

6-86 SIGNALS, LIGHTING AND ELECTRICAL

6-86.01 General

Traffic signals and lighting equipment shall be furnished and installed at the approximate locations shown on the plans as directed by the City Engineer, in conformance with the applicable provisions of Section 86 "Electrical Work" of the Standard Specifications and these Construction Specifications.

All materials shall meet the requirements of Section 86-1.02 "Materials" of the Standard Specifications.

The Contractor shall place the order for long lead-time signal and lighting equipment not provided by the City within 5 days of receiving the executed Contract.

6-86.02 Contract Submittals

The Contractor shall furnish information as required in Sections 86-1.01C "Submittals" of the Standard Specifications and these Construction Specifications.

Manufacturer's warranties and guarantees furnished for materials used in the work and instruction sheets and part lists supplied with materials shall be delivered to the City prior to final acceptance of the project.

All equipment and materials that the Contractor proposes to install shall be submitted to the City for approval and shall conform to the contract plans, project specifications and these Construction Specifications.

At the request of the City, the Contractor shall also furnish the following information (for City capital projects):

A cost breakdown of equipment to be furnished, in manufacturer's catalog sheets for the following items, identified as to what is being furnished including all options, accessories, mounts and manufacturer's certifications.

6-86.03 Installation

Traffic signal and lighting system installation shall be in accordance with the following sections of the Standard Specifications:

56-3	Stands, Poles, Pedestals, and Posts
87-1.03	Construction

The Contractor's attention is also directed to Section 6-15 "Existing Facilities" of these Construction Specifications and the project plans/specifications.

Replacement of curb and gutter, curb ramps, exposed foundations and other concrete where skilled finish work is required - not including flat sidewalk sections - shall be done by qualified concrete finishers.

6-86.04 Foundations

Foundations shall conform to the provisions in Section 56-3 "Standards, Poles, Pedestals, and Posts" of the Standard Specifications and these Construction Specifications.

This work includes constructing cast-in-drilled-hole concrete pile foundations for traffic signal and lighting standards.

Concrete must contain not less than 590 pounds of cementitious material per cubic yard.

For standards located in sidewalk areas, the pile foundation must be:

1. Placed to final sidewalk grade before the sidewalk is placed
2. Square for the top 4 inches

Use sleeve nuts on Type 1-B standards. The bottom of the base plate must be flush with finished grade.

The controller cabinet foundation shall be constructed per the plans and the applicable details of State of California, Department of Transportation Standard Plan ES-3C, except the height of the foundation pedestal shall be 18 inches. Contractor shall furnish all components, including anchor bolts.

6-86.05 Standards, Steel Pedestals and posts

Standards, steel pedestals and posts shall conform to the provisions in Section 56-3 "Standards, Poles, Pedestals, and Posts" of the Standard Specifications and these Construction Specifications.

Steel bolts not designated on the plans as high-strength (HS) or stainless steel shall be for general applications and shall conform to the requirements in ASTM Designation: A 307.

Anchor bolts shall conform to the requirements in ASTM Designation: F 1554, Grade 36. High-strength (HS) anchor bolts shall conform to the requirements in ASTM Designation: F 1554, Grade 105.

The sign mounting hardware shall be installed at the locations shown on the plans.

Street name signs shall be installed per City's Standard Plan 146.

Handhole reinforcement rings for standards, steel pedestals, and posts shall be continuous around the handholes.

After installation, the Contractor shall touch up damaged galvanizing per Section 75-1.02B of the Standard Specifications.

At the end of all signal mast arms, the MAS side attachment mounting with a slipfitter shall be used. Type 1-B pedestals shall be used as designated on the pole schedule. The vehicle and pedestrian signals shall use the unimount mounting hardware.

See the plans for Unimount Mounting (UM) hardware detail and City Standard Plan 147.

6-86.06 Conduit

Conduit shall conform to the provisions in Section 86-1.02B(1), "Conduit and Accessories" and Section 87-1.03 "Construction" of the Standard Specifications and these Construction Specifications.

Insulated bonding bushings will be required on metal conduit.

All conduit shown on the Project Plans shall be rigid, non-metallic Schedule 40 PVC, except as otherwise shown on the Project Plans or required by Section 87-1.03B, "Conduit Installation," of the Caltrans Standard Specifications.

Conduit to be installed underground shall be Type 3 unless otherwise specified.

The conduit in a foundation and between a foundation and the nearest pull box shall be Type 1.

When Type 3 conduit is placed in a trench (not in pavement or under Portland cement concrete sidewalk), after the bedding material is placed and the conduit is installed, the trench shall be backfilled to not less than 4 inches above the conduit with minor concrete conforming to the provisions in Section 90-02, "Minor Concrete," of the Standard Specifications, except the concrete shall contain not less than 421 pounds of cementitious material per cubic yard. The remaining trench shall be backfilled to finished grade with backfill material.

Conduit runs shown on the plans to be located behind curbs may be installed in the street, within 2 feet of, and parallel with the face of the curb, by the trenching in pavement method in conformance with the provisions in Section 87-1.03B, "Conduit Installation," of the Standard Specifications. Pull boxes shall be located behind the curb or at the locations shown on the plans.

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

Contractor to install conduit prior to final asphalt concrete lift.

At other locations where conduit is to be installed by jacking or drilling as provided in Section 87-1.03B "Conduit Installation" of the Standard Specifications, and if delay to any vehicle will not exceed 5 minutes, conduit may be installed by the trenching method as follows:

TRENCHING INSTALLATION OF CONDUIT: Conduit shall be placed under existing pavement in a trench approximately 2 inches wider than the outside diameter of the conduit to be installed. Trench shall not exceed 6 inches in width. The top of the installed conduit shall be a minimum 18 inches below finish grade. If the conduit is installed in existing pavement that will be removed in a later stage of the project, the conduit shall be placed at a depth where it will not be damaged by construction activities when the existing pavement is removed and the new pavement is constructed.

No trenching within the new pavement will be allowed. All new conduits within the new pavement areas shall be installed prior to paving, either installed within the existing pavement at a depth where it will not be damaged by later stage construction activities or after the existing pavement has been removed and prior to installing the new pavement.

The outline of all areas of pavement to be removed shall be cut to a minimum depth of 3 inches with an abrasive type saw or with a rock cutting excavator specifically designed for this purpose. Cuts shall be neat and true with no shatter outside the removal area.

The conduit shall be placed in the bottom of the trench and the trench shall be backfilled to 2 inches above the top of the conduit with clean compacted sand or material excavated with a rock cutting excavator.

The remainder of the trench shall be backfilled to not less than 0.1 foot below the asphalt pavement surface with commercial quality concrete containing not less than 540 pounds of cement per cubic yard. The top 0.1 foot shall be filled with asphalt concrete, Type B, ½ inch maximum aggregate, per Section 39 "Asphalt Concrete" of the Standard Specifications. Prior to spreading asphalt concrete, see Section 39-2.01C(3)(f) "Tack Coat" of the Standard Specifications

Spreading and compacting of asphalt concrete shall be performed by any method which will produce an asphalt concrete surfacing of uniform smoothness, texture and density.

All excavated areas in the street shall be completely backfilled at the end of each work day.

Other methods of placing conduit must be approved by the City Engineer.

6-86.07 Pull Boxes

Pull boxes shall conform to the provisions in Section 86-1.02(C), "Pull Boxes" and Section 87-1.03C, "Installation of Pull Boxes," of the Standard Specifications and these Construction Specifications.

The pull box and cover must comply with ANSI/SCTE 77, "Specifications for Underground Enclosure Integrity," for Tier 22 load rating and must be gray in color.

Extension for the pull box must be of the same material as the pull box and attached to the pull box to maintain the minimum combined depths as shown.

The bolts, nuts, and washers must be a captive bolt design.

The captive bolt design must be capable of withstanding a torque range of 55 to 60 ft-lb and a minimum pull out strength of 750 lb. Perform the test with the cover in place and the bolts torqued. The pull box and cover must not be damaged while performing the test to the minimum pull out strength.

Stainless steel hardware must have an 18 percent chromium content and an 8 percent nickel content.

Galvanize ferrous metal parts under Section 75-1.02B, "Galvanizing" of the Standard Specifications.

Manufacturer's instructions must provide guidance on:

1. Quantity and size of entries that can be made without degrading the strength of the pull box below Tier 22 load rating
2. Where side entries cannot be made
3. Acceptable method to be used to create the entry

Tier 22 load rating must be labeled or stenciled by the manufacturer on the inside and outside of the pull box and on the underside of the cover.

Do not install pull box in curb ramps or driveways.

Pull box for a post or a pole standard must be located within 5 feet of the standard. Place a pull box adjacent to the back of the curb or edge of the shoulder. If this is impractical, place the pull box in a suitable, protected, and accessible location.

Grout in bottom of pull boxes will be required.

Recesses for suspension of ballasts will not be required.

All pull boxes shall be installed every 200' (Maximum) and shall be No. 5 unless otherwise noted on the plans. Extensions shall be installed if wires will be within 6 inches of the top of a single box.

Provide a 2-year manufacturer replacement warranty for pull box and cover from the date of installation of the pull box and cover. All warranty documentation must be submitted to the City Engineer before installation.

6-86.08 Conductors and Wiring

Conductors and wiring shall conform to the provisions in Section 86-1.02F "Conductors and Cables" and Section 87-1.03F "Conductors and Cable Installation" of the Standard Specifications and these Construction Specifications.

Conductors shall be spliced by the use of "C"-shaped compression connectors. Splices shall be insulated by "Method A" in accordance with State of California, Department of Transportation Standard Plan ES-13A.

Fused splice connectors as specified in Section 87-1.03N shall not be installed.

Conductors shall be wrapped around projecting end of conduit in pull boxes, as shown on the plans. Cables shall be secured to the projecting end of conduit in pull boxes to prevent pulling of cables without removing the securing device.

Conductors shall be pulled into conduits by hand. The use of winches or other power actuated pulling equipment shall not be permitted.

PED button conductor shall be blue and white with a blue stripe in color.

Copper Conductors:

Insulation for No. 14 and larger conductors shall be THW PVC.

Traffic Signal Interconnect Cable:

Traffic signal interconnect cable shall conform to these Special Provisions and the Project Plans, and shall be installed and terminated in accordance with the manufacturers recommendations.

Traffic signal interconnect cable shall consist of No. 20-6 pairs of individual shielding, 300V, 60 degrees C. Conductors No.20 Awg stranded tinned copper, insulation is 0.013" minimum color coded polypropylene individually shielded with aluminum/polyester foil and a No. 22 Awg stranded tinned copper wire incased in 0.040" minimum black high density polyethylene. Capacitance between conductors-30pF/ft between 1 conductor and balance of conductors connected to shield- 55pF/ft. Suitable for traffic signal interconnect and data transmission.

Traffic Signal Interconnect Cable Colors

Traffic Signal Interconnect Cable Colors	
Color Code	Colors
1	Black paired with red
2	Black paired with white
3	Black paired with green
4	Black paired with blue
5	Black paired with yellow
6	Black paired with brown

Application: Suitable for direct burial
Outdoor Uses
Signal interconnect and data transmission

Nom. O.D: 0.450 inches

Approx. Weight: 112.0 lbs/mft

Traffic signal interconnect cable shall not be spliced.

Pull boxes for interconnect cable shall be placed at 200 ft (maximum) intervals. There shall be a minimum of four (4) feet of slack in each pull box and six (6) feet at each controller cabinet.

6-86.09 Bonding and Grounding

Bonding and grounding shall conform to the provisions in Section 86-1.02O and Section 87-1.03O "Grounding Electrodes" of the Standard Specifications and these Construction Specifications.

6-86.10 Service

Service shall conform to the provisions in Section 86-1.02P "Service Equipment Enclosures" and 87.1.03L "Utility Service" of the Standard Specifications and these Construction Specifications.

The Contractor shall furnish and install Tesco padmount Type III-AF service equipment at the location shown on the plans.

The Contractor shall furnish and install Tesco Type 27-22 battery backup system with ambient temperature enclosure anodized aluminum complete with six 24 volt batteries full LED operation.

The service pedestal, battery backup cabinet and the controller cabinet shall be painted Rustoleum "Dunes Tan," Sherwin Williams "Deer Valley" #SW2184 gloss, direct to metal (DTM) or approved equal.

Circuit breakers shall be the cable-in/cable-out type, mounted on non-energized clips. All circuit breakers shall be mounted vertically with the up position of the handle being the "ON" position.

The Contractor shall obtain a building permit for any new electrical services.

6-86.11 Testing

Prior to the traffic signal equipment to be activated, the contractor is required to coordinate a pre-test to be conducted by the City's traffic engineer and electricians. Seventy-two hours minimum advance notice is required to schedule this pre-test. During the pre-test, the City's electrician will determine if all components of the traffic signal system are operational as designed, including the battery backup system and video detection system, if so equipped. If deficiencies are found, the contractor shall make the necessary corrections and schedule a follow up pre-testing. Only after all the deficiencies found are corrected can the contractor schedule the signal "Turn-On". The Contractor shall perform insulation resistance test in the presence of an Electric Utility representative prior to the Turn-On. The contractor shall provide a minimum of forty-eight hour advance notice to schedule the Turn-On.

6-86.12 Galvanizing and Painting

Galvanizing shall conform to Section 75-1.02B, "Galvanizing" of the Standard Specifications.

Painting shall conform to Section 78-4.08 "Painting Electrical Material" of the Standard Specifications.

6-86.13 Controller Assemblies

Controller assemblies shall conform to the provisions in Section 86-1.02Q and 87-1.03Q "Cabinets" of the Standard Specifications and these Construction Specifications.

Contractor shall furnish and install Econolite Cobalt controller with auxiliary equipment and TS2 Type 2 – P44 cabinet with 2 detector racks at the location shown on the plans.

The controller cabinet shall be painted Rustoleum "Dunes Tan," Sherwin Williams "Deer Valley" #SW2184 gloss, direct to metal (DTM) or approved equal.

The Contractor shall arrange to have a signal technician, qualified to work on the controller unit and employed by the controller unit manufacturer or his representative, present at the time the equipment is turned on.

The turn-on of the signal shall not commence without the presence of a representative of the City Engineer's Office. The City representative shall assign all controller timing.

6-86.14 Vehicle Signals

Vehicle signal faces, signal heads and auxiliary equipment as shown on the plans, and the installation thereof, shall conform to the provisions in the following Section 86-1.02R and 87-1.03R "Signal Heads" of the Standard Specifications and these Construction Specifications:

All visors shall be "Tunnel" type, with open slot at the bottom, metal with color black.

All vehicle signal faces shall be provided with 12 inch sections.

Backplates shall be powdered coated and signal section housing shall be metal type and louvered, color black.

All new red, yellow and green signal indications shall utilize light emitting diode (LED) modules conform to Section 86-1.02R(4)(b) "LED Signal Modules".

Warranty

All LED traffic signal modules supplied shall be warranted for 15 years against manufacturing defects from date of delivery.

6-86.15 Pedestrian Signals

LIGHT EMITTING DIODE (LED) PEDESTRIAN AND COUNTDOWN SIGNAL MODULE – Pedestrian signals shall conform Section 86-1.02S and 87-1.03S “Pedestrian Signal Heads” of the Standard Specifications and the following provisions.

All pedestrian heads shall be countdown LED traffic signals, Full Hand/Full Man Overlay + countdown modules and conform to Manual on Uniform Traffic Control Devices (MUTCD). The numbers shall have a minimum height of 9 inches.

Due to past issues, the City does not allow pedestrian signals manufactured by General Electric (GE).

Warranty

Unless otherwise specified:

- A. The unit shall be repaired or replaced by the Contractor if it exhibits a failure due to workmanship or material defect within the first sixty (60) months of delivery.
- B. The unit shall be repaired or replaced if the intensity level falls below fifty percent (50%) of the original values within sixty (60) months of delivery.

6-86.16 Accessible Pedestrian Signals and Detectors

Accessible pedestrian signals and detectors shall conform to Section 86-1.02T, “Accessible Pedestrian Signals,” and Section 87-1.03T, “Accessible Pedestrian Signals,” of the Caltrans Standard Specifications, Caltrans Standard Plans, the CA MUTCD, the Project Plans and these Special Provisions.

The Contractor shall furnish and install a Polara iNavigator 2-Wire Accessible Pedestrian System in accordance with the manufacturer’s recommendation.

All pedestrian push button housing shall be the metal type (color black) and furnished and installed by the Contractor.

The Contractor is responsible for the installation and programming of the Accessible Pedestrian Signals and Detectors at all signal pole locations and inside the controller cabinet as indicated on the Project Plans and in accordance with the Manufacturer’s recommendation to provide a fully functional system.

Pedestrian push button posts shall conform to Section 86-1.02J, “Standards, Poles, Pedestals and Posts,” of the Caltrans Standard Specifications. Pedestrian push buttons shall be located in accordance with requirements of the ADA and the latest edition CA MUTCD Guidelines.

The R10-3e pedestrian push button sign shall be porcelain-enameled metal with Protective Overlay Graffiti Film in compliance with the CA MUTCD Standard. The Contractor shall furnish and install tamper proof safety screws (Kendall #9018 or approved equal)

6-86.17 Detectors

Detectors shall conform to the provisions in Section 86-1.02F “Conductor” and Section 87-1.03V “Detectors” of the Standard Specifications and these Construction Specifications.

Loop wire shall be Type 2.

Loop detector lead-in cable shall be Type B.

Slot cut in the pavement shall be washed clean, blown out and thoroughly dried before installing conductors. Residue resulting from slot cutting operations shall not be permitted to flow across shoulders or lanes occupied by public traffic and shall be removed from the pavement surface before any such material flows off of the pavement surface. Residue from slot cutting operations shall be properly disposed of.

Signal loop detector lead-in cable, from the pull box adjacent to the loop to the field terminals in the cabinet, shall be Type B per Section 86-1.02F(3) "Cables" of the Standard Specifications. The ends of all lead-in cables and all loop conductors shall be sealed and made waterproof prior to being installed in conduit and prior to being left for splicing.

City detectors shall use EDI Model LM622t rack detectors and Econolite MMU-16E traffic monitors or approved equals.

The Contractor shall furnish four (4) spare Econolite Model LM622t detector amplifiers.

Slots shall be filled with elastomeric sealant or hot-melt rubberized asphalt sealant conforming to Section 86-1.02W "Loop Detector Sealant" of the Standard Specifications. The depth of loop sealant above the top of the uppermost loop wire in the sawed slots shall be 2 inches, minimum.

6-86.18 Video Detection System

6-86.18.01 General

The video detection system to be used shall be Econolite Autoscope Vision Video Detection System or an approved equal. All video detection equipment shall be manufactured, or otherwise provided, in accordance with these Construction Specifications and the Technical Provisions of these Specifications. The approaches shall have the detection zones as shown on the plans.

6-86.18.02 Hardware

The video detection system shall be comprised of two major hardware components: a video sensor and a communications interface panel. An optional wired input/output card shall be available for certain cabinet types.

A. Video Sensor

The video detection system shall include a video sensor that integrates a high-definition (HD) camera with an embedded processor for analyzing the video and performing detection.

- a. Camera and Processor
 - i. The camera shall be a color CMOS imaging array.
 - ii. The camera shall have HD resolution of at least 720p (1280x720 pixels).
 - iii. The camera shall include a minimum 10X optical zoom.
 1. It shall be possible to zoom the lens as required to satisfy across-the-intersection detection objectives, including stop line and advance detection.

2. It shall be possible to zoom the lens remotely from the TMC for temporary traffic surveillance operations or to inspect the cleanliness of the faceplate.
 - iv. The camera shall have direct, real-time iris and shutter speed control by the integrated processor.
 - v. The processor shall support H.264 video compression for streaming output.
- b. Video Sensor Enclosure Assembly
- i. The camera and processor shall be housed in a sealed IP-67 enclosure.
 1. The faceplate of the enclosure shall be glass and shall have hydrophilic coating on the exterior surface to reduce debris accumulation and maintenance.
 2. The faceplate shall have a thermostatically-controlled indium tin oxide (ITO) heater applied directly on the interior surface to keep the faceplate clear of condensation, snow, ice and frost.
 - ii. An adjustable aluminum visor shall shield the faceplate from the sun and extraneous light sources.
 - iii. An integral aiming sight shall assist in aiming the camera for the detection objectives.
 - iv. A removable rear cap and cable strain relief shall seal the power connection.
 1. The rear cap shall be tethered to the enclosure to avoid dropping the cap during installation.
 2. The rear cap shall be fastened to the body of the video sensor with a single, captive bolt.
 - v. The rear cap and enclosure shall include Gore breathers to equalize internal and external pressure while preventing moisture from entering the camera.
 - vi. The sensor shall be self-supporting on manufacturer's mounting brackets for easier fastening during installation.
 1. It shall be possible to rotate the field-of-view 360° without changing the angle of the visor.
- c. Power and Communications
- i. Power and communications for the video sensor shall be carried over a single three-conductor cable.
 1. Termination of the three-conductor cable shall be inside the rear cap of the enclosure on a three-position, removable Phoenix terminal block. Each conductor shall be attached to the Phoenix plug via a screw connection.
 - ii. The video sensor shall operate normally over an input voltage range of 89 to 265 VAC at 50 or 60 Hz.
 - iii. Power consumption shall be no more than 16 watts typical.
 - iv. No supplemental surge suppression shall be required outside the cabinet.
 - v. All communications to the video sensor shall be broadband-over-power via the same three-conductor cable that powers the unit. Coaxial cable shall not be required.

B. Communications Interface Panel

The video detection system shall include an interface panel in the traffic cabinet that manages communications between the video sensors, the traffic management center, a maintenance technician, and the traffic cabinet itself.

- a. Video Sensor Connection
 - i. The communications interface panel shall provide connection points for four video sensors.
 - 1. Each sensor connection shall be a 3-pole terminal block, which supplies power and broadband-over-power communications to the sensor.
 - 2. The broadband-over-power communications shall provide a throughput of 70 to 90 Mbps.
 - 3. The broadband-over-power connection shall support at least 1,000 feet of cabling to the video sensor.
 - 4. Each video sensor connection shall include a power switch.
 - 5. There shall be an LED for each video sensor to indicate the state of the power to the sensor and an LED for each video sensor to indicate the status of communications.
 - 6. Each video sensor connection shall contain a resettable fuse.
 - 7. Each video sensor connection shall provide high-energy transient protection.
- b. Traffic Management Center (TMC) Communications
 - i. An Ethernet port shall be provided to connect to a remote Traffic Management Center (TMC).
 - 1. The TMC connection shall support 10/100/1000 Mbps Ethernet communication.
 - 2. The communications interface panel shall proxy all network requests that arrive on the TMC connection to avoid unwanted network traffic from reaching the broadband-over-power network between the communications interface panel and the video sensors.
 - 3. All communications to the video detection system through the TMC connection shall be to a single IP address.
 - 4. The system shall be able to provide Full HD quality video through its WAN port for use in streaming video back to the TMC or any remote location.
- c. Local User Communications
 - i. A wired Ethernet port shall be provided to connect the technician at the cabinet to the video detection system for setup and maintenance purposes.
 - 1. The maintenance port shall support 10/100/1000 Mbps Ethernet communication.
 - 2. All communications to the video detection system through the maintenance port shall be to a single IP address.
 - 3. The maintenance port shall support DHCP to automatically assign an IP address to the user's computer.
 - ii. An 802.11g Wi-Fi access point shall allow wireless connection to the video detection system at the cabinet for setup and maintenance purposes.
 - 1. All communications to the video detection system through the Wi-Fi access point shall be to a single IP Address.
 - 2. The Wi-Fi access point shall support DHCP to automatically assign an IP Address to the user's computer.
 - 3. The Wi-Fi access point shall include a dipole, omnidirectional antenna.

4. A momentary pushbutton shall allow the user to turn the Wi-Fi access point on or off.
5. The Wi-Fi access point shall turn itself off automatically after a period of inactivity from connected devices.
6. An LED shall indicate when the Wi-Fi access point is enabled.
7. The Wi-Fi access point shall operate simultaneously with the wired maintenance port and with the TMC connection.
8. The Wi-Fi access point shall require a password for connection by a user's computer. The default password shall be changeable.

d. Traffic Controller Connection

The communications interface panel shall provide one (1) connection to communicate to the traffic controller through the cabinet.

- i. The traffic controller connection shall support a TS2 Type 1 compatible SDLC interface.
 1. The traffic controller connector shall be a 15-pin female metal shell D sub-miniature type connector to support a standard NEMA TS2 or TEES SDLC cable.
 2. The traffic controller connection shall support a protocol interface to SDLC-capable traffic controllers (NEMA or TEES).
 3. The traffic controller connection shall support the NEMA TS2 SDLC protocol to include up to 64 detector outputs and 32 inputs.
- ii. The traffic controller connection shall be able to connect to a wired input/output card, which supports wired I/O in cabinets without a SDLC-capable controller.
 1. The wired I/O data communications link shall support at least 24 outputs and 16 inputs.
- iii. It shall be possible to connect and use both SDLC communications and communication to the wired input/output card simultaneously.

e. USB Ports

- i. The communications interface panel shall include two USB 2.0 ports.
 1. If a communications interface panel fails to start and run due to a software or operating system failure, it shall be possible to reinstall all system and application software from a USB memory stick without necessitating removal of the communications interface panel from the cabinet.
 2. Video recording of up to 2 cameras simultaneously shall commence automatically when an appropriately configured USB memory stick is installed in either USB port.

f. Power

- i. The communications interface panel shall accept input voltage in the range of 89-265 VAC, 50/60 Hz power from the transient-protected side of the cabinet.
- ii. The communications interface panel shall be protected by two slow blow fuses. Spares shall be attached to the panel.

C. Wired Input/Output Card

The video detection system shall support an optional wired input/output card that communicates with the communications interface panel for real-time detection states

and other I/O to the traffic controller. The card may reside in a standard detector rack or shelf-mount enclosure with power module.

- a. The optional wired input/output card shall comply with the form factor and electrical characteristics to plug directly into a NEMA type C or D detector rack or Caltrans TEES Input File.
 - i. The card shall occupy two slots of the detector rack.
 - ii. The card shall provide four detector outputs on its rear-edge connector.
 - iii. A front connector shall provide communication to the communications interface panel.
 - iv. A front connector shall allow 16 inputs and 24 contact-closure detector outputs for wiring into the cabinet.
 1. A front panel LED for each of the 16 inputs and 24 outputs shall indicate the state of the input or output.
 - v. The wired input/output card shall support optional expansion cards in other slots. Each expansion card shall support 4 outputs to the back edge of the card.
 - vi. The wired input/output card shall support optional harnesses for connection to Input Files or C1, C4, C11, and C12 ports to support Type 170 or Type 2070 controllers.

6-86.17.02 System Software

The video detection system shall include management software for configuration, monitoring and data collection purposes.

A. Management Software

- a. Management software shall be a Windows-based application.
 - i. The software shall be compatible with latest Windows operating systems (OS).
 - ii. The software shall communicate with the video detection system via Ethernet.
- b. The management software shall automatically determine all video sensors and communications interface panels available on the local network and populate a list of all devices.
- c. The management software shall provide a means to add video sensors and communications interface panels on routed networks by the communications panel's WAN IP address.
- d. The management software shall provide the user a means to name individual video sensors and communications interface panels.
- e. The management software shall provide a means for the user to zoom the camera optics while viewing a live video stream.
- f. The management software shall provide a means for the user to easily calibrate distances in the field of view so as to create a 3-dimensional mapping of the complete field of view.
- g. The management software shall provide the user a means to create 4-sided detection zones in the field of view using either a still snapshot or live video.
 - i. The management software will overlay an outline of each detection zone over the background image.
 - ii. It shall be possible for the user to place detection zones anywhere in the field of view for stop line detection and/or advance detection.
 - iii. It shall be possible for the user to set the desired color of both the "on" and "off" states of the overlay for individual detection zones.

- iv. It shall be possible for the user to alter the size and shape of any previously created zone.
 - 1. It shall be possible for the user to click and drag any of the 4 sides of a zone and the system will automatically scale the length of the side consistent with the 3-dimensional field of view.
 - 2. It shall be possible for the user to move an entire zone without automatic rescaling.
- v. It shall be possible for the user to create a new zone by selecting an existing zone and duplicating it on either left or right side, or specifying a new zone behind (for advance) with a specific length and distance back from selected zone.
- vi. It shall be possible for the user to easily rotate a zone by selecting any of its four corners and dragging to rotate it.
- vii. It shall be possible to easily flip the zone direction 180 degrees from its current orientation.
- viii. It shall be possible for the user to name each zone uniquely.
- ix. It shall be possible for the user to assign each zone to detect vehicles, to detect bicycles, or to detect both, and to specify different outputs for each type.
- x. It shall be possible for the user to specify the output of a zone as a presence, pulse, or snappy type output (presence during red and pulse during green signal phase state).
- xi. The pulse output shall be usable for both approaching and receding traffic.
- xii. The pulse output shall have a user programmable duration from 100 to 400 ms.
- xiii. It shall be possible for a zone to have multiple output types (presence, pulse, snappy) on separate output channels.
- xiv. It shall be possible for the user to tie the presence outputs of multiple zones as well as signal phase state together with AND/OR Boolean logic.
- xv. It shall be possible for the user to assign the same output to multiple zones such that the output will be on if any of the zones are detecting a vehicle or bicycle.
- xvi. It shall be possible for the user to assign a single zone to more than one output such that if a vehicle or bicycle is detected, all the assigned outputs shall be turned on.
- xvii. The management software shall be capable of creating at least 99 detection zones per video sensor.
- h. It shall be possible for the management software to retrieve all configuration parameters from video sensors or communications interface panels.
 - i. It shall be possible for the user to save all the settings for a video sensor or a communications interface panel to a laptop file.
 - ii. The management software shall provide a means to read or import all the settings from a previously saved configuration file for a video sensor or a communications interface panel.
- i. The management software shall be able to download a new version of the application software into a communications interface panel and its attached video sensors.
- j. The management software shall provide a screen to monitor operation of a video sensor.

- i. The monitoring screen shall include a live video stream from the video sensor with at least HD 1280x720 pixel resolution.
- ii. The monitoring screen shall show indications of detection in real time by changing the color of the detection zone.
- iii. It shall be possible for the user to configure different indications for vehicle detections vs. bicycle detections when both are configured for the same zone.
- iv. The monitoring screen shall include the following optional, configurable objects. It shall be possible for the user to size and position them anywhere on the screen and to change the color and size of text.
 - 1. An indication of when either a zone or an output is on or off, along with a user-configurable name for that indicator, applicable to any zone or output type.
 - 2. The current time in the video sensor.
 - 3. A user-configurable title or name.
 - 4. The version number of the video sensor software.
 - 5. Configurable text as defined by the user.
- v. Undo/Redo functions shall be available for operations during detection zone setup and programming.
- vi. It shall be possible for the user to turn the overlay graphics on or off with a single setting.
- k. The management software shall provide a screen to monitor operation of the intersection with a quad-view video stream from the communications interface panel.
 - i. The quad-view video stream shall have a resolution of at least HD 1280x720 pixels, where each of the sensor videos comprising the quad-view shall be at least 640x360 pixels.
 - ii. It shall be possible for the user to configure the order that the sensor videos appear in the quad-view.
 - iii. The real-time quad-view video stream shall be capable of displaying the overlay graphics for all four sensors simultaneously.
- l. While monitoring the video of a single video sensor or of the quad-view, it shall be possible for the user to request a “snapshot” or single-frame image to save to a named file on a laptop.
- m. While monitoring the video of a single video sensor or of the quad-view, it shall be possible for the user to record a period of the video to save to a named file on a laptop.

6-86.18.03 System Functionality

The video detection system shall provide the following features and functionality.

A. Detection Performance

- a. The video detection system shall detect the presence of vehicles in defined zones and turn on the assigned output when the vehicle is present in the zone.
 - i. Stop Line Detection
 - 1. For detection zones placed at the stop line, the probability of not detecting the presence of a vehicle shall be 1% or less when aggregated over a 24-hour period (as stated in 6-87-17.03.A.b) when the video sensor is installed and configured properly.
 - 2. For detection zones placed at the stop line, the probability of falsely detecting a vehicle that is not present shall be

3% or less when aggregated over a 24-hour period (as stated in 6-87-17.03.A.b) when the video sensor is installed and configured properly.

ii. Advance Detection

1. It shall be possible to place advance detector zones such that the farthest point of the zone is up to 600 feet from the video sensor. Advance detector zone placement shall include 2-3 car lengths of field-of-view beyond the farthest point of the zone.

iii. Receding Zones

1. The video detection system shall be capable of detecting receding vehicles in day or night conditions when the video sensor is installed and configured properly.
- b. To ensure statistical significance for the above detection performance specifications, the data shall be collected over 24-hour time intervals (so as to avoid a single lighting condition) and will contain a minimum of one hundred (100) vehicles per lane. The calculations of detection performance will not include turning movements where vehicles do not pass through the detectors, vehicle lane-change anomalies, or where they stop short or stop beyond the combined detection zones.

B. Failsafe Mode

- a. The video detection system shall provide three (3) failsafe options during optical contrast loss. The default shall be maximum recall. The end-user may also choose to use minimum recall or fixed recall in which a user-defined number of seconds may be implemented to hold call during green.
- b. The video sensor shall continuously monitor the overall contrast in the video. If the overall contrast falls below a preset level (such as caused by dirty faceplate, severe glare, extreme fog, or temporary ice/snow on the faceplate), the sensor shall enable the chosen failsafe mode. When sufficient contrast is restored in the video, the sensor will exit the failsafe mode.
- c. The communications interface panel shall continuously monitor the connectivity status of the attached video sensors. If any video sensor goes offline due to either electrical failure or internal software failure, the communications interface panel shall enable the failsafe mode for that video sensor. If the video sensor comes back online, failsafe mode shall end.

C. Data Collection

- a. The video detection system shall automatically collect and store traffic flow data in non-volatile memory for later retrieval and analysis. No additional hardware or software shall be necessary. Data functionality shall include the following:
 - i. Data shall be collected automatically for all zones created by the user once the learn period is complete and normal detection is active. No further setup shall be required.
 - ii. Vehicle counts per zone.
 - iii. Vehicle turning movements independent of zone.
 - iv. Vehicle average speeds.
 - v. Vehicle lengths.
 - vi. Detection statistics with the on/off timestamps when zones were activated.

- vii. Detection actuation statistics for whether a zone was triggered by a vehicle or a bicycle.
 - b. The management software shall be able to retrieve collected data over a specified period of time or for all currently stored data and save into a standard CSV file.
 - c. The sensor hardware shall include up to 8GB of memory storage capacity for data collection.
 - d. Data Download Types
 - i. Options shall be provided for downloaded data in the form of a .csv file for Raw data, Binned data, Detections and Zone Status as defined below:
 1. Raw Data – Includes time stamped Zone statistics for vehicle or bike actuations and average speed as well as time stamped Exiting Vehicle Statistics which include volume, turning movement direction, speed and length for vehicles exiting each zone.
 2. Binned Data – Pre-binned data with bin time set by the user down to as little as 1-minute. Data shall include volume, occupancy, turning movement counts and speed for vehicles for each zone.
 3. Detections – Date/time stamped data regarding vehicles exiting zones including type of object (vehicle or bike), speed, length and direction of movement (through, left, right).
 4. Zone Status – Date/Time stamped indications of whether a vehicle or bicycle actuated a zone and the average speed of all objects in the zone.
 - e. Remote Data Interface
 - i. Data including counts, turning movements, speed and length, as well as zone names, sensor status, and video snapshots shall be available to remote systems via remote communication to the system using an Applications Programming Interface (API). This API shall consist of a set of GET commands embedded in HTTP protocol. The resulting data returned shall be in JSON format.

D. Operations Log

- a. The communications interface panel and each video sensor shall maintain a time-stamped operations log of routine and special events in non-volatile memory for later retrieval and analysis.

E. Time Synchronization

- a. The video detection system and management software shall provide three methods to synchronize the time of day clocks in the communication interface panel and the video sensors, as follows:
 - i. Manual time synchronization operation by the user, which sets the time to the current time on the laptop where the management software is running.
 - ii. A configuration setting to allow the communications interface panel to automatically obtain time from the NEMA TS2 protocol on the SDLC channel and broadcast it to the video sensors.
 - iii. A configuration setting to allow the communications interface panel to automatically obtain time from up to five Network Time Protocol (NTP) sources and broadcast it to the video sensors.

F. Video Streaming

- a. In addition to the ability to view video streams in the management software, it shall be possible to view video from individual sensors or to view the quad-view from the communications interface panel using a third-party video player application on a tablet, smartphone or laptop computer.
- b. Video bitrate is user-definable between 100 Kbps-5000 Kbps. The default shall be 2048 Kbps. All bitrates shall provide 30 fps.

6-86.18.04 Installation and Setup

The video detection system hardware shall be designed for flexible, fast and easy installation and setup.

- A. It shall be possible to mount the video sensor on an intersection pole, mast arm, or luminaire arm.
- B. No special tools or extra equipment, other than a laptop for configuration, will be required.
- C. Once all hardware is installed, connected and functional, it shall be possible to configure the video detection system for a typical 4-approach, 8-phase intersection in 15 minutes or less.
- D. All video detection equipment shall be procured by the Contractor and installed as follows:
 - a. All equipment installed in the traffic signal controller cabinet shall be by the manufacturer or its representative. Video detection equipment shall be installed after the controller cabinet has been tested.
 - b. Image sensors, including mounting brackets, hardware, etc., shall be installed by the Contractor.
 - c. All cables from the image sensors to the controllers and between controllers shall be installed by the Contractor as shown on the conductor schedule on the plans.
- E. For project to replace existing loop detection to video detection:
 - a. The Contractor shall verify the existence, location, and operation of all loop detectors within the proposed video detection zones as shown on the plans. Any existing loop detectors within the proposed video detection zones shall be abandoned in place and all existing detector lead-in cables shall be removed from the conduits.
 - b. The Contractor shall also verify the existence, location, and operation of all advance loop detectors that are interconnected with the existing loop detectors within the proposed video detection zones. All operational advance loop detectors shall remain in place and be interconnected to work in conjunction with the new video detection system.
 - c. Any detector modules that are no longer needed for the intended operation of the traffic signal system shall be removed and salvaged to the City of Lodi Public Works Yard.

6-86.18.05 Warranty, Service and Support

- A. Warranty
 - a. The manufacturer shall warrant the video detection system for a minimum of three (3) years. An option for up to six (6) years of warranty shall be available.
- B. Service
 - a. Ongoing software support by the manufacturer will include software updates of the video sensor, communications interface panel, and management software. These updates will be provided free of charge during the warranty period. The manufacturer will maintain a program for

technical support and software updates following expiration of the warranty period. This program will be available to the contracting agency in the form of a separate agreement for continuing support.

C. Support

- a. A quick-start guide, installation guide, application notes, and other materials shall be available from the manufacturer to assist in product installation and setup for various applications. In addition, training online or in person shall be available.
- b. Training shall be available to personnel of the contracting agency in application design, operation, setup, and maintenance of the video detection system.
- c. Manufacturer shall provide a tech support website, support email address and a 1-800 number for technical support.

6-86.19 Vehicle Pre-emption System

Emergency vehicle preemption shall be 3M "Opticom" Model 752 phase selector unit or approved equal completely wired in a controller cabinet and optical detector units (3M Model 721 or approved equal) mast arm mounted per signal plans.

6-86.20 Luminaires

Luminaires shall conform to the provisions in Section 86-1.02K "Luminaries" of the Standard Specifications and these Construction Specifications. The luminaries shall be LED conforming to Lodi Electric Utility Standards unless otherwise specified on the plans.

Photoelectric controls shall conform to the provisions in Section 86-1.02M and Section 87-1.03M "Photoelectric Controls" of the Standard Specifications and these Construction Specifications.

6-86.21 Signs on Signal Mast Arm

The Contractor shall furnish and install street name signs and other signs as shown on the plans and in accordance with these Construction Specifications.

The street name signs shall be mounted as shown on the City's Standard Plan 146. Attachment hardware shall be Signfix, Scotchbrand VHB acrylic foam tape, or approved equal. The signs shall be mounted at three attachment points. Fastening hardware on sign face will not be allowed.

All new signs including signal street name signs shall be single faced, fabricated on 0.08 inch aluminum blanks with Nippon Carbide or equal super engineering grade reflective sheeting. For signs with green background and white legends and border, white diamond grade reflective sheeting shall be used. For fluorescent yellow green background signs, diamond grade reflective sheeting shall be used. Protective Overlay Graffiti Film shall be applied to all signs. Protective Overlay Graffiti Film shall be applied to all signs.

The signal street name signs shall consist of white legends and border with green background. All letters should be Series "D" lettering lower case (8") with initial letter upper case (10.67"), unless otherwise notice on the plans.

Contractor shall submit shop drawings of street names signs to the Engineer. The minimum width for street name sign shall be 5 feet.