

Section 925—Traffic Signal Equipment

925.1 General Description

This section provides specifications for a variety of traffic signal equipment.

925.1.01 Related References

A. Standard Specifications

[Section 500—Concrete Structures](#)

[Section 647—Traffic Signal Installation](#)

[Section 682—Electrical Wire, Cable and Conduit](#)

[Section 833—Joint Fillers and Sealers](#)

[Section 870—Paints \(Field Painting\)](#)

[Section 923—Electrical Conduit](#)

[Section 935—Fiber Optic System](#)

B. Referenced Documents

NEMA TS-1 ITE Traffic Signal Lamps

IMSA #20-1-1984

IMSA #20-4-1984

IMSA #20-6-1984

IMSA #50-2-1984

IMSA #51-5-1984

UL #493 Carol #C6047 or Belden #9773

Traffic Signal Control Equipment Specifications, current edition and addenda, State of California Business, Transportation & Housing Agency

CALTRANS Qualified Products List, QPL, “Polyurethane Sealant for Inductive Loops” and QPL-XX, “Model 2070 traffic Controllers”, Transportation Electrical Equipment Specifications (TEES).

[QPL 75](#)

925.2 Materials

A. Requirements

Ensure that the traffic signal equipment and materials meet the Plans and Specifications.

All equipment furnished shall be new and meet the requirements of the following:

- Underwriter’s Laboratory Incorporated (UL)
- Electronic Industries Association (EIA)
- National Electric Code (NEC)
- American Society of Testing and Materials (ASTM)
- American National Standards Institute (ANSI)
- International Municipal Signal Association (IMSA)
- National Electrical Manufacturers Association (NEMA)

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- Applicable Standards, Specifications, and Regulations of the:

Georgia Department of Transportation
Traffic Signal Electrical Facility & NaviGator Support (TSEF)
935 E. Confederate Avenue, Building 5
Atlanta, GA 30316

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

- Provide all manufacturers' warranties and guarantees for all signal equipment items listed in this document as well as any signal equipment listed in the plans, except for state supplied equipment.
- Ensure that warranties and guarantees are consistent with those provided as customary trade practices; or as otherwise specified in the plans, Standard Specifications, Supplemental Specifications or Special Provisions.
- Ensure that manufacturer's and supplier's warranties and guarantees are transferable to the agency or user that is responsible for traffic signal maintenance, are continuous throughout their duration and state that they are subject to such transfer.
- Ensure equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a period of two years from date of receipt or one year from date of acceptance of installation.
- Ensure the manufacturer will repair any faulty equipment during this period at no charge to the Department for parts, labor or shipping to and from the factory.

925.2.01 Type 2070 Controller Assemblies

A. Requirements

For 2070 controller cabinet assemblies, use 2070 controller units that meet the requirements of the following or are previously approved by TSEF:

- *Traffic Electrical Equipment Specifications (TEES)* published by the State of California Business, Transportation, and Housing Agency; Department of Transportation, current edition and current addenda
- CALTRANS Qualified Products List (QPL)

The following specifications augment the CALTRANS specifications and take precedence over conflicting CALTRANS Specifications.

1. Input/output (I/O) and Configuration:

The 2070 Controller shall be supplied in one of the following configurations, as specified in the Plans (all modules are specified in TEES, but these configurations supersede the defined configurations in TEES):

2070L: Provide Chassis, 2070-1B Single-Board CPU, 2070-2A 170-style Field I/O Module, 2070-3B Front Panel (8x40 display), 2070-4B 3.5-amp Power Supply, and a 2070-7a Module.

2070 LB: Provide Chassis, 2070-1B Single –Board CPU, 2070-2A, 170-style Field I/O Module, 2070-3C Front Panel, 2070-4B 3.5-amp Power Supply, and a 2070-7A Module.

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2070 LCN: Provide Chassis, 2070-1B Single-Board CPU, 2070-2b NEMA-style Field I/O Module, 2070-3B Front Panel (8x40 display), 2070-4B 3.5-amp Power Supply, 2070-8 NEMA Interface Module, and a 2070-7A Module.

2. **Power Supply Modules:**

Either the 2070-4A or 2070-4B module shall be provided as required in the configuration requirements in the preceding Item. In addition to all requirements of the TEES, the power supplies shall be clearly marked as a “2070-4A” or “2070-4B”. These markings shall be used in place of the “2070-4B” markings as specified in TEES. The Vendor may supply a 2070-4A power supply module in lieu of a 2070-4B, as long as it is so marked and adds on additional cost to GDOT.

3. **Documentation:**

Include with each controller, manuals that document the programming, operation, and maintenance of the unit. Include schematic drawings and pin assignment charts in the manuals for maintenance. Documentation shall include all components, including communications modules.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

(See Subsection 925.2.01 for compliance with CALTRANS QPL).

D. Materials Warranty:

(See Subsection 925.2.D for Materials Warranties).

925.2.02 Type 170E Cabinet Assemblies

A. Requirements

Ensure that the cabinet assembly meets the requirements of the CALTRANS Specifications as described in this document.

In addition to the CALTRANS Specifications, ensure that the cabinet assembly conforms to the requirements listed below, which take precedence over conflicting CALTRANS Specifications.

1. **Cabinet configuration:**

Supply cabinets in accordance with these specifications. Equip the cabinets with auxiliary equipment as follows:

a. **Model 332A Cabinet:**

Lower input field termination panel

1 – Model 242 DC Isolator in Slot 14 of Upper Input File

4 – Flash Transfer Relays

2 – Model 204 Flashers

b. **Model 336 Cabinet:**

1-Model 242 DC Isolator in Slot 14 of Input File

4- Flash Transfer Relays

2-Model 204 Flashers

1-"M" Base Adapter installed (Base Mount Cabinets Only)

1-Aluminum Cover Plate for Cabinet Bottom (Pole Mount Cabinets Only)

c. **Model 337 Cabinet**

3-Flash Transfer Relays

1-Model 204 Flasher

Note: Include above components in cabinet at time of delivery.

Other auxiliary cabinet components such as controllers, monitors, load switches, etc. will be ordered as separate items.

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2. Finish

Use cabinets that have a bare aluminum finish (see [Subsection 925.2.03.A.1](#) for controller-cabinet minimum fabrication specifications).

3. Locks

Equip the main cabinet door with locks that accept No. 2 Corbin keys. Provide two sets of keys with each cabinet. One set of keys is defined as one – No. 2 key and one - police panel key.

4. Power

Equip the cabinet assemblies with a power distribution assembly to generate AC and DC power for the electronic components, except the DC power for the controller units. Provide the Model 332 and 336 cabinets with a DC isolator for stop time/flash sense, located in slot 14 of the input file.

5. Mounting

Equip the cabinets for pole or base mounting, as specified in the Plans.

a. Base Mount

Supply Model 336 cabinets, when specified as base mount, with a “M” base-mounting adapter installed.

b. Pole Mount

Supply Model 336 or 337 cabinets, when specified as pole mount, with two exterior pole mounting brackets that allow for mounting on steel, concrete, and timber poles.

Ensure that the bracket mounting holes are properly reinforced with metal plates of adequate size and strength, welded longitudinally across the inside depth of the cabinet.

Ensure that the exterior-mounting bracket is shipped installed on the cabinet housing. Additionally, provide an aluminum plate, which covers the bottom cabinet opening.

6. Unused Phase Monitoring

Provide odd-phase reds with ballast resistor dummy loads. Do not wire the cabinet to monitor pedestrian yellow indications.

Neatly lace and bundle the wiring from the signal monitor for pedestrian yellow monitoring on the back panel.

7. Red Monitoring

Provide a connector and terminal assembly designated as P20 (Magnum P/N 722120 or equivalent) for monitoring the absence of red as an integral part of the output file.

Terminate the connector and ensure compatible with the cable and C connector of a Type 2010 conflict monitor unit capable of monitoring the absence of red.

Provide the pin assignments of the P20 connector and terminal assemble with the cabinet plans.

Ensure that the P20 connector is physically alike to the cable and connector of a Type 2010 conflict monitor unit to prevent the absence of red cable connector from being inserted into the P20 connector 180 degrees out of alignment.

Submit details for programming of the unused red channels for approval.

8. Cabinet Light

Include in each cabinet one fluorescent lighting fixture mounted inside the top front portion of the cabinet.

The fixture includes a cool white lamp, covered, and operated by a normal power factor, UL listed ballast.

Install a door-actuated switch to turn on the cabinet light when either door is opened.

9. Diagnostic Testing Shorting Jack

Install a phone jack that can mate with a Switchcraft Model 190 plug in the cabinet for automatic cabinet diagnostic testing. Position the jack to be easily accessible.

When the plug is inserted, a reset signal generated by the controller unit at pin C1-102 of the 210 monitor is routed to the external reset input.

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10. Cabinet Interlock

Do not install the interlock circuit, as detailed in the CALTRANS Specifications.

11. Intelligent Load Switches

Provide cabinets with output files wired to be compatible with intelligent load switches.

Wire pin 4 of the load switch sockets to DC ground, wire pin 11 to AC ground, and wire pin 12 of all load switches together and then bring to C1 pin 75 for fault output to the 2070 controller.

12. Cabinet Drawer

Equip each Model 332A, and 336 cabinet with an aluminum storage compartment mounted in the rack assembly with the approximate following dimensions: 16 inches (400 mm) wide, 14 inches (350 mm) long, 1.75 inches (44 mm) deep.

Mount this compartment directly under the Type 2070 controller. Provide a drawer with telescoping drawer guides to allow full extension from the rack assembly.

When extended, the storage compartment opens to provide storage space for cabinet documentation and other miscellaneous items.

Ensure that the storage compartment be of adequate construction to support a weight of 25 pounds (12 kg) when extended.

Provide a top for the storage compartment that has a non-slip plastic laminate attached, which covers a minimum of 90% of the surface area of the top.

13. Test Program

Supply each cabinet with a diagnostic test program, which verifies the operation of the cabinet. Ensure that the program can test cabinet wiring related to the output file, input file, and police panel and flash switches.

In addition, ensure that the program can check the operation of the conflict monitor, by generating all possible conflicts, in sequence, and resetting the monitor automatically (a shorting plug jack in the cabinet is specified previously).

Provide the cabinet test program on EPROMS that can be installed in the program module of the Model 2070 controller. Include full documentation for all test programs.

14. Surge Protection

Equip each cabinet with devices to protect the control equipment from surges and over voltages.

Design the surge protector panels to allow for adequate space for a wire connection and surge protector replacement without the removal of terminal blocks or panels. Provide surge protectors for the input sections as detailed below and as shown in the Input Terminal and Surge Arrestor Detail.

Supply surge protectors that meet the following specifications.

a. AC Service Input

Include a surge protection unit for each cabinet on the AC service input that meets or exceeds the following requirements:

- Provide a hybrid type power line surge protection device, which may be incorporated into the power distribution assembly.

Install the protector between the applied line voltage and earth ground. Use a surge protector capable of reducing the effect of lightning transient voltages applied to the AC line, that conforms to the following:

Peak surge current for an 8 x 20 μ s waveform:	20,000A for 20 occurrences
Clamp voltage @ 20,000A:	280V max
Maximum continuous operating current:	@ 120V / 60 Hz 10A

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Series Inductance:	AC Line/AC Neutral - 200 microhenries
Response time:	Voltage never exceeds 280V during surge
Spike suppression for +/- 700 V spike:	+/- 40 V deviation from sine wave at all phases angles between 0 and 180 degrees.

- Provide a protector with the following terminals:

Main Line (AC line first stage terminal)

Main Neutral (AC neutral input terminal)

Equipment Line In (AC line second stage input terminal, 10A)

Equipment Line Out (AC line second stage output terminal, 10A)

Equipment neutral out (neutral terminal to protected equipment)

GND (Earth connection)

- Supply a protector that is epoxy encapsulated in a flame-retardant material.
- Configure the Equipment Line Out to provide power to the Type 2070 and to the 24 V power supply.

b. AC+ Interconnect Cable Inputs

Use a surge protection device to protect each AC interconnect line as it enters the cabinet with a surge protection device that meets or exceeds the following requirements:

- 3-electrode gas tube type of surge arrestor
- Striking voltage of 300-500 V DC with a minimum holder over voltage of 155V DC
- A three terminal device, one of which is connected to ground, the other two are connected across each input respectively
- The units must meet the following minimum requirements:

Impulse breakdown:	Less than 100V in less than 1.1 μ s at 10 kV/ μ s
Impulse breakdown balance:	0.01 microsecond (or less) difference at 10 kV/ μ s impulse
Energy application:	Withstands 20A AC for one (1) second applied ten (10) times at three (3) minute intervals on either section
Current rating:	10,000A (8 x 20 μ s impulse)
Capacitance:	6 pF, line to ground

c. Inductive Loop Detector Inputs

Protect each inductive loop detector channel input by an external surge protection device that meets or exceeds the following requirements:

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- A three-terminal device, two (2) of which are connected across the signal inputs of the detector with the third connected to the chassis ground to protect against common mode damage.
- Instantly clamps differential mode surges (induced voltage across the loop detector input terminals) via a semiconductor array. The array appears as a low capacitance to the detector.
- Clamps common mode surges (induced voltage between the loop leads and ground) via solid state clamping devices.
- Withstand 25-100A surge current occurrences of a 10 x 700 μ s waveform.
- Have the following clamp characteristics:

Maximum break over voltage:	170 V
Maximum on-stage clamping voltage:	3V
Response Time:	<5 ns
Off-stage leakage current:	<10 μ A
Capacitance:	less than 220 pf

- Ensure that the unit also meets the following minimum requirements:

Peak surge current:	6 times
Differential mode:	400 A (8 x 20 ms)
Common mode:	1,000 A (8 x 20 ms)
Estimated occurrences:	500 @ 200 A
Response time:	40 ns
Input capacitance:	35 pF typical
Temperature:	-40° F to +185° F (-40° C to 85° C)
Mounting:	No. 10-32 x 3/8-inch (No. 5 x 10 mm) bolt

Clamp voltage

@400 A diff. Mode:	30 V max.
@1,000 A comm. Mode:	30 V max.

d. Signal Load Switches (Switchpacks)

Provide the output of the switchpack in the output file with metal oxide varistors (MOV) tied from the AC positive field terminal to the chassis ground to protect switchpacks from surges on the AC output lines.

Ensure that these MOVs meet or exceed these requirements:

- Steady state sinusoidal voltage (RMS) rating at 50 to 60 Hz of at least 150 V at 77 °F (25 °C)
- Steady state applied DC voltage rating of at least 200 V at 77 °F (25 °C)

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- Transient energy rating is of at least 80 J for a single impulse of 10/1,000 μ s current waveform at 77 °F (25 °C)
 - Peak current rating of 6,500 A for a single impulse of 8/20 μ s waveform with the rated continuous voltage applied
 - Varistor voltage of at least 212 V at 1.0mA of DC current applied for the duration of 20 μ s to 5s
 - Clamping voltage of at least 395 V with an applied 8/20 μ s impulse of 100 A
 - Typical capacitance at a frequency of 0.1 to 1.0 MHz of 1600 pF
 - Two-terminal device, one of which is connected to the AC output of the signal load switch on the output file terminals (backside of the field terminals) with the other connected to AC neutral
- e. Communication Inputs

Protect low voltage communications input as it enters the cabinet with a solid-state surge protection unit that meets or exceeds these requirements:

- Dual pair (4-wire) module with a printed circuit board connector, double sided and gold plated for reliability
- Ability to mate with and be installed in a 10-circuit Buchanan connector PNPCBIB or equivalent
- Usable as two independent signal pairs
- The data circuits pass through the protection in a serial fashion
- C2 connector of the 2070 controller that terminates on the line side of the unit
- Communication field wires for this local side that terminate on the line side of the unit
- Ground terminals connected to power ground
- Ensure that the unit meets the following minimum requirements:

Peak surge current:	10 kA (8 x 20 μ s wave shape)
	500A (10 x 700 μ s wave shape)
Occurrences @ peak:	50 typical
Response time:	<1ns
Voltage Clamp:	8V line to line
Series Resistance:	24 Ω total
Temperature	-40 °F (-40 °C) to +185 °F (85 °F)
Primary protector:	3 element gas tube 5kA, (8 x 20 μ s wave shape), per side
Secondary protector:	Silicon avalance, 1.5 kW minimum

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f. Low Voltage DC Inputs

Provide an external surge protection device for each low voltage DC input channel which meets the same requirements as the communication inputs with the following exception of the Voltage clamp, which shall be 30 V line-to-line.

15. Type 2010 Signal Monitors:

a. Introduction

This Specification sets forth the minimum requirements for a rack-mountable, sixteen channel, solid-state 2010 Signal Monitor for a Type 170 / 179 / 2070 Traffic Cabinet Assembly. Ensure that as a minimum, the Signal Monitor complies with all Specifications outlined in Chapter 4 of the *California Traffic Signal Control Equipment Specifications*, January 1989. Where differences occur, this Specification governs. Ensure that the manufacturer of the unit is listed on the current California Department of Transportation (Caltrans) Qualified Products List (QPL) for signal monitors.

Provide a Signal Monitor that is capable of monitoring sixteen channels consisting of a Green input, a Yellow input, and a Red input for each channel. Ensure that the unit also includes the enhanced monitoring functions described in [Subsection 925.2.01.A.15.b](#), diagnostic display functions described in [Subsection 925.2.01.A.15.c](#), event logging functions described in [Subsection 925.2.01.A.15.d](#), communications functions described in [Subsection 925.2.01.A.15.e](#), and hardware functions described in [Subsection 925.2.01.A.15.f](#).

b. Monitor Functions

Except for Conflict faults, compute all fault timing for each channel individually.

1) Conflict Monitoring

Ensure that the Signal Monitor is able to detect the presence of conflicting green or yellow signal voltages on the AC field terminals between two or more non-compatible channels. A Conflict fault (CONFLICT) shall be a latching fault.

2) Conflict Recognition Time

Ensure the Signal Monitor shall triggers when voltages on any conflicting channels are present for more than 500 ms. Ensure that the Signal Monitor does not trigger when voltages on any conflicting channels are present for less than 200 ms. Conflicting signals sensed for more than 200 ms and less than 500 ms may or may not trigger the unit.

3) 24VDC Monitoring VDC

Ensure that the Signal Monitor is able to detect that the cabinet +24 Vdc supply has fallen below 18 Vdc. A 24VDC failure (VDC FAIL) shall be a latching fault.

4) 24VDC Recognition Time

Ensure that the Signal Monitor shall triggers when the voltage on the +24V input is below 18 Vdc for more than 500 ms. Ensure that the Signal Monitor does not trigger when the voltage on the +24V input is below 18 Vdc for less than 200 ms. A voltage level of +22 Vdc will be required to prevent the unit from triggering.

5) Controller Watchdog Monitoring

Ensure that the Signal Monitor triggers when the Watchdog input does not toggle within the programmed time period (WDT ERROR). Ensure that the unit remains latched in the fault state until reset by the Reset button, an External Reset input command, or AC Line voltage restoring from a AC Line Brownout event (see 2.4). Ensure that a reset resulting from an AC Line Brownout event does not clear the WDT ERROR LED.

6) Controller Watchdog Latch Option

Ensure a programming option sets the Watchdog monitoring function to a latching mode and that only a reset from the Reset button or External Reset input can clear a Watchdog fault. An AC Line brownout condition will not reset the fault.

7) Controller Watchdog Recognition Time

Ensure a programming option sets the maximum Watchdog recognition time to 1000 ± 100 ms or 1500 ± 100 ms.

8) Controller Watchdog Enable Switch

Provide an internal switch to disable the Watchdog monitoring function. Mount the switch on the PCB and be clearly label "WD ENABLE - ON...OFF". Ensure that placement of the switch in the OFF position causes monitoring of the Watchdog to be inhibited.

9) WDT ERROR LED Control

Ensure that the WDT ERROR LED illuminates when the unit has been triggered by a Watchdog fault. Ensure that it can only be cleared by a reset command from the front panel Reset switch or External Reset input. If the Watchdog monitoring function is inhibited due to the Watchdog Enable switch, the WDT ERROR LED shall flash at a 0.5 Hz rate.

10) AC Line Monitoring

a) AC Line Brownout Recognition

Ensure that the Signal Monitor is able to detect that the AC Line has fallen below 98 ± 2 Vac for greater than 400 ± 50 ms. This shall force the output Relay to the de-energized "fault" state, enable the Stop-Time output, and cause the AC POWER LED to flash at a 2 Hz rate. Ensure that the unit maintains this state until the AC Line voltage rises above 103 ± 2 Vac for greater than 400 ± 50 ms. Provide a jumper option which will change the AC Brownout dropout level to 92 ± 2 Vac and the restore level to 98 ± 2 Vac.

b) AC Line Power-up and Brownout Delay Time

When the AC Line is greater than 103 ± 2 volts after power-up or Brownout restore, ensure that the Signal Monitor holds the Output Relay in the de-energized "fault" state and enable the Stop-Time output, for a period of not less than 6.0 ± 0.5 seconds and not greater than 10.0 ± 0.5 seconds. Ensure that this flash interval is terminated after at least 6.0 ± 0.5 seconds if the Signal Monitor has detected at least five transitions of the Watchdog input. If the Signal Monitor does not detect five transitions of the Watchdog input before 10.0 ± 0.5 seconds, ensure that the Signal Monitor goes to the fault state. During this interval, ensure that the AC POWER LED flashes at a 4 Hz rate.

c) Red Fail Monitoring

Ensure that the Signal Monitor is able to detect the absence of an active voltage on the green and yellow and red field signal inputs of a channel. Red Fail fault (RED FAIL) shall be a latching fault. Ensure that the Red Fail monitoring function is enabled for all channels except when the Red Enable input is not active, or pin #EE is active, or Special Function #1 input is active, or Special Function #2 input is active.

d) Red Fail Recognition Time

Ensure the Signal Monitor triggers when an active voltage on one of the three inputs of a channel are absent for more than 1500 ms. Ensure that the Signal Monitor does not trigger when an active voltage on one of the three inputs of a channel are absent for less than 1200 ms. Channels without proper voltages sensed for more than 1200 ms and less than 1500 ms may or may not trigger the unit. Provide an option switch (RF 2010) which will change the fault recognition time to between 700 ms and 1000 ms.

e) Red Interface Cable Fault

Ensure a programming option is provided such that operating without the Red Interface cable installed shall cause the Signal Monitor to enter the fault mode causing the Output relay contacts to close and enabling the Stop-Time output to the controller. To indicate this fault mode, ensure that the Red Fail indicator is illuminated with all fault channel indicators Off.

Ensure that any Red Fail preemption control to the monitor uses the Special Function inputs #1 or #2.

f) Dual Indication Monitoring

Ensure that the Signal Monitor is able to detect the presence of active voltage on the green and yellow, green and red, or yellow and red field signal inputs of a channel. GYR Dual Indication fault (DUAL IND) shall be a latching fault. Ensure this function is enabled on a per channel basis using dip switches mounted on the PCB labeled "CH1" through "CH16". Ensure that the GYR Dual Indication monitoring function is enabled for all selected channels except when the Red Enable input is not active or pin #EE is active.

g) GY Dual Indication Monitoring

Ensure that the Signal Monitor is able to detect the presence of active voltage on the green and yellow field signal inputs of a channel. GY Dual Indication fault (DUAL IND) shall be a latching fault. Enable this function with a dip switch on the PCB labeled "GY ENABLE". When the switch is in the ON position, monitor all channels for simultaneous active green and yellow inputs on a channel. When selected by the GY ENABLE switch, ensure that the GY Dual Indication monitoring function is disabled when pin #EE is active.

h) Dual Indication Recognition Time

Ensure that the Signal Monitor triggers when multiple inputs are active on a channel for more than 500 ms. Ensure that the Signal Monitor does not trigger when multiple inputs are active on a channel for less than 250 ms. Channels with multiple voltages active for more than 250 ms and less than 500 ms may or may not trigger the unit.

i) Sequence (Short or Absent Yellow) Monitoring

Ensure that the Signal Monitor is able to detect that a channel has not provided an adequate Yellow Clearance interval during a green to yellow to red sequence. A Sequence failure (SEQUENCE) shall be a latching fault. Ensure that this function is enabled on a per channel basis using dip switches mounted on the PCB labeled "CH1" through "CH16". Ensure that the Sequence monitoring function is enabled for all selected channels except when the Red Enable input is not active or pin #EE is active.

j) Sequence Recognition Time

The minimum Yellow Clearance interval may be modified by switches mounted on the PCB labeled "YEL TIME 1", "YEL TIME 2", and "YEL TIME 3". Ensure that the Yellow Clearance interval is 2.7 seconds plus 0.2 seconds times the binary sum of the three switches. The minimum Yellow Clearance interval shall therefore have a range of 2.7 seconds to 4.1 seconds, ± 0.1 seconds.

k) Recurrent Pulse Detection (RP Detect)

Ensure that the Signal Monitor detects Conflict, Red Fail, and Dual Indication faults that result from intermittent or flickering field signal inputs. These recurring pulses shall result in a latching fault with the RP DETECT indicator illuminated along with the resulting Conflict, Red Fail, or Dual Indication indicator. Provide an option switch to disable the RP detect function.

l) Configuration Change Monitoring

On power-up, reset, and periodically during operation, ensure that the Signal Monitor compares the current configuration settings with the previously stored value and if the settings have changed, the Signal Monitor automatically logs the new setting. Ensure that these settings include the permissive diode matrix, all switches, all jumpers, and the Watchdog Enable switch.

Provide a programming option such that any change in the configuration parameters will cause the Signal Monitor to enter the fault mode causing the Output relay contacts to close

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and enabling the Stop-Time output to the controller. To indicate this fault mode ensure that the PCA indicator will flash at a 4 Hz rate. Depressing the Reset button for 5 full seconds is required to clear this fault and log the new configuration parameters.

If the programming option is not selected, ensure that the unit does not set the fault mode but will still log the configuration change.

m) Program Card Ajar

Ensure that when the Programming Card is removed or not seated properly, the Signal Monitor forces the Output Relay to the de-energized "fault" state, enable the Stop-Time output, and illuminate the PCA LED. A reset command from the front panel Reset switch or External Reset input is required once the Program Card is in place.

n) Exit Flash

When the Signal Monitor exits the flash state (Output relay de-energized) as a result of a Reset command or AC Line brownout restore, ensure that the Stop Time output goes to the inactive state 250 ± 50 ms before the Output relay transfers to the energized state. This transition will provide an early indication to the Controller Unit that the cabinet will transfer from flash to signal operation.

c. Display Functions

Ensure that it is possible to view the active channels for each individual color (GYR) during operation and when latched in a fault state. When the Signal Monitor is latched in a fault state ensure that it is also possible to view the active channels for each individual color and fault status for each channel for the current fault and the two previous faults.

1) Previous Fault GYR Display

When the Signal Monitor has been triggered by a fault the channel status display will alternate between the channels which were involved in the fault (fault status) for 2 seconds, and the field signals active at the time of the fault for 6 seconds. The channels involved in the fault will flash their respective Green, Yellow, and Red indicators simultaneously at a 4 Hz rate for the 2 second interval.

The two previous faults may be also be displayed individually. This status is not reset by an AC Line power interruption. To enter this display mode remove the Program Card. The sequence is as follows:

<u>Reset</u>	<u>Event</u>	<u>PCA LED</u>	<u>Fault Status LEDs</u>	<u>Channel Status LEDs</u>
---	#1	Single flash	Current Fault Status (newest)	Current Field status
#1	#2	Double flash	Event #2 Fault Status	Event #2 Field status
#2	#3	Triple flash	Event #3 Fault Status (oldest)	Event #3 Field status
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d. Event Logging Functions

Ensure that the Signal Monitor is capable of storing in non-volatile memory a minimum of 100 events. Mark each event with the time and date of the event. These events consist of fault events, AC Line events, reset events, and configuration change events. Provide a graphical means of displaying the signal states of all field inputs for 30 seconds prior to a fault trigger event. Provide the capability to assign a four-digit identification number to the unit shall be provided. Upload the event logs to a PC using the serial port of the Signal Monitor and software provided by the manufacturer.

Ensure each event log report contains the following information:

- Monitor ID#: a four digit (0000-9999) ID number assigned to the monitor.
- Time and Date: time and date of occurrence.
- Event Number: identifies the record number in the log. Event #1 is the most recent event.

1) Monitor Status Report (CS)

Ensure the Current Status report contains the following information:

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- a) Fault Type: the fault type description.
 - b) Field Status: the current GYR field status and field RMS voltages if the monitor is not in the fault state, or the latched field status and field RMS voltages and fault channel status at the time of the fault.
 - c) Cabinet Temperature: the current temperature if the monitor is not in the fault state, or the latched temperature at the time of the fault.
 - d) AC Line Voltage: the current AC Line voltage if the monitor is not in the fault state, or the AC Line voltage at the time of the fault.
 - e) Control Input Status: the current state and RMS voltages of the Red Enable input, EE input, and Special Function #1 and #2 inputs if the monitor is not in the fault state, or the status latched at the time of the fault.
- 2) Previous Fault Log (PF)
- Ensure the Previous Fault log contains the following information:
- a) Fault Type: the fault type description.
 - b) Field Status: the latched field status with RMS voltages, and fault channel status at the time of the fault.
 - c) Cabinet Temperature: the latched temperature at the time of the fault.
 - d) AC Line Voltage: the AC Line voltage at the time of the fault.
 - e) Control Input Status: the latched state of the Red Enable input, EE input, and Special Function #1 and #2 inputs at the time of the fault.
- 3) AC Line Event Log (AC)
- The AC Line log shall contain the following information:
- a) Event Type: describes the type of AC Line event that occurred.
 - Power-up—AC on, monitor performed a cold start
 - Interrupt—AC Line < Brownout level
 - Restore—AC restored from brown-out or interruption (AC Off), no cold start
 - b) AC Line Voltage: the AC Line voltage at the time of the event.
- 4) Monitor Reset Log (MR)
- Ensure the Monitor Reset log contains the following information:
- a) The monitor was reset from a fault by the front panel Reset button or External Reset input.
- 5) Configuration Change Log (CF)
- Ensure the Configuration Change log contains the following information:
- a) Program Card Matrix: the permissive programming for each channel.
 - b) Yellow Disable Jumpers: the Yellow Disable programming for each channel.
 - c) Dual/Sequence Switches: the switch programming for each channel.
 - d) Option Switches: RF 2010, RP Disable, GY Enable, SF1 Polarity, Sequence Timing, Minimum Flash Enable, Configuration Fault Enable, Red Cable Fault enable, AC Brownout timing.
 - e) Watchdog Programming: Watchdog Enable, Watchdog Latch, and Watchdog timing.
 - f) Configuration CRC: A unique CRC value which is based on the configuration of items #a through #e above.
- Indicate on the log, which items have been changed since the last log entry.
- 6) Signal Sequence Log
- Provide a log that graphically displays all field signal states for up to 30 seconds prior to the current fault trigger event. Ensure that the resolution of the display is at least 50 milliseconds.

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- e. Communications Functions
 - 1) Controller Unit Communications

Ensure that the Signal Monitor is compatible with the Command/Response protocol of BI Tran Systems Inc. Model 233 Software. Ensure the unit supports command types 02 and 07.
 - 2) Personal Computer Communications

Have the manufacturer provide software to access the Signal Monitor status and event logs described in [Subsection 925.2.01.A.15.d](#). Ensure this software operates with Microsoft Windows 9x™ or Windows NT™
- f. Hardware
 - 1) Red Monitoring
 - a) Red Field Inputs

Ensure that the Signal Monitor is capable of monitoring sixteen Red field signals. Ensure that a Red input is sensed active when the input voltage exceeds 70 Vrms. Ensure that a Red input is sensed not active when the input voltage is less than 50 Vrms. A Red input may or may not be sensed active when the input voltage is between 50 Vrms and 70 Vrms.
 - b) Red Enable Input

Ensure that the Red Enable input provides an AC input to the unit which enables Red Monitoring, Dual Indication Monitoring, and Sequence monitoring when the input is sensed active.

Ensure that the Red Enable input is sensed active when the input voltage exceeds 70 Vrms. Ensure that the Red Enable input is sensed not active when the input voltage is less than 50 Vrms. The Red Enable input may or may not be sensed active when the input voltage is between 50 Vrms and 70 Vrms.
 - c) Special Function Preemption Inputs

Ensure that the Special Function Preemption inputs #1 and #2 provide an AC input to the unit which disables only Red Fail Monitoring (Lack of Output) when either input is sensed active.

Ensure that a Special Function input is sensed active when the input voltage exceeds 70 Vrms. Ensure that a Special Function input is sensed not active when the input voltage is less than 50 Vrms. A Special Function input may or may not be sensed active when the input voltage is between 50 Vrms and 70 Vrms.

Use a PCB mounted switch to provide the option to invert the active status of the Special Function #1 input. When the switch is in the ON position, ensure that the Special Function #1 input is sensed not active when the input voltage exceeds 70 Vrms. Ensure that the Special Function #1 input is sensed active when the input voltage is less than 50 Vrms. The Special Function #1 input may or may not be sensed active when the input voltage is between 50 Vrms and 70 Vrms.
 - d) Red Interface Connector

This connector provides the required inputs for the unit to monitor the Red field signal outputs. Ensure the connector is a 3M #3428-5302 type or equivalent and be polarized to insure proper mating with the cable. Ensure Ejector latches are included to facilitate removal and prevent the cable from inadvertently disconnecting. Ensure the unit shall function as a standard 210 Signal Monitor when the cable is disconnected. Use the pin assignments shown in Table 1.

Table 1

Pin	Function	Pin	Function
1	Channel 15 Red	11	Channel 9 Red
2	Channel 16 Red	12	Channel 8 Red

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3	Channel 14 Red	13	Channel 7 Red
4	Chassis Ground*	14	Channel 6 Red
5	Channel 13 Red	15	Channel 5 Red
6	Special Function #2	16	Channel 4 Red
7	Channel 12 Red	17	Channel 3 Red
8	Special Function #1	18	Channel 2 Red
9	Channel 10 Red	19	Channel 1 Red
10	Channel 11 Red	20	Red Enable
*A jumper option shall be provided to allow the connection of Pin #4 to be made with Chassis Ground.			

2) Front Panel

Ensure the front panel is constructed of sheet aluminum with a minimum thickness of 0.090 in. (2.286 mm), and finished with an anodized coating. Ensure the model information shall be permanently displayed on the front surface.

a) Indicators

Ensure that all display indicators are mounted on the front panel of the Signal Monitor and are water clear, T-1 package, Super Bright type LEDs. Ensure that all fault LEDs are red except the AC POWER indicator which is green. Provide a separate Red, Yellow, and Green indicator for each channel. Label the indicators and provide the information as follows:

(1) AC POWER

Ensure the AC Power indicator flashes at a rate of 2 Hz when the unit has detected a low voltage condition as described in [Subsection 925.2.02.A.15.b.10\).a](#). Ensure the AC POWER indicator flashes at a rate of 4 Hz during the minimum flash interval as described in [Subsection 925.2.02.A.15.b.10\).b](#). Ensure that the indicator illuminates when the AC Line voltage level is restored above the brownout level. Ensure the indicator extinguishes when the AC Line voltage is less than 80 Vac.

(2) VDC FAILED

Ensure the VDC FAILED indicator illuminates when a 24VDC fault condition is detected. This indicator remains extinguished if the monitor has not been triggered by a 24VDC fault.

(3) WDT ERROR

Ensure the WDT ERROR indicator illuminates when a controller Watchdog fault is detected. Ensure the WDT Error indicator flashes ON once every 2 seconds if the WD Enable switch on the monitor is placed in the OFF position to disable Watchdog monitoring, or the AC Line voltage is below the Watchdog disable level.

(4) CONFLICT

Ensure that the CONFLICT indicator illuminates when a conflicting proceed signal fault is detected.

(5) DIAGNOSTIC

Ensure the DIAGNOSTIC indicator illuminates when one of the following faults are detected: Internal Watchdog fault, Memory Test fault, or Internal power supply fault. This indicator is intended to inform the service technician of a monitor hardware or firmware failure.

(6) RED FAIL

Ensure the RED FAIL indicator illuminates when an absence of signal is detected on a channel(s).
 Ensure the RED FAIL indicator flashes ON once every two seconds if the RED ENABLE input is not active, or a Special Function input is active, or the EE input is active

(7) DUAL IND.

Ensure the Dual IND. indicator illuminates when a GY-Dual or GYR-Dual Indication fault is detected on a channel(s).

(8) SEQUENCE

Ensure the Sequence indicator illuminates when the minimum Yellow Clearance time has not been met on a channel(s).

(9) PCA

Ensure the PCA indicator illuminates if the Program Card is absent or not properly seated.

If the unit is in the Diagnostic Display mode, ensure the PCA indicator flashes ON (once, twice, or three times) to indicate the fault event number being displayed. See [Subsection 925.2.01.A.15.c](#).

(10) RP DETECT

Ensure the RP DETECT indicator illuminates when the unit has detected a Conflict, Red Fail, or Dual Indication fault as a result of recurring pulse field inputs.

(11) CHANNEL STATUS

Ensure that during normal operation the 48 Channel Status indicators displays all active signals (Red, Green, and Yellow).

In the fault mode, ensure that the Channel Status indicators display all signals active at the time of the fault for six seconds and then indicate the channels involved in the fault for 2 seconds.

b) Front Panel Control

(1) RESET Button

Provide a momentary SPST Control switch labeled RESET on the unit front panel to reset the monitor circuitry to a non-failed state. Position the switch on the front panel such that the switch can be operated while gripping the front panel handle. Ensure that a reset command issued from either the front panel button or External Reset input is a one-time reset input to prevent the unit from constant reset due to a switch failure or constant external input, and causes all LED indicators to illuminate for 300 ms.

The Reset button also provides control of the Diagnostic Display mode. For a complete description of Diagnostic Display operation, see [Subsection 925.2.01.A.15.c](#).

c) Serial Communications Connector

Use this connector to provide EIA-232 serial communications. Ensure that it is an AMP 9721A or equivalent 9 pin metal shell D subminiature type with female contacts. Refer to Table 2 for Pin assignments.

Table 2

Pin	Function
1	DCD*
2	TX DATA
3	RX DATA
4	DTR (Data Terminal Ready)
5	SIGNAL GROUND

6	DSR
7	DSR*
8	CTS*
9	NC
* Provide Jumper options to allow the connection of Pin #4 to be made with Pin #7, and the connection of Pin #8 to be made with Pin #1.	

3) Electronics

a) RMS Voltage Sampling

Use high speed sampling techniques to determine the true RMS value of the AC field inputs. Sample each AC input at least 32 times per cycle. Ensure that the RMS voltage measurement is insensitive to phase, frequency, and waveform distortion.

b) Internal MPU Watchdog

Use a microprocessor for all timing and control functions. Verify continuing operation of the microprocessor by an independent monitor circuit, that forces the Output Relay to the de-energized "fault" state, enable the Stop-Time output, and illuminate the DIAGNOSTIC indicator if a pulse is not received from the microprocessor within 300 ms.

If the microprocessor should resume operation, ensure the Signal Monitor continues to operate. Ensure that this monitoring circuit is also configurable to latch in the fault state. Ensure the unit requires a power-up cycle to reset the circuit once it is triggered.

c) Sockets

In the interest of reliability, ensure that only the PROM memory device for the microprocessor firmware is socket mounted. Ensure that the PROM memory socket is a precision screw machine type socket with a gold contact finish providing a reliable gas tight seal. Low insertion force sockets or sockets with "wiper" type contacts are not acceptable.

d) Internal Power Supply

Use a built-in, high-efficiency switching power supply to generate all required internal voltages. Ensure that all supply voltages regulated. Failure of the internal power supply to provide proper operating voltages shall force the output Relay to the de-energized "fault" state, enable the Stop-Time output, and illuminate the DIAGNOSTIC indicator. Provide a user replaceable slow blow fuse for the AC Line input. Ensure the unit is operational over the AC Line voltage range of 75 Vac to 135 Vac.

e) EIA-232 Interface

Ensure the EIA-232 port interface electronics is electrically isolated from all monitor electronics except chassis ground.

f) Configuration Parameters

Select user-programmed configuration settings using PCB mounted switches or jumpers. Designs requiring a Personal Computer (PC) to program or verify the configuration parameters are not acceptable. Ensure that user-programmed configuration settings that are transferred to memory are stored in a programmable read-only memory (PROM or EEPROM). Designs using a battery to maintain configuration data are not acceptable.

g) Field Terminal Inputs

Ensure that all 120 Vac field terminal inputs provide an input impedance of 150K \pm 50K ohms and be terminated with a discrete resistor having a power dissipation rating of 0.5 Watts or greater and a voltage rating exceeding 350 volts.

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h) Component Specifications

Ensure that all electrical components used in the Signal Monitor are rated by the component manufacturer to operate beyond the full unit operating temperature range of -29°F to 165°F (-34°C to $+74^{\circ}\text{C}$).

i) Printed Circuit Boards

Ensure that all printed circuit boards meet the requirements of the *California Traffic Signal Control Equipment Specifications*, January 1989, plus the following requirements to enhance reliability:

- (1) All plated-through holes and exposed circuit traces are plated with solder.
- (2) Both sides of the printed circuit board are covered with a solder mask material.
- (3) The circuit reference designation for all components and the polarity of all capacitors and diodes are clearly marked adjacent to the component. Ensure that Pin #1 for all integrated circuit packages is designated on both sides of all printed circuit boards.
- (4) All electrical mating surfaces are gold plated.
- (5) All printed circuit board assemblies are coated on both sides with a clear moisture-proof and fungus-proof sealant.
- (6) All components and wire harnesses are mounted to the PCB using plated holes. "Piggy back" connections or jumper wires are not acceptable.

16 Model 242 DC Isolator

Provide Model 242 DC Isolators that are in accordance with the latest version of CALTRANS Specifications as referenced earlier in this section.

17. Model 200 Switchpack

Provide Model 200 Switchpacks that are in accordance with the latest version of CALTRANS Specifications as referenced earlier in this section.

18. Model 204 Flasher Unit

Provide Model 204 Flasher Units that are in accordance with the latest version of CALTRANS Specifications as referenced earlier in this section.

19. Flash Transfer Relay

Provide Flash Transfer Relays that are in accordance with the latest version of CALTRANS Specifications as referenced earlier in this section.

20. Cabinet Model 332A

Provide Cabinet Model 332A that meets the CALTRANS Specification with the addition of surge protection as detailed in [Table 925-1 Model 332A Default Input Files Assignment Detail](#) and [Table 925-2 Required Surge Arrestors for Model 332A Cabinet](#).

Supply Model 332A (lower input panel) cabinets, with housing Type 1B, and all components as described in these specifications.

Supply cabinets having two input files which conform to the CALTRANS Specifications and configured to accept two 2070 controllers in the top portion of the cabinet.

Configure the cabinet for dial up communications. Mount a two (2) circuit Buchanan connector on the right side panel (from rear door).

Mount a phone jack with a RJ11 connector above or to the right of the Buchanan terminal block.

Wire the phone jack to the Buchanan and to the Terminal Block (TB0) in accordance with [Figure 925-1](#).

21. Cabinet Model 336S (Base Mount)

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This unit meets the CALTRANS Specification with the addition of approximately 6 additional inches (150 mm) of cabinet height exclusive of the "M" base adapter. Configure the internal component layout so that the additional space is available in the bottom area of the cabinet cage. Ensure that the field wiring input panels and surge protection conform to [Table 925-3 Model 336 Default Input File Assignment Detail](#) and [Table 925-4 Required Surge Arrestors for Model 336 Cabinet](#).

22. Cabinet Model 336 (Pole Mount)

Ensure that this unit meets the requirements of [Subsection 925.2.02.A.21](#) above, except that the cabinet is configured for pole mounting as specified in the General Requirements for Type 170 Cabinet Assemblies.

23. Cabinet Model 336 (Base Mount with Auxiliary Output File)

Ensure that this unit meets the requirements of [Subsection 925.2.02.A.21](#) above, except that the cabinet is configured with an Auxiliary Output File. Additionally, the field wiring terminals may be mounted on the rear of the input file.

24. Cabinet Model 337

The Model 337 cabinet is a compact cabinet with an output capacity of four vehicle phases plus two pedestrian phases; the dimensions not to exceed 17 inches (425 mm) deep x 20 inches (500 mm) wide x 35 inches (875 mm) high and its shipping weight not to exceed 175 pounds (80 kg).

Supply the cabinet assembly with capacity for 11, two-channel slots in the input file.

Ensure that the pin assignments of the C1 connector are compatible with the 2070 controller as applicable according to the required number of input/outputs.

Ensure that the 337 cabinet uses standard Type 2070 input and output file units.

Equip the cabinet with a C2 connector harness with field terminals protected with surge protectors for communication inputs as specified under communications inputs.

Ensure that the cabinet has two full-size doors to allow complete access from the front or back of the cabinet.

Design the rack assembly to mount in CALTRANS standard rails to allow for a Model 204 flasher.

Provide a receptacle to accept the plug in power distribution assembly card guides and edge connectors for the input file card guides to support the conflict monitor, and load switches and flash transfer relays.

Due to the compact design of this cabinet assembly, the Department of Transportation may accept a non-standard type of power distribution assembly (PDA).

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Table 925 – 1 Model 332 Default Input Files Assignment Detail

<i>Slot</i>		<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>	<i>11</i>	<i>12</i>	<i>13</i>	<i>14</i>	
Upper Input File (I)	<i>Type</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>			<i>DC</i>	<i>DC</i>	<i>DC</i>	
	<i>Channel 1</i>	<i>CI Pin</i>	56	39	63	47	58	41	65	49	60		80	67	68	81
		<i>Function</i>	φ1	φ2	φ2	φ2 CALL	φ3	φ4	φ4	φ4 CALL	φ1			φ2 PED	φ6 PED	FLASH
		<i>Field Term</i>	TB-2 1,2	TB-2 5,6	TB-2 9,10	TB-4 1,2	TB-4 5,6	TB-4 9,10	TB-6 1,2	TB-6 5,6	TB-6 9,10			TB-8 4,6	TB-8 7,9	NC
	<i>Channel 2</i>	<i>CI Pin</i>	56	43	76	47	58	45	78	49	62		53	69	70	82
		<i>Function</i>	φ1	φ2	φ2	φ2 CALL	φ3	φ4	φ4	φ4 CALL	φ3			φ4 PED	φ8 PED	STOP TIME
		<i>Field Term</i>	TB-2 3,4	TB-2 7,8	TB-2 11,12	TB-4 3,4	TB-4 7,8	TB-4 11,12	TB-6 3,4	TB-6 7,8	TB-6 11,12			TB-8 5,6	TB-8 8,9	NC
	Lower Input File (J)	<i>Slot</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>	<i>11</i>	<i>12</i>	<i>13</i>	<i>14</i>
		<i>Type</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>			<i>TBA</i>	<i>TBA</i>	<i>DC</i>
<i>Channel 1</i>		<i>CI Pin</i>	55	40	64	48	57	42	66	50	59		54	71	72	51
		<i>Function</i>	φ5	φ6	φ6	φ6 CALL	φ7	φ8	φ8	φ8 CALL	φ5			EVA	EVB	R/R
	<i>Field Term</i>	TB-3 1,2	TB-3 5,6	TB-3 9,10	TB-5 1,2	TB-5 5,6	TB-5 9,10	TB-7 1,2	TB-7 5,6	TB-7 9,10			TB-9 4,6	TB-9 7,9	TB-9 10,12	

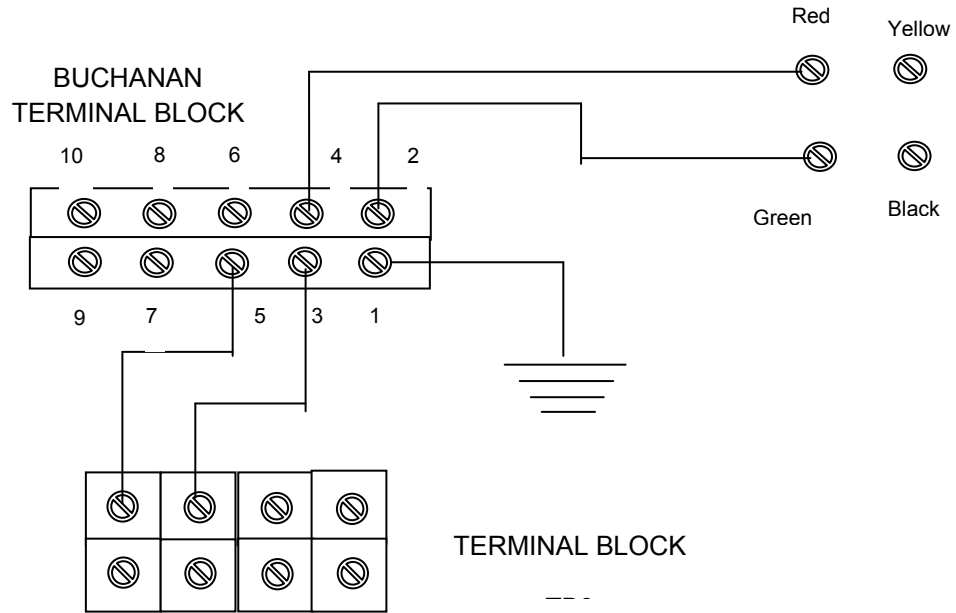
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<i>Channel 2</i>	<i>CI Pin</i>	55	44	77	48	57	46	79	50	61		75	73	74	52
	<i>Function</i>	φ5	φ6	φ6	φ6 CALL	φ7	φ8	φ8	φ8 CALL	φ7			EVC	EVD	
	<i>Field Term</i>	TB-3 3,4	TB-3 7,8	TB-3 11,12	TB-5 3,4	TB-5 7,8	TB-5 11,12	TB-7 3,4	TB-7 7,8	TB-7 11,12			TB-9 5,6	TB-9 8,9	TB-9 11,12

Table 925-2 Required Surge Arrestors for Model 332 Cabinet

<i>Field Terminal Block</i>	<i>Terminals</i>	<i>Required Arrestor</i>
TB-8	1-12	EDCO PC642C-030 plug in arrestors in PCB1B Terminal Block
TB-9	10-12	EDCO PC642C-030 plug in arrestors in PCB1B Terminal Block
TB-9	4-9	EDCO PCB1B Terminal Block only
TB-2, TB-3, TB-4, TB-5, TB-6, TB-7	1-12	EDCO SRA-6LB

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Note: For a typical signal installation, the Model 332 cabinet is the design standard.

Figure 925-1—Wiring Diagram for Dial-up Communications

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Table 925-3 Model 336 Default Input File Assignment Detail															
<i>Slot</i>		<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>	<i>11</i>	<i>12</i>	<i>13</i>	<i>14</i>
<i>Type</i>		<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>Det</i>	<i>DC</i>	<i>TBA</i>	<i>TBA</i>	<i>DC</i>	<i>DC</i>	<i>DC</i>
Channel 1	<i>CI Pin</i>	56	39	58	41	55	40	57	42	51	71	72	67	68	81
	<i>Function</i>	φ1	φ2	φ3	φ4	φ5	φ6	φ7	φ8	SE1	EVA	EVB	φ2 PED	φ6 PED	FLASH
	<i>Field Term</i>	TB-7 1,2	TB-7 5,6	TB-7 9,10	TB-8 1,2	TB-8 5,6	TB-8 9,10	TB-9 1,2	TB-9 5,6	TB-5 1,2	TB-5 5,6	TB-5 9,10	TB-4 1,2	TB-4 5,6	NC
Channel 2	<i>CI Pin</i>	47	43	49	45	48	44	50	46	52	73	74	69	70	82
	<i>Function</i>	φ2 CALL	φ2	φ4 CALL	φ4	φ6 CALL	φ6	φ8 CALL	φ8	R/R	EVC	EVD	φ4 PED	φ8 PED	STOP TIME
	<i>Field Term</i>	TB-7 3,4	TB-7 7,8	TB-7 11,12	TB-8 3,4	TB-8 7,8	TB-8 11,12	TB-9 3,4	TB-9 7,8	TB-5 3,4	TB-5 7,8	TB-5 11,12	TB-4 3,4	TB-4 7,8	NC

Table 925-4 Required Surge Arrestors for Model 336 Cabinet		
<i>Field Terminal Block</i>	<i>Terminals</i>	<i>Required Arrestor</i>
TB-4	1-12	EDCO PC642C-030 plug in arrestors in PCB1B Terminal Block
TB-5	1-4	EDCO PC642C-030 plug in arrestors in PCB1B Terminal Block

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TB-5	5-12	EDCO PCB1B Terminal Block only
TB-7, TB-8, TB-9	1-12	EDCO SRA-6LB

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B. Fabrication

Refer to [Subsection 925.2.03.A.1](#) for controller cabinet minimum fabrication specifications.

C. Acceptance

Refer to [Subsection 925.2.01.A](#) for compliance with CALTRANS QPL.

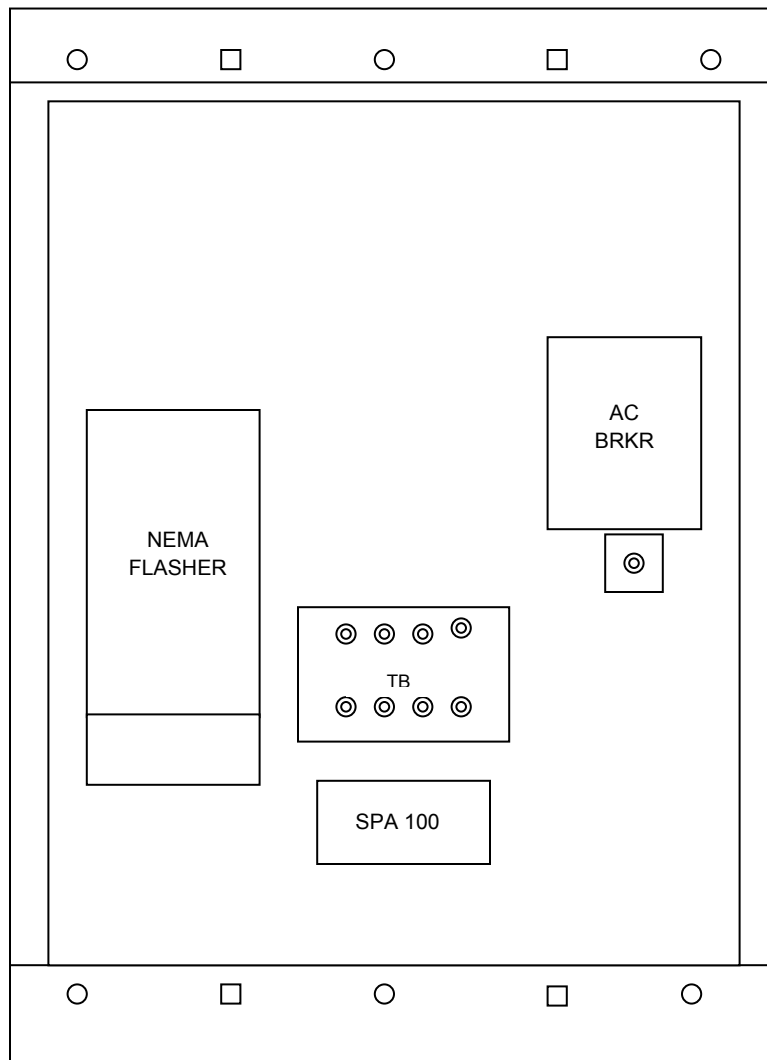
D. Materials Warranty

Refer [Subsection 925.2.D](#) for Materials Warranties.

925.2.03 Flashing Beacon Assembly

A. Requirements

This specification is for a flashing signal cabinet, which consists of an aluminum cabinet containing a flasher assembly, Field connection terminal block, surge arrestor and circuit breaker wired in a manner to operate flashing beacons. Refer to [Figure 925-2](#).



Note: Front view of cabinet Door Assembly not shown

No scale

Figure 925-2—Typical Flashing Signal Cabinet Layout

1. Cabinet

Supply a NEMA Type 3R cabinet assembly, manufactured of aluminum with a minimum thickness of 0.125 inches (3 mm).

Ensure that the cabinet exterior has a smooth, uniform “bare” aluminum finish with all joints between adjoining cabinet components (sides and bottom) continuously welded on the outside to prevent the intrusion of moisture and dust.

Ensure that all welds are free of cracks, blow holes and other irregularities.

Supply a cabinet with the following exterior dimensions:

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	<u>Minimum</u>	<u>Maximum</u>
Height	14 inches (350 mm)	18 inches (450 mm)
Width	10 inches (250 mm)	14 inches (350 mm)
Depth	7 inches (175 mm)	10 inches (250 mm)

Use a cabinet door that is double flanged on all four sides to prevent the entry of dirt and liquids when the door is open.

Install a one-piece gasket formed around the door opening to insure a weather tight seal when the door is secured.

Attach the door to the cabinet housing by a continuous tamper proof hinge.

Equip each cabinet with a Corbin #2 lock and one key. Police panel type locks are not acceptable.

Install an aluminum back panel in the cabinet, mounted on standoffs, to facilitate mounting of internal components.

Install exterior aluminum mounting brackets, which extend a minimum of 1.75 inches (44 mm) and a maximum of 2.5 inches (63 mm) from the top and bottom of the cabinet.

Use brackets that extend across the full width of the cabinet back on the top and bottom.

Provide these brackets with holes for mounting to a flat surface with screws and vertical slots for banding to steel, concrete or wooden signal poles.

2. Flasher Unit

Supply a standard plug in two circuits NEMA flasher.

Ensure that the flasher is of all solid state construction, meets the requirements of the NEMA standards and is rated at a minimum of 10 A per circuit.

Ensure that the flasher utilizes zero voltage turn-on and turn-off current and is capable of dimming outputs.

3. Surge Arrestor

Supply a flasher cabinet that incorporates an AC surge arrestor (EDCO SPA-100 or equivalent) to protect the internal components from lightning and over voltages on the AC service input.

The requirements for the surge arrestor are:

Peak Surge Current	15000 A
Peak Surge Voltage @ 10KA	680 V
Energy Handling	220 J
Power Dissipation Rate	1.5 W maximum
Continuous AC Voltage	130 V AC RMS
Initial Breakdown (1mA)	212 V
Typical Capacitance	4000 pF
Operating Temp.	-40 °F to 185 °F (-40 °C to 85 °C)

4. Circuit Breaker

Include a 15 A circuit breaker in the cabinet. (Square D QOU 115 Series or equivalent).

5. Terminal Block

Include a four position terminal block in the cabinet for making field connections. Properly label all field terminal connections.

6. Construction

Assemble the flasher assembly, terminal block, surge arrestor and circuit breaker in the cabinet as shown on the attached drawing.

Wire all components together as a working unit, thus requiring only field connections to and from the AC power and flashing beacons.

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B. Fabrication

Refer to [Subsection 925.2.03.A.1](#) for controller cabinet minimum fabrication specifications.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.04 Flashing Signal Cabinet With Time Clock

A. Requirements

This specification is for a flashing signal cabinet with time clock which consists of an aluminum cabinet containing a flasher assembly, time clock, field connection terminal block, surge arrestor and circuit breaker wired in a manner to operate school flashing beacons. Refer to [Figure 925-3](#).

1. Cabinet

Supply a NEMA Type 3R cabinet assembly that is manufactured of aluminum with a minimum thickness of 0.125 inches (3 mm).

Ensure that the cabinet exterior has a smooth, uniform natural aluminum finish, and that all joints between adjoining cabinet components (sides and bottom) are continuously welded on the outside to prevent the intrusion of moisture and dust.

Ensure that all welds are free of cracks, blow holes and other irregularities.

The exterior dimensions of the cabinet are as follows:

	<u>Minimum</u>	<u>Maximum</u>
Height	14 inches (350 mm)	18 inches (450 mm)
Width	10 inches (250 mm)	14 inches (350 mm)
Depth	7 inches (175 mm)	10 inches (250 mm)

Supply a cabinet door that is double flanged on all four sides to prevent the entry of dirt and liquids when the door is open.

Use a one-piece gasket that is formed around the door opening to insure a weather tight seal when the door is secured.

Attach the door to the cabinet housing with a continuous tamper proof hinge.

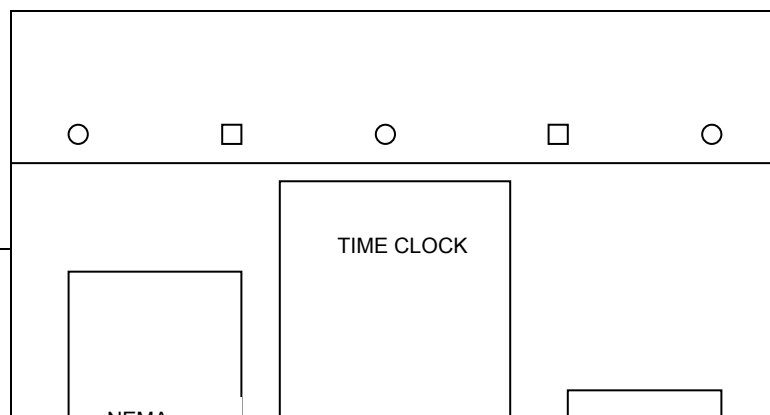
Provide each cabinet with a Corbin #2 lock and one key. Police panel type locks are not acceptable.

Supply each cabinet with an aluminum back panel mounted on standoffs to facilitate mounting of internal components.

Supply cabinets with exterior aluminum mounting brackets, which extend a minimum of 1.75 inches (44 mm) and a maximum of 2.5 inches (63 mm) from the top and bottom of the cabinet.

Use brackets that extend across the full width of the cabinet back on the top and bottom.

Provide these brackets with holes for mounting to a flat surface with screws and vertical slots for banding to steel, concrete or wooden signal poles.



Note: Front view of cabinet Door Assembly not shown

No scale

Figure 925-3—Typical Flashing Cabinet with Time Clock Cabinet Layout

2. Flasher Unit

Supply a standard plug in, two circuits NEMA flasher.

Ensure that the flasher is of all solid state construction, meets the requirements of the NEMA standards and is rated at a minimum of 10 A per circuit.

Ensure that the flasher utilizes zero voltage turn-on and turn-off current and be capable of dimming outputs.

3. Time Switch

Supply a time switch that meets the requirements of [Subsection 925.2.05](#) of this specification.

4. Surge Arrestor

Supply flasher cabinets that incorporate an AC surge arrestor (EDCO SPA-100 or equivalent) to protect the internal components from lightning and over voltages on the AC service input.

The requirements of the surge arrestor are as follows:

Peak Surge Current	15000 A
Peak Surge Voltage @ 10KA	680 V
Energy Handling	220 J

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Power Dissipation Rate	1.5 W maximum
Continuous AC Voltage	130 V AC RMS
Initial Breakdown (1mA)	212 V
Typical Capacitance	4000 pF
Operating Temp.	-40 °F to 185 °F (-40 °C to 85 °C)

5. **Circuit Breaker**

Include a 15 A circuit breaker in each cabinet. (Square D QOU 115 Series or equivalent).

6. **Terminal Block**

Include a four position terminal block in each cabinet for making field connections. Properly label all field terminal connections.

7. **Construction**

Assemble the flasher assembly, terminal block, surge arrestor and circuit breaker in the cabinet as shown on the attached drawing.

Wire all components together as a working unit, thus requiring only field connections of the AC power and flashing beacons.

B. Fabrication

Refer to [Subsection 925.2.03.A.1](#) for controller cabinet minimum fabrication specifications.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.05 Time Clock

A. Requirements

Supply time clocks that are single circuit, calendar programmable, solid state, fully self-contained units (RTC AP 21 or equivalent) that meet the following specifications:

1. Alphanumeric liquid crystal display.
2. Automatic daylight savings time and leap year compensation. Changes in the daylight savings time program made through the keypad and not requires hardware modification.
3. Minimum twenty-four (24) hour capacitive back up. Battery back up is not acceptable.
4. Keypad entry programming without the use of any external devices such as a PC, external programming unit, another time switch, etc.
5. Operate on 95 to 135 V AC, 60 Hz line current.
6. SPDT relay output rated at 15 A.
7. Maximum size of 4 inches (100 mm) wide, 8 inches (200 mm) high and 2 inches (50 mm) deep.
8. A programming manual is to be included with each unit.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.06 Self Tuning Loop Detector

A. Requirements

This specification sets forth the minimum acceptable design, operational and functional performance requirements for multi-channel, inductive loop vehicle detection systems.

1. General Requirements

a. Mounting

Ensure that the unit is configured for rack mount insertion into a NEMA (TS 1 or TS 2) card rack and/or CALTRANS Type 2070 cabinet input file.

b. Environmental

Ensure that the unit is in full compliance with the environmental tests, transient tests and size requirements of NEMA standard TS-1 Section 15, TS-2 Section 6.5 and the California Type 2070 specifications.

Provide documentation from an independent laboratory, which certifies that the unit is in compliance with the above specifications.

c. LED Indicator

Ensure that each channel includes two high visibility LED indicators; one for the detect state and the second to indicate the status of the fault monitor.

d. Phase Indicator

Ensure that each channel has an erasable write-on pad to aid in identification of the associated phase or function.

2. Operational Requirements

a. Tuning

Supply units that are fully digital and self-tuning.

Ensure that each channel of the unit can automatically tune to any loop and lead in combination within two (2) seconds of application of power or when a reset signal is received.

Ensure that the tuning circuit is designed so that drift, caused by environmental changes or changes in applied power, does not cause false actuation's.

b. Scanning

Supply units that sequentially scan each channel (only one channel energized at any given time) to eliminate crosstalk from multiple loops in adjacent lanes and/or allow overlapped loops for directional control and/or allow use of multi-conductor homerun cable when connected to the same detector unit.

c. Sensitivity Setting

Ensure that each channel is equipped with front panel selectable sensitivity settings in presence and pulse modes.

d. Frequency

Supply units that have a minimum of three switch selectable operating frequencies.

e. Inductance Range

Ensure that each channel can tune to an inductive load from 50 to 2000 microhenries with a Q factor > 5.

f. Grounded Loops

Ensure that each channel can continue to operate with poor quality loop systems ($Q > 2$) including those that have a single point short to ground.

g. Fault Monitoring

Supply units that constantly monitor the operation of each channel.

Ensure that the unit detects shorted loops, open circuit loops or sudden changes in inductance (>25% of nominal).

Ensure that each type of fault is indicated on a fault LED by a unique sequence of flashes until the fault is rectified.

Ensure that while the channel is in the fault condition, the channel output remains in the detect state.

When the fault is rectified, the fault LED continues to emit the sequence signifying the last fault detected, but the detect LED and output returns to normal operation.

h. Failsafe Output

Ensure that each channel output generates a continuous solid state output to the controller when power to the detector is removed.

i. Operational Modes

Supply units with each channel selectable for either pulse or presence modes and that meet the following requirements:

- Pulse Mode

This setting provides a single output pulse (125 ms +/- 25) in response to a vehicle entering the loop.

If a vehicle remains in the sensing zone in excess of two (2) seconds, the unit "tunes out" said vehicle.

The channel is then capable of detecting another vehicle entering the same detection zone.

- Presence Mode

The presence hold time is a minimum of four (4) minutes for small vehicles (motorcycles) and a minimum of sixty (60) minutes for automobiles.

Ensure that the unit tunes out of continuous peak hour traffic over long or multiple small loops as long as there is vehicle motion in the sensing zone every ten (10) minutes.

j. Resets

Ensure that the channels are manually resettable by removing the power momentarily.

Ensure that the channels reset remotely when the voltage on Pin C falls below 8 V DC for a period > 15 μ s, and that the unit resumes normal operation within four (4) seconds after the application of power or after a reset signal of 15 μ s.

k. Field Tuning

Ensure that field adjustments to the operation of the detector do not require the use of a meter, circuit changes, special software or any substitutions, modifications or additions to the unit.

3. Performance Requirements

If testing should be required, provide the Department with a test unit and/or software within ten (10) calendar days of the request.

Should the unit fail to meet the design and/or performance requirements of this specification, the unit will be rejected.

Ensure that the units meet the following requirements:

- a. Capable of detecting passage, holding presence and accurately counting all types of licensed motor vehicles when connected in various loop configurations and lead-in combinations without detecting vehicles in adjacent lanes.

Typical Loop Configurations with Lead-in of 5 feet (1.5 m) to 1,500 feet (1000 m) are:

6 feet x 6 feet (1.8 m x 1.8 m)

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6 feet x 20 feet (1.8 m x 6 m)

6 feet x 40 feet [(1.8 m x 12 m) standard or quadrupole]

- b. Capable of responding to an inductance change of 0.02% and sense vehicles at speeds of up to 80 mph (130 km/h).
- c. Not detect vehicles, moving or stopped, at distances greater than three feet for any loop perimeter.
- d. Detect all vehicles over multiple turn and/or multiple loops that may be connected in series, parallel or series/parallel with homerun lengths from <5 feet (1.5 m) to > 1,500 feet (1,000 m).

4. Optional Features

In addition to the requirements listed in the previous sections, the units may be requested with any combination of the following optional features:

a. Option 1- Timing Features - Delay & Extension

When this option is specified, ensure that the unit incorporates the following features:

- Delay Timing
Minimum selectable delay time of 1 to 30 seconds in minimum 1-second increments for each channel.
- Extension Timing
Minimum selectable extension time of 0.5 to 10 seconds in minimum 0.5-second increments for each channel.

b. Option 2 - Advanced Features

When the option for advanced features is specified, supply units that incorporate the following advanced features:

- Serial Port Interface
When the serial port interface is specified, equip the detector with a front and rear panel RS 232 port for the transmission of data. Provide Windows 95 compatible software for interfacing with the detector.
- PC Interface
Ensure that PC software, when connected directly to the unit through the front panel RS 232 port, provides a screen to display the following loop system operating characteristics, on a per channel basis, for system setup, data collection and diagnostics.
 - * Loop Status
 - * Loop Inductance (μH)
 - * Loop Frequency (kHz)
 - * Inductance Change (nH)
 - * Last Fault: Open, Shorted, >25% ΔL
 - * Fault Occurrence: Date & Time
 - * Vehicle Count
- Speed, Volume & Occupancy
The software, when connected directly to the unit, is capable of collecting and storing speed, volume and occupancy data from each detector channel.
The software allows assignment of loop-to-loop distances to enable accurate speed and vehicle length measurements.
The speed volume and occupancy information is uploaded and stored in the vendor-supplied software.
Upon request, supply the necessary information/protocols to allow the Department to write custom software to retrieve speed, volume and occupancy data.

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B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.07 Loop Sealant

A. Requirements

Furnish and install loop sealant according to [Subsection 833.2.09, “Polyurethane Sealant for Inductive Loops”](#). For a list of sources, see [QPL 75](#).

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.08 Vehicle Signal Heads

A. Requirements

Supply vehicle signal heads that are 12 inches (300 mm) in diameter.

Ensure that the 12 inch (300 mm) polycarbonate vehicle signal heads meet the current ITE specification on Vehicle Traffic Control Signal Heads with the following modifications and / or clarifications:

1. Unless otherwise approved by the Engineer or as noted on the Plans, supply signal heads with the following exterior color scheme:
 - Signal Housing - Highway Yellow.
 - Front Face including Doors and Visors: Flat Black
2. Ensure that the reflector is the ALZAK type and hinged to the housing to prevent movement when the door is opened. Ensure that the construction of the reflector allows it to be opened for wiring inspection.
Lamps are not to be included with signal heads unless otherwise approved.
3. Terminate the wiring from each signal section in the top section of the head assembly.
4. Provide adjustable focus sockets that are supported so as to allow rotation.
5. Spring cushion mount the reflector holder to absorb vibration and to provide an effective seal against the silicon lens gasket.
6. Mount one aluminum reinforcing support plate in the top of the red section of each three-section signal head for the installation of mounting hardware.
7. Install a support plate between each section of all signal heads. Place these plates such that there is a plate in the bottom of and/or top of any sections where sections adjoin to another section.
8. Supply signal heads that accommodate a maximum of 150 W, 120-V lamps.

B. Fabrication

Refer to ITE Standards for material composition and finish specifications.

C. Acceptance

Refer to ITE Standards for material composition, finish specifications, and wind loading requirements.

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D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.09 Pedestrian Signal Head

A. Requirements

Provide each section with a visor encompassing the top and sides of the signal face of a size and shape adequate to shield the lens from external lighted sources.

An acceptable option is a “Z-crate” or louver type visor for mounting over the pedestrian signal face.

Construct the housing door, door latch, and hinges of aluminum, or approved equal.

Provide hinge pins of stainless steel.

Ensure that the door is provided with a neoprene gasket capable of making a weather resistant, dustproof seal when closed. Unless otherwise specified by the Engineer, supply pedestrian signal heads with a black face and a yellow body.

Ensure that pedestrian indications are distinguishable to the pedestrian both day and night and at all distances from 10 feet (3 m) to the full width of the areas to be crossed.

Supply pedestrian indications that are rectangular in shape and consist of the "HAND & PERSON" symbol.

Use symbols that are 12 inches (300 mm) high. Use only internal illumination.

Ensure that when illuminated, the “HAND” symbol is Lunar White and the “PERSON” symbol is Portland Orange, meeting the ITE standards. Ensure that an opaque material obscures all areas of the face or lens, except for the message.

Ensure that when not illuminated, the symbols are not to be distinguishable by pedestrians at the far end of the crosswalk they control.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.10 Traffic Signal Lamps

A. Requirements

Supply Traffic Signal Lamps that meet the current ITE Specification.

Ensure the Traffic Signal Lamps supplied for Vehicle Signal Heads are a minimum of 135 W and a maximum of 150 W.

Ensure the Traffic Signal Lamps supplied for Pedestrian Signal Heads are 69 W only.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.11 Optically Programmed or High Visibility Signal Head

A. Requirements

Supply signal heads that permit the visibility zone of the indication to be determined optically and require no hoods or louvers.

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The projected indication may be selectively visible or veiled anywhere within 15 degrees of the optical axis.

Ensure that no indication results from external illumination and that one light unit does not illuminate a second. The components of the optical system include the lamp, lamp collar, optical limiter-diffuser, and objective lens.

Ensure that the optical system accommodates projection of diverse, selected indications to separate portions of the roadway such that only one indication will be simultaneously apparent to any viewer.

Ensure that the projected indication conforms to ITE transmittance and chromaticity standards.

1. Construction

- a. Ensure that the lamp is nominal 150 W, 120 V AC, three prongs, and sealed beam having an integral reflector with stippled cover and an average rated life of at least 6,000 hours.

Couple the lamp to the diffusing element with a collar including a specular inner surface. The diffusing element may be discrete or integral with the convex surface of the optical limiter.

- b. Supply an optical limiter with an accessible imaging surface at focus on the optical axis for objects 900 to 1,200 feet (270 to 360 m) distance and permit an effective veiling mask to be variously applied as determined by the desired visibility zone.

Ensure that the optical limiter is provided with positive indexing means and is composed of heat-resistant glass.

- c. Ensure that the objective lens is a high-resolution planar incremental lens hermetically sealed within a flat laminate of weather resistant acrylic or approved equal.

Supply a lens that is symmetrical in outline and that may be rotated to any 90-degree orientation about the optical axis without displacing the primary image.

2. Mounting

- a. Supply signals that mount to standard 1.5 inch (38 mm) fittings as a single section, as a multiple section face, or in combination with other signals.

Provide signal sections with an adjustable connection that permits incremental tilting from 0 to 10 degrees above or below the horizontal while maintaining a common vertical axis through couplers and mounting.

Ensure that terminal connections permit external adjustment about the mounting axis in 5-degree increments.

- b. Ensure that the signal is mountable with ordinary tools and capable of being serviced with no tools.

Supply attachments such as back plates or adapters that conform and readily fasten to existing mounting surfaces without affecting water and light integrity of the signal. Supply heads with tri-studs for mounting.

3. Electrical

Supply lamp fixtures that comprise a separately accessible housing and integral lamp support indexed ceramic socket and self-aligning, quick release lamp retainer.

Ensure that electrical connection between case and lamp housing can be accomplished with an interlock assembly, which disconnects lamp holder when opened. Include a covered terminal block for clip or screw attachment of lead wires for each signal section.

Use concealed No. 18 AWG, stranded and coded wires to interconnect all sections to permit field connection within any section.

4. Photo Controls

Ensure that each signal includes integral means for regulating its intensity between limits as a function of the individual background illumination.

Ensure that lamp intensity is not less than 97% of uncontrolled intensity at 10 750 lux, and reduces to 15 + 2% of maximum at less than 10.75 lux.

Ensure that response is proportional and essentially instantaneous to any detectable increase of illumination from darkness to 10 750 lux, and damped for any decrease from 10 750 lux.

Section 925—Traffic Signal Equipment

Ensure that the intensity controller is comprised of an integrated, directional light sensing and regulating device interposed between lamp and line wires.

Ensure that it is compatible with 60 Hz input and responsive within the range 105 to 135 V AC.

Output may be phase controlled, but ensure that the device provides nominal terminal impedance of 1,200 Ω open circuit and a corresponding holding current.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.12 Vehicle Signal Head Lens

A. Requirements

Ensure that the vehicle signal head lens conforms to current ITE standards.

Unless specified in the plans, supply 12 inch (300 mm) lenses of the type and color specified in the plans.

Lenses may be constructed from polycarbonate plastic or glass.

Supply lenses of the concave/convex type with the convex side smooth and the concave side fluted for the purpose of properly directing the light rays.

Ensure that the lenses are clearly marked to indicate the maximum wattage of the lamp to be used and the orientation of the lens for proper installation purposes.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.13 LED Vehicle Modules and LD Pedestrian Signals

A. Requirements

This specification covers Type 1 and Type 2 Light Emitting Diode (LED) red, green and yellow modules for vehicle signals. It also covers LED pedestrian “HAND & PERSON ” signal modules.

1. General Requirements

- a. Ensure that Type 1 LED signal modules fit in standard incandescent vehicle traffic signal housings.

Ensure that Type 1 LED signal module include a LED circuit board with LEDs and required circuit components, 36 inch (900 mm) 16 AWG wire leads with strain relief and spade terminals, a rigid housing, and a one piece neoprene gasket.

Supply lenses for Type 1 ball modules that are made of ultraviolet stabilized polycarbonate or glass, and incorporate facets to enhance the optical efficiency of the LED traffic signal module.

Ensure that the external lens surface for all vehicle signals is smooth, with no raised features, to minimize the collection of dirt, diesel smoke, and other particulate contaminates, and to facilitate periodic cleaning.

Supply Type 1 LED signal modules that are watertight when mounted in traffic signal housing.

Ensure that the Type 1 LED signal modules utilize the same mounting hardware that is used to secure the incandescent lens and gasket assembly.

Ensure that the housing of Type 1 LED signal modules have prominent and permanent markings to designate the proper orientation of the LED signal module in the traffic signal housing.

The marking consists of an up arrow, or the word “Up” or “Top”.

Supply lenses that are keyed to the housing of the LED signal module to insure the proper orientation.

- b. Ensure that the Type 2 LED signal modules are designed to mount in the standard lamp socket normally used with an incandescent lamp.

When a Type 2 LED signal module is used, provide a standard lens in the doorframe to seal the signal section from the weather.

Supply Type 2 LED signal modules that do not require any modification to the standard lamp socket or reflector.

Supply Type 2 LED signal modules that do not require a specific mounting orientation or have a variance in light output, pattern or visibility for any mounting orientation.

Ensure that Type 2 LED signal modules are a sealed unit containing all components necessary for operation except the corresponding lens mounted in the doorframe.

- c. Ensure that the LED pedestrian signal modules fit in standard incandescent pedestrian signal housings.

Supply LED pedestrian signal modules with all hardware and gaskets necessary for installation and to achieve a watertight enclosure.

Supply stand-alone pedestrian “HAND” LED signal kits that are Portland Orange and have a filled-in figure symbol.

Ensure that combination “HAND & PERSON” LED Pedestrian signal modules incorporate a Lunar White walking person symbol.

The “HAND & PERSON” symbol may be an outline type symbol, and to insure color compliance with existing Lunar White standards for pedestrian walking person pedestrian signals, includes a replacement lens for the existing OEM lens.

Ensure that the “HAND & PERSON” symbols are overlaid on top each other so that the illuminated image appears to be in the middle of the signal housing.

2. Optical

Ensure that the light intensity and distribution from LED signal modules and pedestrian signals, as a minimum, meet the current ITE and current Caltrans standards and measurement criteria for LED traffic signal modules.

Provide test data from an independent laboratory to verify that the performance of the product meets current ITE requirements.

Ensure that the light output of all LED vehicle signal modules and LED pedestrian signal kits meet current ITE specifications for chromaticity.

Ensure that the individual LEDs are wired such that a catastrophic failure of one LED will result in the loss of not more than 5% of the signal module light output.

The failure of a single LED in a string causes loss of light from only that LED, not the entire string or indication.

Provide control circuitry that prevents the current flow through the LEDs in the “off” state to avoid any false indications as may be perceived by the human eye during daytime and nighttime hours.

Ensure that the LED traffic signal module is operationally compatible with NEMA TS – 1 and NEMA TS – 2 conflict monitoring parameters.

Ensure that the intensity of the LED signal module does not vary by more than 10% over the allowable voltage range as specified in the electrical section below.

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Ensure that the LED signal modules maintain not less than 90% of the required intensity, as defined by the July 1998 ITE intensity standards for LED traffic signal modules.

Ensure this over the temperature range of -40°F to 165°F (-40°C to $+74^{\circ}\text{C}$) at 120 V AC, when new and after four (4) years of field installation.

3. Electrical

Supply LED signal modules that operate over the temperature range of -40°F to 165°F (-40°C to 74°C).

Ensure that the power factor is 90% or greater, at nominal rated voltage, at 77°F (25°C), after 60 minutes of operation.

Ensure that the total harmonic distortion (THD) is less than 20% at rated voltage, at 77°F (25°C) and that all LED traffic signal modules are in compliance with FCC noise regulations.

Supply Red, Yellow, and Portland Orange LEDs that utilize AlInGaP technology, either AS (Absorbing Substrate) or TS (Transparent Substrate), and do not exhibit degradation of more than 30% of their initial light intensity following accelerated life testing (operating at 185°F [85°C] and 85% humidity, for 1,000 hours).

AlGaAs technology is not acceptable.

Supply green LEDs that utilize gallium nitride technology.

Ensure that the LED signal modules operate on line voltage, 120 V AC nominal, and are able to operate over the voltage range of 80 V AC to 135 V AC.

Supply Red Arrow LED traffic signals that are temperature compensated so as to maintain intensity at elevated temperatures.

Supply red arrow type LED traffic signals that are tested and documented as being in compliance with Caltrans intensity standards for red arrows at elevated temperatures.

Provide transient voltage suppression rated at 1,500 W for 1 millisecond and fusing with a maximum rating of 2 A to minimize the effect and repair cost of an extreme over voltage situation or other failure mode.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Ensure that LED traffic signal modules and LED pedestrian modules are performance warranted to be in compliance with July 1998 ITE and Caltrans minimum intensity standards for LED traffic signal modules, measured at 120 V AC and 165°F (74°C), for a period of three (3) years.

Ensure that the manufacturer's name, part number, date code, and electrical characteristics of the LED signal module is visible on the assembly, and that each LED signal module is identified for warranty purposes.

925.2.14 Blank-Out Signs

A. Requirements

Ensure that each sign provides a clearly visible and definable legend for 500 feet with ample safety factors.

Provide hardware to mount the sign on standard 1.5 inch (38 mm) pipe brackets or to mount directly to signal mast arms or span wire.

Supply blank-out signs faces 30 inches x 36 inches (750 mm x 900 mm) that are capable of displaying one message at a time in one direction.

1. Case

Use a case formed from aluminum extrusion F1-6-E and a special aluminum door frame angle.

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For Alloy 6063-T5, ensure that the wall is at least 0.075 inches thick and the corners and joints are at least 0.080 inches (2 mm) thick.

Use filler arc for all welding.

Ensure that the corner radii of both case and door are approximately 3 inches (75 mm).

Use a BR-type take-apart door hinge and draw bolt. Furnish one P-15 1.5 inch (38 mm) hub on the top surface.

Prime the entire case with zinc chromate, bake the inside with two coats of non-yellowing white, and paint the outside with two coats of highway yellow.

2. Electrical

Provide fluorescent illumination with 8 F-36-T12-CW/HO fluorescent bi-pin lamps fired by two 4-lamp ballasts, 90% power factor corrected, 120 V AC. This provides approximately 25% additional lumen output for HO lamps.

Ensure that the glass fiber-optic blank-out signs meet the requirements in the Specifications for lane use control signals. Obtain approval for messages and letter dimensions from the Engineer.

3. Sun Phantom Screen

Attach to each sign a heavy-duty aluminum louver-type sun phantom screen covering the entire sign face. Slant the louvers down enough to eliminate the sun glare without obstructing the view of the sign face.

4. Painting

Paint the signal surfaces, inside and out, with two coats of oven-baked enamel in addition to the primer coat. Paint the non-illuminated portions of the signal face black. Paint the housings, brackets, fittings, and etc. highway yellow.

5. Lens

Use a fabricated, three-section plexiglass lens clear face, with or without legend, that can accept a silk-screened legend on the first surface. Provide a thickness of at least 0.31 inches (8 mm).

6. Legend

Acceptable legends are as follows:

NO LEFT TURN

NO RIGHT TURN

SIGNAL AHEAD

NO TURNS

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.15 Lane-Use Control Signal

A. Requirements

Ensure that all signals are glass fiber optic and conform to current ITE standards. Supply all signals with the necessary mounting hardware to provide for mounting as shown on the plans. Provide mounting for one way or two way configurations.

1. General Requirements

a. Weight

Ensure that one-way units weigh not more than 50 pounds (23 kg) and two-way units weigh not more than 60 pounds (27 kg), regardless of messages.

b. Color

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Ensure that the color of lane-use control signal indications is clearly visible for 0.25 mile (0.38 km) at all times under normal atmospheric conditions. Provide lane-use control signals with a visibility angle of a minimum of 60 degrees.

c. Housing

Ensure that the housing of each signal is polycarbonate or a one-piece corrosion resistant aluminum alloy die casting or equal and meets current related ASTM specifications.

Ensure that all configurations are balanced to provide a plumb hanging unit. Ensure that all components are readily and easily accessible from the open door.

d. Housing door

Ensure that the housing door is one-piece corrosion resistant aluminum or polycarbonate and meets current related ASTM specifications.

Provide two substantial door hinges with stainless steel hinge pins. Ensure hinges are on the left side of each section with a latch boss on the right side.

Provide stainless steel dual eye bolt latches or similar approved devices to securely close and latch the housing door. Equip the housing or door with a continuous molded neoprene gasket to make the interior of the unit dustproof and waterproof.

e. Wiring

Provide each signal housing with a complete terminal board. Ensure that one side of terminal strip accommodates socket leads and the other side accommodates field wires. Ensure that the terminal board provides totally separate wiring of each symbol.

Ensure each lamp is separately wired to a terminal block located in each housing. Provide each lamp holder socket with color-coded leads.

For combination symbols, color-code socket leads separately to distinguish between red “X”, yellow “X” or downward arrow symbols. Provide leads that are No. 14 AWG type THW, 600 V AC, and fixture wire with 194 °F (90 °C) thermoplastic insulation.

f. Visors

Provide visors not less than 12 inches (300 mm) long for multiple unit and 7 inches (175 mm) long for single unit signals for each signal face.

Ensure that the visors are constructed of sheet aluminum or polycarbonate and encompass the top and sides of each section.

g. Painting

Paint all signal surfaces, inside and out, with two coats of oven baked enamel in addition to the primer coat. Paint the insides of the visors flat black.

The non-illuminated portions of the signal face black or dark gray and all housings, brackets and fittings highway yellow.

h. Hardware and fittings:

Supply all necessary fittings, pipe brackets, hangers, hubs, etc. for the type of mounting specified.

i. Sun -phantom screen

Provide each signal face with a screen, which substantially counteracts sun phantom effect.

2. Signal Display

Ensure that the symbols, which are on an opaque black or dark gray background, meet ITE requirements and are blacked out when not illuminated.

3. Fiber Optical System

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- a. Ensure that the glass fiber optic illuminating system consists of a legend illuminated by glass fiber optic bundles transmitting light to the arranged signal legend. Refer to [Section 935](#) - Fiber Optic Cable Design Criteria.
- b. Ensure that each separate color indication in a sign face is illuminated by an independent pair of 12 V AC, 50 W, MR-16, ENL quartz halogen lamp with an average lamp life of 4,000 hours. Additional pairs of 50 W lamps, as required by legend size, or at the discretion of the manufacturer, will be allowed.
Use transformers to operate these lamps that output 10.8 V AC with load applied. Ensure that the glass fiber bundle which illuminates a given color indication is constructed such that adjacent fibers in the bundle receive their light input from separate lamps of the pair used to illuminate that specific color indication.
- c. Ensure that the green arrow indication does not utilize the same termination points as any "X" indication.
Provide indicators near the bottom of each sign face to indicate the status of each lamp utilized for that face. These indicators are to emit light of the same color as the sign face indication, which utilizes the same lamp. Angle these indicators downward at approximately 30 degrees and place them as not to interfere with the visibility or discernibility of the sign face indications.
- d. Ensure that total power required for any single indication does not exceed 250 W.
- e. Ensure that all lamps are contained behind a water tight signal face or lens assembly.
- f. Ensure that the entire optical system is weatherproof and is not vulnerable to extremes in temperature or moisture.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.16 Pedestrian Push Button Station

A. Requirements

Ensure that pedestrian push buttons are of tamperproof construction and consist of a direct push type button and single momentary contact switch in a cast metal housing.

Finish the housing with baked enamel and paint the push button housing and pedestrian heads highway yellow (unless otherwise specified by the Engineer).

Ensure that any screws or bolts are stainless steel. Provide the unit with a 0.5 inch (13 mm) threaded opening with plug.

Ensure that the assembly is weatherproof and so constructed that when properly installed, it will be impossible to receive an electrical shock under any weather condition. Ensure this item consists of Pelco hardware or approved equal.

Ensure that Pedestrian Pushbuttons are integrated with a sign as shown in the standard details. Ensure the proper size sign is used as indicated on the plans.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.17 Signal Head Back Plate

A. Requirements

Ensure that each back plate is designed to properly shield a traffic signal head from background distractions for better visibility.

Design the back plates to extend beyond the signal head to a minimum of 6 inches (150 mm) on all sides and have all corners rounded with minimum 2 inch (50 mm) radii.

Construct the back plates from aluminum, sheet metal, UV stabilized polycarbonate or, ABS plastic material with a finished color of flat black.

Ensure that polycarbonate back plates are at least 0.15 inches (4 mm) thick; ABS back plates are at least 0.05 inches (1 mm) thick and metal back plates are at least 0.05 inches (1 mm) thick.

Design the back plates with predrilled holes to provide for simple attachment to the specified brand, size and configuration of traffic signal head with all mounting hardware included.

Ensure that the back plates do not interfere with the signal mounting hardware. Ensure that the back plates include louvers.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.18 Signal Head Visors

A. Requirements

Typically, visors are one piece tunnel type and removable unless specified otherwise in the signal plans.

Ensure that visors are polycarbonate and at least 9 inches (225 mm) deep for 12 inch (300 mm) heads. Special angle visors are full circle with the long side at least 18 inches (450 mm) deep.

Unless otherwise specified by the Engineer, provide black signal head visors.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.19 Signal Head Louvers

A. Requirements

Ensure that louvers (with the vanes oriented vertically) are directional with a 7-degree cutoff right of center. Rotating the louver 180 degrees will produce a 7-degree cutoff left of center.

Provide twelve-inch (300 mm) louvers with 5 vanes. Finish all louvered surfaces in flat black. Ensure that programmable louvers are directional with a 7-degree cutoff and that all louver surfaces have a flat black finish.

Ensure that the units can be installed and programmed in accordance with the manufacturer's instruction on visors that are recommended by the manufacturer.

Have the programmable louver display approved by the Engineer prior to placing the signal in stop and go operation.

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B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.20 Hardware For Mast Arm Mounting

A. Requirements

Ensure that signal heads are rigidly mounted to the mast arm. Provide mounting hardware that is ASTRO-BRAC or similar.

This item will be approved upon submittal of catalog cuts. Refer to Standard Detail Drawings for additional information.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.21 Hardware For Signal Head Pole Mounting

A. Requirements

General Provisions 101 through 150.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Ensure that this item consists of Pelco 1.5 inch (38 mm) hardware or approved equal as shown in the standard details.

This item will be approved upon submittal of catalog cuts.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.22 Balance Adjuster

A. Requirements

General Provisions 101 through 150.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Ensure this item consists of Pelco or equivalent hardware. This item will be approved upon submittal of catalog cuts.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.23 Hardware For Mounting 12 Inch (300 mm) Pedestrian Head

A. Requirements

General Provisions 101 through 150.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

Ensure this item consists of Pelco or equivalent hardware. This item will be approved upon submittal of catalog cuts.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.24 Pedestal Pole

A. Requirements

The pedestal poles support vehicle signal heads, pedestrian signal heads, and push button. Furnish pedestal poles according to type and overall length.

1. Ensure that all poles are made of one continuous piece of bare finish aluminum from top to base connection for the entire height of the pole.

The shaft, of appropriate shape, may or may not be uniformly tapered from butt to tip. A pole used to support only a traffic signal may be tapered.

2. Fabricate pole caps, when required, of cast material, and secure in place with set-screws.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.25 Pedestal Pole Base

A. Requirements

Ensure that all design radii are smooth and intact. Ensure that the exterior surface finish is smooth and cosmetically acceptable by being free of molding fins, cracks and other exterior blemishes.

Fabricate from new aluminum ingot. Do not use scrap materials.

Minimum requirements are as follows:

ALUMINUM ALLOY NO.	319	ELONGATION [% IN 2 IN. (50 mm)]	2.5
TENSILE STRENGTH, KSI (MPa)	34 (234)	BRINELL HARDNESS	85
YEILD STRENGTH, KSI (MPa) (1600)	19 (131)	SHEAR STRENGTH, KSI (MPa)	232

1. Ensure this item consists of square cast aluminum with bare finish, and has a minimum weight of 21 pounds (9.5 kg). Thread the upper end to receive a 4 inch (100 mm) National Pipe Thread (NPT) pipe shaft.
2. Design the base so that it may be fastened to a foundation with four (4) 0.75 inch (19 mm) anchor bolts located 90 degrees apart on the bottom of the base.

Provide slots in the bottom of the base 1.5 inch (38 mm) wide and 2.5 inches (63 mm) long measured along the circumference of the bolt circle, allowing a proper fit even if the bolts are placed slightly off center.

3. Design the base to accommodate bolt circles of a minimum of 12 inches (300 mm) through a maximum of 14.5 inches (363 mm) and anchor bolts with a minimum of 0.63 inches (16 mm) through 1 inch (25 mm) diameter.

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4. Design the base with a removable plastic door. Ensure that the door opening is free of burrs and sharp edges and is no less than 8.5 inches (213 mm) square. Attach the door to the base using one socket button head screw to prevent unauthorized entry.
5. Ensure that the base meets or exceeds 1985 AASHTO breakaway requirements. Provide test reports from an FHWA approved independent laboratory certifying that the base has been tested and meets all applicable requirements. In addition, supply a statement of certification from the FHWA stating such tests have been accepted and approved.
6. In order to prove structural soundness, provide a certification from a recognized independent structural laboratory certifying that the base will withstand a bending moment of 10,750 ft-lbs (14 575 N-m).
7. Ensure that the door is injection molded from ABS plastic to deter vandalism and theft, and has the following properties:

TEST	<u>ASTM METHOD</u>	<u>VALUE</u>
Tensile @ Yield [0.13 inches (3 mm)]	D638	6600 psi (45 500 kPa)
Flexural @ Yield	D790	11,000 psi (75 850 kPa)
Rockwell Hardness	D785	101 (R Scale)
Notched Izod	D256	5 ft-lb./in. (0.03 N-m/mm)

8. Ensure that the door exhibits the following properties:
 - Has an edge thickness of 0.25 inches (6 mm) and a minimum thickness of 0.156 inches (4 mm)
 - Contains flame-retardant material, meeting or exceeding underwriters laboratories UL 94 test H.B
 - Gray aluminum tone in color, unless otherwise specified
 - Contains ultra-violet inhibitors and stabilizers for protection against UV degradation
 - Is injection molded with a smooth front finish
 - Has flat and straight surfaces without blisters, buckling or warping; have reinforcing ribs
 - Contains two (2) injection molded lugs on the bottom of the door with slots of the proper width and depth to fit the base door opening. ([Figure 925-2](#))
9. Supply the base with a set of four (4) anchor bolts, 0.75 inch (19 mm) diameter by 18 inches (450 mm) in length, material per ASTM A 572A 572M, Galvanized per ASTM A 153/A 153M. Supply (1) hex nut and (1) flat washer with each bolt.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

General Provisions 101 through 150.

925.2.26 Timber Poles

A. Requirements

Ensure that all timber poles meet the requirements of [Section 861](#). Poles must be inspected and tested by the GDOT Office of Materials and Research and hammer stamped by the inspector.

Ensure that all poles have a brand or stamp 10 feet (3 m) from the butt that notes the type wood, date of manufacture, manufacturer, class and length.

Ensure that all timber poles that have guy attachments or support spanwire or arms that suspend signal heads over the roadway or sidewalk are Class II.

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Poles that support loop lead-in, messenger or communications cable that does not have guy attachments may be Class IV size.

Ensure that all poles meet the requirements in the table below unless otherwise noted on the traffic signal plans or list of materials.

Class	Nominal Length, ft (m)	Minimum Circumference	
		At 6 feet (2.4 m) from butt, in. (mm)	
II	30 (9)	34.0 (850)	
II	35 (10.5)	36.5 (913)	
II	40 (12)	38.5 (963)	
II	45 (13.5)	40.5 (1013)	
II	50 (15)	42.0 (1050)	
IV	30 (9)	29.5 (738)	
IV	35 (10.5)	31.5 (788)	
IV	40 (12)	33.5 (838)	
IV	45 (13.5)	35.0 (875)	

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.27 Steel Strain Poles

A. Requirements

Ensure that steel strain poles conform to [Section 639](#) and include hardware for span wire attachments, anchor base, and anchor bolts for the purpose of supporting span wire suspended signs and/or signals.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.28 Pre-Stressed Concrete Strain Pole

A. Requirements

Ensure that Pre-stressed concrete strain poles for overhead signs and signal supports conform to [Section 500](#).

For signal supports, ensure that the opening at the top and bottom of the pole is large enough to allow all wiring into and out of pole. Do not strap conduit to strain pole because of insufficient opening allowances.

B. Fabrication

General Provisions 101 through 150.

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C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.29 Traffic Signal Pull Box

A. Requirements

Ensure that traffic signal pull boxes are based on a test load of 20,800 pounds (9455 kg) load over a 10 inch x 10 inch (250 mm x 250 mm) area. Ensure polymer concrete pull boxes are used. Supply polymer concrete covers satisfying the loading qualification with each pull or junction box. Furnish covers with the logo “TRAFFIC SIGNAL”.

Use Type 1 pull boxes [12 inches x 12 inches (300 mm x 300 mm)] for loop lead-ins. Use Type 2 or Type 3 pull boxes [11 inches x 18 inches (275 mm x 450 mm)] for cables other than loop lead-ins and splices. Use Type 4 and 5 pull boxes for fiber optic cable. Refer to the Standard Detail Drawings and the Traffic Signal Design Manual for further information.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.30 Prefabricated Controller Cabinet Base

A. Requirements

Ensure that prefab controller cabinet bases are designed to withstand wind loading of 100 mph (160 km/h) with a 332A cabinet mounted. Refer to Standard Detail Drawings for further information.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.31 Loop Lead-In Cable

A. Requirements

Ensure that loop detector lead-in cable, No. 14 AWG, stranded, 3-pair shielded cable meets IMSA specification #50-2-1984.

B. Fabrication

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General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.32 Encased Loop Detector Wire

A. Requirements

Ensure that encased loop detector wire, meets IMSA specification 50-2 and is 18 AWG, 3 pair stranded and twisted tin plated copper (TPC) conductor, with .015 (15 mils) polyethylene (PE) insulation for each conductor. Each pair shall be stranded with TPC drain wire and overall covered with aluminum Mylar shield.

Ensure that the outer jacket be .040 (40 mils), black ultra violet (UV) resistant, and that the cable is rated PE 300 V AC direct burial with a nominal outside diameter of .40 inches (10 mm).

Ensure that identification markings are stamped on the cable jacket.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.33 Aerial (Lashed) & Duct Signal Cable

A. Requirements

Ensure that aerial (lashed) or duct (conduit) No. 14 AWG, stranded, 4-conductor, with black polyethylene (PE) jacket and 600 V AC rating meets IMSA specification #20-1-1984. Use conductors that are straight, not twisted pairs.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.34 Self-Supporting Twisted Pair Aerial Signal Communications Cable

A. Requirements

Ensure that self-supporting, figure eight, aerial signal communications cable, No. 19 AWG, stranded 6-pair conductors is rated at 600 V AC and meet IMSA specification #20-4-1984.

Use conductors that are twisted pairs with copper tape shield under a black PE jacket. Ensure that messenger strand is 0.25 inch (6 mm), 7-strand and conforms to ASTM A 475 Siemens-Martin grade or better with a Class A coating.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.35 Underground Feeder Cable, Type UF

A. Requirements

Ensure that underground feeder cable, Type UF w/ground has two (2) conductors with pvc/nylon jacket and a minimum 600 V AC rating per UL #493. Two-conductor, No. 6 AWG wire may be used.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.36 Messenger & Guy Strand (Span Wire)

A. Requirements

Ensure that all messenger and guy strand (span wire) conforms to ASTM A 475 Siemens-Martin grade or better with a Class A coating, 7-wire span wire.

Ensure ¼-inch (6 mm) Messenger & guy strand shall be used to support interconnect cable or as tether spans.

Messenger & guy strand 0.31 inch (7 mm) shall be used only where it is essential to match an existing 0.31 inch (7 mm) span wire that will not be replaced as part of a new installation.

Ensure all span wire for signal heads, blank out sign, optically programmed heads, lane control signs, standard, aerial or sidewalk guys uses a minimum Messenger & guy strand 0.38 inch (9 mm) as a minimum size.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.37 Power Disconnect Box

A. Requirements

Ensure that all power disconnect boxes are Midwest Catalog U065P 240 V AC, 60 Amp Phase 1 (metal non-fused disconnect) or equivalent.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.38 Cable Ties

A. Requirements

Ensure that all cable ties are nylon, ultraviolet resistant black and consist of the following as a minimum:

Nominal Length	8 inches (200 mm)
Width	0.30 inches (7 mm)

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Tensile Strength 120 pounds (55 kg)

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.39 Guide Insulators

A. Requirements

Ensure that all guide insulators are Empire fiberglass strain insulators Series 500-24EE or equivalent.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.40 Universal Closure Kit

A. Requirements

Supply a Universal Signal Closure Kit to seal the signal head at either the top or bottom. Ensure that the kit will fit any manufacturer's signal head (top or bottom) without the use of special tools or modification.

1. Ensure that the Signal Closure Kit is a Pelco SE-3054 or equivalent.
2. Ensure that the gasket is 60-70 durometer neoprene.
3. Ensure that Closure Cap is injection molded ABS plastic. The plastic is to be loaded with UV stabilizers.
4. Ensure that Adapter Bar is made so that it will secure the closure cap and compensate for varying thickness of signal heads.
5. Provide two # 10 (9mm) screws to fit any manufacturer's signal head. Ensure that one screw is 0.75 inches (19 mm) in length and the second screw is 1 inch (25 mm) in length.
6. Pack each assembly in a clear plastic bag. Mark the bag with the manufacturer's name and part number. Include the Universal Signal Closure Kit in a package containing the span wire clamp and Tri-Stud wire entrance fitting.
7. Ensure that the Closure Cap is molded to closely match the color of the signal head (Federal Yellow). The adapter bar and screws are to be zinc plated steel.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.41 Cast Aluminum Span Wire Clamp

A. Requirements

Provide Pelco or equivalent Span Wire Clamps that are cast from Aluminum Alloy 713 or equivalent, free of voids, pits, dents, molding sand and excessive foundry grinding marks. Ensure that all design radii are smooth and intact.

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Provide an exterior surface finish that is smooth and cosmetically acceptable, free of molding fins, cracks and other exterior blemishes. Ensure that span wire clamps are fabricated from aluminum ingot with minimum requirements as follows:

ALUMINUM ALLOY No.	713
YIELD STRENGTH, ksi (MPa)	25 (172)
TENSILE STRENGTH, ksi (MPa)	35 (240)
BRINELL HARDNESS	75
ELONGATING [% in 2 inches (50 mm)]	3

1. Ensure that the Span Wire Clamp can accommodate cables 0.25 inch (6 mm) to 0.63 inch (16 mm) diameter.
2. Ensure that the weight is less than 1.75 pounds (0.8 kg) with hardware.
3. Ensure that the Span Wire Clamp have a minimum overall length of 7 inches (175 mm).
4. Ensure that the Span Wire Clamp have a centerline dimension from cable to clevis pin of 2 inches (50 mm) [+/- 0.5 inches (13 mm)].
5. Ensure that the Span Wire Clamp have a cast aluminum cable bar to protect the cable when tightening the U-bolts.
6. Ensure that the Span Wire Clamp have a mounting opening of 0.75 inches (19 mm) [+/- 0.03 inches (0.8 mm)].
7. Ensure that the Span Wire Clamp have 0.5 inch (13 mm) - 13 NPT U-bolts with 0.5 inch (13 mm) lockwashers and nuts.
8. Ensure that the clevis pin are 0.63 inch (16 mm) diameter with a length of 2.25 inches (56 mm) and secured with a hump back stainless steel cotter pin.
9. Ensure that the Clamp and Cable Bar have an Alodine 1200 conversion coating to help resist oxidation.
10. Ensure that the Clevis Pin and hardware are galvanized per ASTM 123/A 123M or stainless steel.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.42 Cast Aluminum Tri-Stud Span Wire Entrance Fitting

A. Requirements

Ensure that the Tri-Stud Span Wire Entrance Fittings are Pelco or equivalent cast from Aluminum Alloy 713 or equivalent, free of voids, pits, dents, molding sand and excessive foundry grinding marks.

Ensure that the all design radii are smooth and intact. Ensure that the exterior surface finish is smooth and cosmetically acceptable, free of molding fin, cracks and other exterior blemishes.

Ensure that the material is fabricated from aluminum ingot with minimum requirements as follows:

ALUMINUM ALLOY No.	713
YIELD STRENGTH, ksi (MPa)	25 (172)
TENSILE STRENGTH, ksi (MPa)	35 (240)
BRINELL HARDNESS	75
ELONGATION [% in 2 inches (50 mm)]	3

1. Ensure that the Tri-Stud Span Wire Entrance fitting has a mounting support at the top of the wire entrance 0.69 inches (17 mm) thick [+/- 0.07 inches (1.5 mm)].

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2. Ensure that the Tri-Stud Span Wire Entrance fitting weight is not less than 1.75 pounds (0.8 kg) with hardware.
3. Ensure that the mounting support has at least six (6) clevis openings for adjustment with suspension bracing between every two (2) openings.
4. Ensure that the Tri-Stud Span Wire Entrance has a minimum of 0.5 inch (13 mm) diameter throughout for wire access and that wire access is free of burrs and casting webs.
5. Ensure that the Wire Entrance opening is recessed and has a neoprene grommet with sealed membrane sections.
6. Ensure that the signal head attachment end is serrated and has a minimum of 3-signal head centering bosses extending 0.19 inches (5 mm) from the serrations.
7. Ensure that the serrations have a 72-tooth design to match the signal head.
8. Ensure that three (3) stainless steel studs are cast into the wire entrance fitting. Ensure that the studs are 0.31 inches (7 mm) and extend 1.5 inches (38 mm) [\pm 0.13 inches (4 mm)] beyond the serrations. Provide each Tri-Stud span wire entrance fitting with a Tri-Stud hardware kit.
9. Ensure that the Tri-Stud Span Wire Entrance Fitting has an alodine conversion coating to provide a proper base for paint adhesion. Ensure that the assembly is painted federal yellow and baked in a drying oven after painting.
10. Ensure that the all Hardware is galvanized or stainless steel.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.

925.2.43 Bull Rings

A. Requirements

Provide bull rings that are weldless steel 0.63 inch (16 mm) diameter. Submit catalog cuts for approval.

B. Fabrication

General Provisions 101 through 150.

C. Acceptance

General Provisions 101 through 150.

D. Materials Warranty

Refer to [Subsection 925.2.D](#) for Materials Warranties.