic cable splicing shall not be permitted in cable runs or pull boxes. Splicing shall be done only in splice vaults with splice enclosures or at fiber termination points as shown on the Plans. All splices shall be of the fusion type and made with equipment certified for a typical loss of less than 0.2dB.

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 vaults shall be Type N48 with extension in accordance with the details in the Plans and shall conform to Section 86-2.06 of the State Specifications. Covers shall be two sections. 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 marking shall be “FIBER OPTIC” and “COMMUNICATIONS”.

All splice vault covers shall have an AASHTO HS 20-44 rating.

49-2.08.C Fiber Optic Splice Closure

Fiber optic splice closures must be butt-end style, corrosion resistant, watertight, and meet the latest requirements of GR-771-CORE. Underground splice closures must seal, bond, anchor, and provide efficient routing, storage, organization, and protection for fiber optic cable and splices. The splice closure must provide an internal configuration and end cap with a minimum of six ports with the capacity to accept 1” diameter cables for entry and exit of trunk, and branch cables. Splice closures must have a reliable dual seal design with both the cable jackets and core tubes sealed, without the use of water-blocking material. The splice closures must be capable of being opened and completely resealed without loss of performance.

The fiber optic splice closures must be equipped with splice trays that are designed specifically for housing single-mode fusion splices protected by heat-shrink sleeves, are easy to install and remove, and have provisions for a minimum number of splices accommodated by the splice closure. At a minimum, the splice closure must accommodate 144 splices. The splice closure maximum dimensions must not exceed 22”L x 9”W x 7.5”H.

49-2.09 Bonding and Grounding

Bonding and Grounding shall conform to Section 86-1.02F(1)(c)(ii) “Bonding Jumpers and Equipment Grounding Conductors” and 87-1.03J “Standards, Poles, Pedestals, and Posts”, of the State Specifications, and these Specifications. For bonding purposes in all non-metallic type conduits, a No. 8 copper wire shall be run continuously in circuits used for series lighting, and a No. 10 copper wire shall be run continuously in all other circuits. Where non-metallic conduit is to be installed for future conductors, a green No. 10 THW copper wire shall be installed in these conduits. Equipment bonding and grounding conductors are not required in conduits which contain only loop lead-in cable or signal interconnect cable or both.

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

49-2.10 Service

All street light systems shall have underground service provided through a utility company approved metered service pedestal. Each service enclosure (or “can”) shall be fabricated from fourteen (14) gauge Type 304D stainless steel and shall conform to the requirements for cabinets fabricated from stainless steel as specified in Section 86-1.02P, “Enclosures”, of the State Specifications, and these Specifications.

Service equipment enclosures for traffic signal system shall be Type III-CF with dual meters for “traffic signals and lighting.”

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

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

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

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

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

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

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

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

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

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

and shall be fastened by screws.

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

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

The Contractor shall protect and lock the service enclosure during construction. When the work has been accepted for maintenance, each enclosure shall be locked with a Contractor-supplied master lock that will accept a Type 2526 key.

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

49-2.10.A Metered Service (120/208 Volt, 120/240 Volt)

The metered electrical service will be served from SMUD facilities as shown on the Plans. Unless otherwise specified, service shall be wired for 120/208 volts or 120/240 volts, three-wire and single phase as shown on the Plans. Circuits shall not be wired to bypass the meter.

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

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

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

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

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

1. Two 2-pole, 120-volt alternating current main breakers with 100-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. Each main breaker shall have an internal common trip. Each pole shall have individual “ON-OFF” control and handle tie for common operation. Breakers shall be Westinghouse Quicklag C or approved equal.
2. One single-pole, 120-volt alternating current branch circuit breaker for control circuit with 15-ampere trip and a rating of 10,000-amperes AIC at 120/240 volts. Breaker shall be Westinghouse Quicklag C or approved equal.
3. Two single-pole, 120-volt alternating current branch circuit breakers for traffic signals, each with 60-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. Breakers shall be Westinghouse Quicklag C or approved equal.
4. Minimum six, single-pole, 120-volt alternating current branch circuit breakers for street lighting, each sized per the Special Provisions and the Standard Drawings

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(minimum 30-ampere trip), and with a rating of 10,000 amperes AIC at 120/240 volts. Breakers shall be Westinghouse Quicklag C or approved equal.

5. Minimum two, 3-pole, normally open, 60-ampere mercury displacement lighting contactors. Coil voltage shall be 120 VAC, 60 cycle. Mercury displacement lighting contactors shall be Dayton Electric Manufacturing Co., Model Number 3X753E, or approved equal.
6. One oil tight “Hand-Off-Auto” selector switch.
7. One solid copper neutral bus.
8. Incoming terminals (landing lugs).
9. Solid neutral terminal strip.
10. Terminal strips for conductors within the cabinet.

49-2.10.B Metered Service with Encapsulated Step-Down Transformer (277/480 Volt to 120-240 Volt)

The metered electrical service will be served from SMUD facilities as shown on the Plans. Unless otherwise specified, service shall be wired for 277/480 volts, four-wire and three phase as shown on the Plans. Circuits shall not be wired to bypass the meter.

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

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

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

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

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

1. One 2-pole, 277/480-volt alternating current main breaker with 100-ampere trip and a rating of 14,000 amperes AIC at 277/480 volts. The main breaker shall have an internal common trip. Each pole shall have individual “ON-OFF” control and handle tie for common operation. Breaker shall be Westinghouse Quicklag GHC or approved equal.
2. Minimum six, single-pole, 277/480-volt alternating current branch circuit breakers for street lighting, each sized per the Special Provisions and the Standard Drawings (minimum 30-ampere trip), and with a rating of 14,000 amperes AIC at 277/480 volts. Breakers shall be Westinghouse Quicklag GHC or approved equal.
3. One single-pole, 120-volt alternating current branch circuit breaker for control circuit with 15-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. Breaker shall be Westinghouse Quicklag C or approved equal.
4. One single-pole, 120-volt alternating current branch circuit breaker for traffic

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signals, with 50-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. The breaker shall be Westinghouse Quicklag C or approved equal.

5. One 2-pole, 120-volt alternating current branch circuit breaker for intersection safety lighting, with 15-ampere trip and a rating of 10,000 amperes AIC at 120/240 volts. The breaker shall have an internal common trip. Each pole shall have individual “ON-OFF” control and handle tie for common operation. The breaker shall be Westinghouse Quicklag C or approved equal.
6. Minimum three, 3-pole, normally open, 60-ampere mercury displacement lighting contactors. Coil voltage shall be 120 VAC, 60 cycle. Mercury displacement lighting contactors shall be Dayton Electric Manufacturing Co., Model Number 3X753E, or approved equal.
7. One oil tight “Hand-Off-Auto” selector switch.
8. One solid copper neutral bus.
9. Incoming terminals (landing lugs).
10. Solid neutral terminal strip.
11. Terminal strips for conductors within the cabinet.
12. One single-phase transformer rated at 5KVA. Primary shall be 277 volts and secondary shall be 120 volts. This transformer to be metered and shall supply the traffic signal power.
13. One single phase transformer rated at 2 KVA. Primary shall be 480 volts and secondary shall be 120/240 volts. This transformer to be unmetered and shall provide the power for intersection safety lighting and the control circuit.
14. Provide primary transformer protection per the NEC.

49-2.11 Testing

Testing shall conform to these Specifications.

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

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

New or modified street lighting work shall be tested with lamps being energized for 24 hours continuously and a second test to verify the photo cell is functioning by placing a cover over the photocell to insure the street lights work in “AUTO” mode. The tests of the street lighting shall be for the purpose of identifying the light distribution patterns, determining the acceptability of the ballasts, fixtures and lamps for electrical and noise standards, verifying that all connections are electrically and mechanically sufficient, and for other purposes as directed by the City or in the Special Provisions. The Contractor shall furnish all material and equipment for such testing at the Contractor’s expense.

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49-3 CONTROLLER ASSEMBLIES

All controller assemblies will be furnished by the Contractor and shall be approved by the City for use by the Contractor, unless otherwise shown or specified in the Contract.

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

49-4 TRAFFIC SIGNAL FACES AND FITTINGS

Traffic signal faces and fittings shall conform to Section 86, Division X, "Electrical Work", of the State Specifications, and these Specifications.

49-4.01 Vehicle Signal Faces and Signal Heads

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

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

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

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

All new vehicle indications shall be 12-inch.

The Contractor shall furnish a manufacturer's 5-year warranty for all new signal indications.

49-4.02 Directional Louvers

Plastic programmable directional louvers will be permitted where shown or specified in the Contract.

49-4.03 Backplates

Backplates shall be furnished and installed on all vehicle signal faces. All backplates shall be metal with two inch (2") retro-reflective yellow border.

49-4.04 Accessible Pedestrian Signals

Accessible Pedestrian Signals shall conform to 86-1.02T "Accessible Pedestrian Signals" and 87-1.03T "Accessible Pedestrian Signals", of the State Specifications, and these Specifications. Accessible pedestrian signals shall be Polara INavigator 2-wire system with location voice recording and R10-3 (9"x12") face plate.

49-5 DETECTORS

All new vehicle detection shall be video detectors.

49-5.01 Vehicle Video Detectors

Vehicle video detectors shall be listed on the Per the City’s Authorized Materials List for Traffic Signal Cabinets and Components.

49-5.02 Vehicle Loop Detectors

Detectors shall conform to Section 87-1.03V “Detectors”, of the State Specifications, and of these Specifications.

Splices shall be insulated as specified in these Specifications.

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

All detector loops shall be five feet by five feet (5’ x 5’). Detector loops near intersection limit lines shall consist of an array of two (2) loops for each lane, including right turn lane. The front loop shall be a modified Type A loop with four turns and the back loop is a Type A loop with three turns. Spacing between loops in the same lane shall be ten feet (10’). Each detector loop shall be provided with its own detector lead in cable and connected in controller for operation.

The Contractor shall be responsible for laying out all detector loops in conformance with the traffic signal and striping plans. Detector loops shall be centered within each lane except that within left turn lanes less than eleven feet (11’) wide, the right side of the loop shall be located three and a half feet (3.5”) from the lane line on the right. Detector loops shall be marked, and their location approved by the Engineer prior to pavement cutting.

Detector lead-in cables shall be provided as shown on the plans and loops shall be connected to the lead-in cables as shown on the plans.

Detectors for right turn lanes shall provide an adjustable delay feature.

All testing shall be completed and approved prior to traffic signal turn-on.

Detector handhole shall be Type “B”.

All conduits connecting to detector loop handholes shall be two inch (2”) minimum.

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

49-5.02.A Construction Materials

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

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

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Dielectric Material, Type I, Class C, Grade 5, J3. The diameter of the lead-in cable shall be approximately one-quarter inch (0.25”).

All detector loops shall be five feet by five feet (5' x 5'). Detector loops near intersection limit lines shall consist of an array of four loops for each lane, excluding right turn lane which has two loops. The front loop shall be a modified Type A loop with four turns and the back loop is a Type A loop with three turns. Spacing between loops in the same lane shall be ten feet (10'). Each detector loop shall be provided with its own detector lead in cable and connected in controller for operation.

49-5.02.B Installation Details

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

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

Unless otherwise shown or specified in the Contract or directed by the City in the field, each new detector loop shall be five (5) feet by five (5) feet and shall be centered in the traveled lane. All detector loops shall be field marked by the Contractor and their location approved by the City prior to pavement cutting. For installations that will serve lanes that are not parallel or concentric to lane markings existing at the time of loop installation, the Contractor shall accurately mark the future lane lines prior to pavement cutting.

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

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

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

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

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

Each detector loop circuit shall be tested for continuity, circuit resistance, and insulation resistance at the controller location. The loop circuit resistance shall not exceed 0.50 ohms

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

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

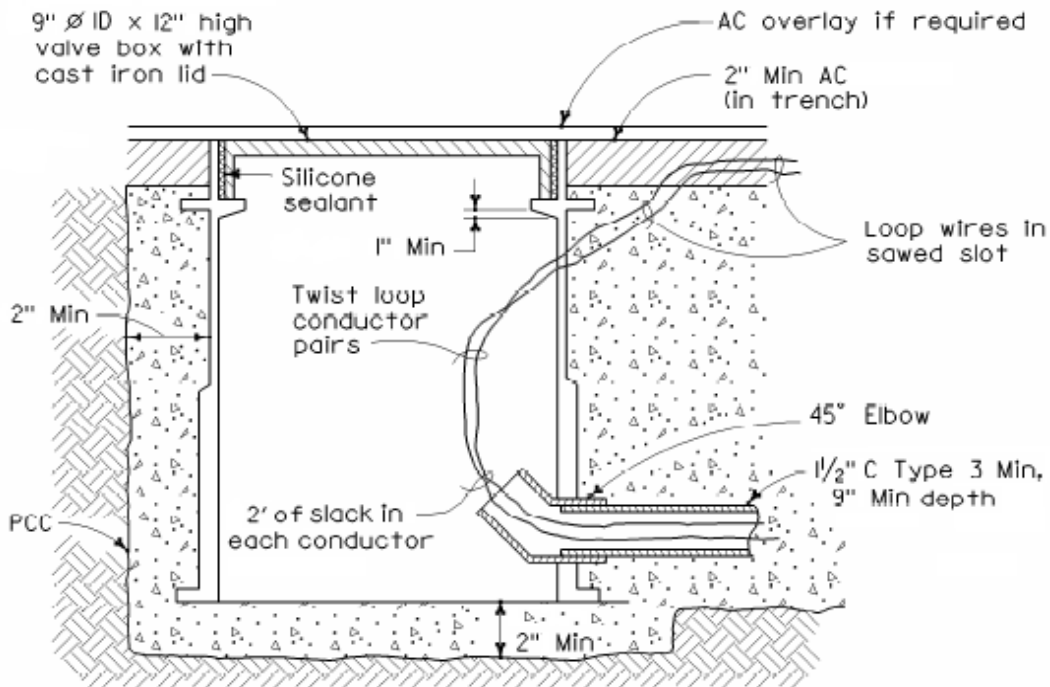
If the conduit is not dry, the ends of all lead-in cable shall be taped and waterproofed prior to installation. If splicing is not done immediately after installation, the ends of both the loop conductors and lead-in cable shall be taped and waterproofed with an electrical insulating coating. The insulating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

Sealant for loop detectors shall be as specified for Elastomeric Sealant. Epoxy sealant will not be permitted.

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

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

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



TYPE B DETECTOR HANDHOLE DETAILS

INSTALLATION REQUIREMENTS

TYPE B DETECTORS HANDHOLE

1. Outline of trench shall be saw cut to a minimum depth of $\frac{3}{8}$ " except where asphalt concrete overlay is to be placed.
2. The valve box shall be fabricated of calcium carbonate and polyester resins with fiberglass reinforcement and designed for heavy traffic loads.
3. Cast iron lid shall be marked "Detector" and shall be secured in place by applying waterproof silicone sealant. Valve box shall be centered on lane line, unless otherwise shown on the plans.
4. Entire length of trench, from valve box to adjacent pull box, shall be backfilled with portland cement concrete except the top 2" in asphalt concrete surfaced roadways shall be backfilled with asphalt concrete.

49-5.03 Opticom Cable and Detectors

The Contractor shall furnish and install new 3M opticom cable, where shown on the plan. Opticom cable shall be installed to the opticom detector installed on the traffic signal mast arm, as shown on the plan. New 3M opticom detectors, Model 721 or better, shall be furnished and installed on the top of the signal mast arm for each approach as shown on the plans. For each detector installation, the associated cable shall be continuous and unspliced from the controller cabinet to each opticom detector with a minimum of five feet of slack in the pull box at the base of pole. The Contractor shall furnish and install Opticom Model 752 phase selectors as required for complete signal operations as required by the plans.

49-6 CCTV CAMERA SYSTEM

CCTV camera system shall conform to the City’s Approved Materials List for Traffic Signal Cabinets and Components.

49-7 LIGHTING

Lighting shall conform to these Specifications.

49-7.01 LED Luminaires

Light emitting diode (LED) luminaires shall conform to the Specifications noted herein. ISO foot-candle diagrams are not required to be shown on the Plans.

A. General

1. Luminaires for street lighting shall be Type III cutoff distribution, unless otherwise specified in these Standards.
2. LED luminaires shall be of the same style and color of existing luminaire types in conformance to the Standard Drawing and Approved Equipment List. Where conflicts exist between Standard Drawing and these specifications, these specifications shall govern.
3. Common Type, Series A (Cobra head) LED luminaires shall have a slim, low profile design that minimizes wind load requirements (EPA \leq 1 SF). Fixture housing shall be constructed from rugged aluminum components. LED drivers shall be mounted in the housing which shall be suitable for wet listed operation (per UL 1508 requirements). A high-performance heat-sink shall be specifically designed for LED ‘Street Light’ application.
4. Finish color shall include an E-coat epoxy primer with an ultra-durable powder topcoat providing excellent resistance to corrosion and ultraviolet degradation and abrasion, exceeding a rating of six per ASTM D1654 after 1,000 hours of testing per ASTM B117. Laguna West Luminaires” (Standard Drawing SL-43) SHALL BE Aqua Marine, federal standard color #14516.
5. All luminaires and luminaire components, including, but not limited to, lamps, fuses, and housings, shall be new, unused, and of the manufacturer’s latest design and model available at the time the Plans are approved, unless otherwise specified by the City.
6. Luminaires shall have an external label per ANSI C136.15 (Luminaire Field

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Identification). If applicable, luminaires shall have an internal label per ANSI C136.22 (Internal Labeling of Luminaires).

7. Luminaires and all components shall be UL and/or CSA listed.
8. All wiring shall be neat, bundled, and kept away from excess heat.
9. On some streetlight luminaires, one or more third-party devices may be wired to the photocontrol receptacle or to the same power feed as the luminaire. For example, third-party devices include Wi-Fi equipment and traffic cameras. Manufacturer's luminaire warranty must allow for such attachments.

B. Mechanical Specifications

1. Luminaire housing components shall be low-copper aluminum, with high performance heat sink(s) designed specifically for LED luminaires. No active cooling features (fans, etc.) are permitted.
2. Luminaire configuration shall allow for modular upgradability and/or field repair of all electrical components (i.e. led modules, Driver(s), etc.)
3. Luminaire shall have phenolic terminal block for power input suitable for #6 - #14 AWG wire.
4. Luminaire shall have lens gasket designed to prevent entrance of foreign material into the sealed optical system.
5. Luminaire shall allow for:
 - a. Tool-less access to LED Driver compartment
 - b. Unit shall provide tool-free access to all electrical components.
6. For cobra head luminaires, the Effective Projected Area (EPA) of luminaires shall not exceed 1.0 square feet, and shall withstand one hundred miles per hour (100 mph) wind gusts when mounted on a standard eight foot (8') aluminum mounting bracket arm without additional reinforcement.
7. Gasket seals shall be designed to prevent intrusion by birds, insects, moisture, and environmental contaminants.
8. Mounting and housing bolts shall be of non-corrosive material.
9. Luminaires shall be weatherproofed and meet the Minimum National Electrical Manufacturers Association (NEMA) Ingress Protection (IP) rating of fifty five (55) for the lamp cavity and twenty four (24) for the gear cavity.
10. Mechanical design of protruding external surfaces (heat sink fins) shall facilitate hose-down cleaning and discourage debris accumulation.
11. For cobra head luminaires, refractors or lenses shall be made from UV inhibited high impact optical grade material that is resistant to scratching.
12. The luminaire shall incorporate a heavy duty latching system to keep luminaire closed (no wire latches). Latching system shall be of non-corrosive material.

For cobra head luminaires, total luminaire weight shall be less than thirty pounds (30 lbs). House shield option shall be available for field-installable house-side light

control for all luminaires.

C. Electrical Specifications

1. Drivers shall be Class 1. Driver requirements include:
 - a. Electronic
 - b. Input voltage range 120-277 ± 10%
 - c. Output Current 0.35A dc - 1.0A dc (+/-5%)
 - d. Input Frequency 50/60 Hz
 - e. Power Factor >90% at full load
 - f. THD <20% at full load
 - g. Load regulation: +/- 1% from no load to full load
 - h. Output ripple <10%
 - i. Output should be isolated
 - j. Case temperature: rated for -40°C through +80°C
 - k. Overheat protection, self-limited short circuit protection and overload protected
 - l. Primary fused
 - m. Driver Life Rating – less than 0.5% failure rate at 100,000 operating hours (at full rated power and operating ambient temperature of 25°C)
 - n. Rated case temperature suitable for operation in a luminaire operating in the ambient temperatures indicated above.
 - o. Same rated life as the luminaire. If the driver's lifetime is less than that quoted for the luminaire, the driver's lifetime must be used instead.
 - p. Thermally separated from the LED chips.
 - q. Upon receiving a 0-10V signal, LEDs shall dim down to at least 10% power. Driver must include leads to accept a 0-10 V signal.
2. Units to be provided with integral 10kV surge suppression protection standard, as tested in accordance with ANSI/IEEE C62.41.2 and ANSI standard C136.37.
3. Electromagnetic interference meets the requirements of 47 CFR part 15/18, class A.
4. LED circuitry shall prevent visible flicker to the unaided eye over typical voltage fluctuations.
5. Individual LEDs shall be constructed such that a catastrophic loss or failure of one LED will not result in the loss of the entire luminaire.
6. Units shall have quick disconnect harness to be provided on power fed to driver for ease of maintenance.
7. Luminaire Operating Ambient Range: -40°C to + 40°C
8. Active Thermal Monitoring: Both driver and optical unit shall have thermal sensors

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to detect over-temperature conditions.

9. Off-state power consumption shall be < 0.5 watts, excluding lighting controls.
10. Average rated life of the luminaire and all electrical components shall be greater than or equal to 100,000 hrs.

D. Standards and Tests

1. Luminaire shall meet the requirements of the following standards and tests:
 - a. UL 1598, UL 1598C for retrofit conversion kits, and UL 8750 safety standards.
 - b. IEC605598, IEC62031 and IEC60950 safety standards.
 - c. ASTM B117 500-hour Salt Fog
 - d. ASTM G53 UVB313 1000-hour UV
 - e. IEC60068-2 Thermal Shock
 - f. IEC60068-14 High Temperature / High Humidity
 - g. ANSI C36.31 Vibration
 - h. IEC61000, EN55015 and CISPR15 for radiated emissions and electrical noise.
 - i. FCC Title 47, Part 15
 - j. International Dark-Skies Association BUG ratings
 - k. European Directive on Reduction of Hazardous Substances (RoHS).
 - l. IEEE C62.41.2 Category C-Medium Surge Protection
 - m. NEMA SSL 3-2010, high power white LED binning for general illumination

E. Photometric Performance

1. Minimum average maintained illuminance measured between the project limits on a given roadway shall be in conformance with Standard Drawing SL-2
2. Minimum average maintained illuminance for intersections shall be as follows:
 - a. In urban areas, 1.6 horizontal lux (0.16 fc) on the area normally bounded by the crosswalks, and 6.5 horizontal lux (0.65 fc) at the intersection of centerlines of the entering streets.
 - b. In rural areas, 1.1 horizontal lux on the area normally bounded by the crosswalks, and 3.2 horizontal lux at the intersection of centerlines of the entering streets.
3. Light pattern (distribution) shall be type III, except that “Old Town” decorative luminaires (OTB) shall be type V, or as approved by City.
4. Maximum backlight, upplight, and glare (BUG) ratings per IES TM-15-11 (Luminaire Classification System for Outdoor Luminaires) for the various luminaires shall be as follows:

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Luminaire Type	Backlight Rating	Up light Rating	Glare Rating
Common Type, Series A (Cobra head)	B2	U0	G2
Common Type, Series B (Post-top mounted)	B1	U3	G1
All Decorative Types	B3	U3	G3

5. Zonal Lumen Density: 100%: 0-90°, ≤10%: 80-90° (DLC qualification)
 6. Correlated Color Temperature (CCT) and Color Rendering Index (CRI):
 - a. CCT = 4000K ±300
 - b. CRI ≥ 70 for cobra heads, CRI ≥ 65 for all other luminaire types
 7. L70 Lumen Maintenance: 100,000 hrs; using IES LM-80
 8. Minimum initial delivered lumens per watt requirement 70 lm/W (DLC qualification; using IES LM-79)
- F. Photoelectric Control Devices
1. A 7 pin photocontrol receptacle in full compliance with ANSI C136.41-2013 shall be accessible, installed, and prewired in each luminaire. For cobra head and Common Type, Series B, post top mounted luminaires, photocontrol receptacles shall be mounted on the top of the fixture.
 2. A photocontrol receptacle shorting cap shall be included with each LED luminaire.
 3. Photo cell receptacles shall be "long life" with a minimum twenty-year (20 year) design life. Photoelectric controls shall meet the applicable requirements of the following industry standard: ANSI C136.10-2006 - American National Standard for Roadway and Area Lighting Equipment-Locking-type Photocontrol Devices and Mating Receptacles• Physical and Electrical Interchangeability and Testing.
 4. Requirements:
 - a. Assembled photoelectric controls and each of their individual components shall be designed and constructed to have a nominal life of ten (10) years.
 - b. Each photoelectric control shall be provided with a means to conveniently and permanently record date of installation and date of removal.
 - c. Each photoelectric control shall be provided with an internal, one hundred sixty (160) joule minimum, metal oxide varistor (MOV) type surge arrester.
 - d. Photoelectric controls shall be provided with a means of sealing according to the requirements of ANSI C136.10, Section 4.3
 - e. Photoelectric control base gasket shall be fabricated from a neoprene blend.
 - f. Photoelectric control circuit boards shall be constructed of glass epoxy material.

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- g. Circuit board components shall be protected from the environment with a thin, transparent coating that does not promote heat buildup.

Color code	Black
Plug Type	Locking type, three-pole, three-wire
Photosensor Type	Silicon
Operating voltage range, volts, ac	105 to 305
Load rating, LED, minimum, watts	1,000
Load rating, incandescent lamp, minimum, watts	1,000
Load rating, high-intensity discharge (HID), minimum, VA	1,800
Operating temperature range, ambient, degrees C	-40 to +70
Tum on response time range, seconds	0.5 to 50
Tum off response time range, seconds	0.5 to 50
Tum on light level, fc	2.8 +/- 0.6
Tum off light level, maximum, fc	5.1
Tum-off/tum-on ratio, nominal	1.5
Failure mode, nominal	Fail-off

5. Testing

- a. Photoelectric controls shall be tested according to the requirements of ANSI C136.10. Test results shall be provided upon request.

6. Marking

- a. Each individual photoelectric control device shall be marked with the following information:
 - Manufacturer's name
 - Model number
 - Voltage rating
 - Load rating
 - North orientation
 - Rotation of installation and removal

7. Approved Manufacturers

- a. Photoelectric control devices shall be one of the following types, or approved equal.

Manufactures	Catalog Numbers
Ripley Lighting Controls	6390LL-BK-FO
Dark to Light	DLL 127-F-1.5-BK
Sun-Tech (Sunrise Technologies, Inc.)	TRS-2-FO

8. Warranty

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- a. All photoelectric control components shall be warranted by its manufacturer for a minimum of ten (10) years.

G. Warranty

All electrical components including, but not limited to, light emitting diodes (LED) and drivers shall be warranted by the luminaire's manufacturer for a minimum of ten (10) years from the date of acceptance by the City. All manufacturer supplied components of the luminaire shall have an included minimum ten (10) year full warranty. Each LED streetlight luminaire shall have a unique serial/tracking number sufficient for use by Manufacturer and the City to track warranty start and end dates. If the warranty is not a full ten (10) year warranty on all luminaire components in the finished luminaire assembly, the luminaire will be determined to not meet City specifications and will be rejected.

The Contractor/Developer shall, as part of the guarantee, replace any and all LED luminaires that fail within a one-year period following final job acceptance. If the Contractor/Developer fails to respond within Two (2) working days after notification, the City reserves the right to replace the luminaire and deduct the cost from any monies due the Contractor/Developer.

If any LED fails within a given luminaire upon initial installation, the luminaire shall be considered failed and eligible for replacement under the warranty. Post initial installation, if ten percent (10%) or more of the LEDs within a given luminaire cease to be operational or demonstrate negligible light output within the warranty period, the luminaire shall be considered failed and eligible for replacement under the warranty.

Luminaire finish shall also be warranted by the luminaire's manufacturer for a minimum of ten (10) years from the date of acceptance.

Luminaire's manufacturer shall be responsible to City for full replacement of LED streetlight luminaries that fail during the warranty period as determined by the City. All replacement LED streetlight luminaries shall be warranted for an additional ten (10) year period from the date of acceptance.

Delivery location for replacement luminaires shall be as specified by City at the time of shipment. Prior to shipping replacement luminaires Manufacturer shall confirm the delivery location with City.

Any additional warranties provided by law, including, but not limited to, the warranty of merchantability and warranty of fitness for a particular purpose shall remain in full force and effect and inure to the benefit of City. City reserves all rights and remedies provided by law for breach of any applicable warranty.

49-7.02 *RESERVED*

49-7.03 *RESERVED*

49-7.04 *Photoelectric Controls*

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

Unless otherwise shown or specified in the Contract, the photoelectric controls shall be

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

Switches shall be furnished with an indicating nameplate reading "Hand-Off-Auto" and shall be connected as specified in Section 49-2.10, "Service", in this Section of these Specifications and as shown on the Standard Drawings. Test switch shall have an "OFF" position.

49-7.04.A Photoelectric Unit

The photoelectric unit shall be furnished and installed by the Contractor. The unit shall be designed such that, in the event of failure, it fails in the "on" mode so that the circuit is complete.

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

49-7.04.B Contactors

Contactors shall be as specified in Section 49-2.10, "Service", in this Section of these Specifications and as shown on the Standard Drawings.

49-7.04.C Contactor and Test Switch Housing

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

49-7.04.D Wiring

Wiring shall be as specified in Section 49-2.10, "Service", in this Section of these Specifications and as shown on the Standard Drawings.

49-8 PROJECT-SUPPLIED EQUIPMENT

Contractor shall supply all equipment unless otherwise noted on the approved plans. The Contractor shall notify the Engineer fourteen (14) weeks in advance of the date when the Project-supplied equipment will be needed. The Contractor shall pick up and transport to the job site all project-supplied equipment and shall contact the City signal inspector at least forty-eight (48) hours in advance to schedule pick-up at the City Corporation Yard at 10250 Iron Rock Way, Elk Grove, CA 95624. Tel. (916) 871-7192.

The Contractor shall supply all poles, heads, framework, all detector equipment, conduit, conductors, pull boxes, traffic signal controller, traffic signal controller cabinets, battery backup system, communication equipment, CCTV camera system and all other materials and equipment not specifically identified as "Project-Supplied" on the Contract Plans and Specifications.

49-9 REMOVING AND SALVAGING ELECTRICAL EQUIPMENT

All equipment shown on the plans as salvaged shall be tagged with a suitable waterproof tag and marking pen before removal from the work site. The tag shall show the date, the intersection name, and the corner from which the equipment was removed. The Contractor shall be responsible

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for unloading the equipment at the delivery location, including providing any necessary cranes or other lifting devices. The Contractor shall contact the City signal inspector at least forty eight (48) hours in advance to schedule delivery to City Corporation Yard located at 10250 Iron Rock Way, Elk Grove, CA 95624. All other equipment shown to be removed and not reused shall become the property of the Contractor and shall be removed from the right-of-way and disposed of by the Contractor.

49-10 PAYMENT

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