FHWA REGION NO.	STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
7	KANSAS	87-N1(039)-81	1999	40	68

E. Shield Grounding

Communications cable shielding shall be grounded at one point only – at the control center in City Hall for CBD zones and at the on-street master cabinet for non-CBD zones. Shielding at all splice points (aerial, underground or at the controller cabinet) shall be connected together using shield connectors and a #14 THHN stranded, white insulated wire with a ring tongue connector on each end as a bonding jumper between the shield connectors. Proper insulation shall be used on all bare parts of the bonding system to prevent contact with the messenger cable or other metal parts in the closure.

F. Testing

A continuity test and an insulation resistance test of each communications pair (including spares) will be conducted in the presence of the project engineer or his representative. During the tests, all transient suppression devices shall be disconnected. If any test fails, repairs shall be made by the contractor and the entire test for that cable circuit shall be repeated.

G. Continuity Test

The continuity test shall be made between a point upstream of where the new communications cable is spliced to the existing cable and each new field termination point. Each conductor in a pair shall show a resistance of not more than 10 ohms per 300 m of AWG #19 conductors. The resistance shall be measured with a meter having a minimum resistance of 20,000 ohms/volt. Contractor to supply City of Wichita with a typed record of the resistance of each paired conductor.

H. Insulation Resistance Test

The insulation resistance test shall be measured with all other connections to the conductor under test removed, and all other conductors in the cable and the shield grounded. The measurement shall be made with a direct current potential of not less than 360 volts nor more than 550 volts applied for one minute. Insulation resistance shall exceed 3,000 megohm-km. The contractor to supply City of Wichita with typed record of the resistance of each conductor.

11. MESSENGER CABLE

Where shown in the plans, the messenger cable shall be used to support all overhead communications and detector lead-in cable. The messenger cable shall be 8 mm in diameter and shall include devices such as rings or spiral slashing used to attach the cable, and shall run from struture to structure without splicing. Prior to erecting messenger cable, the contractor shall determine the length of the strand required to span the distance between the poles indicated on the drawings, allowing a sufficient additional length of span wire to compensate for sag.

No messenger cables shall be erected which would lie on, or are liable to run on, a utility company wire or cable, tree limb, etc. If a messenger cable is erected within 300 mm of any other cable, wire or structure, it shall be protected with plastic wire guards. The height of the messenger cable on the pole shall conform to requirements of the serving utility and the National Electrical Code, and the National Electric Safety Code.

TRAFFIC SIGNAL EQUIPMENT

01. TYPE 170 TRAFFIC SIGNAL CONTROLLER SYSTEM

Each Type 170 Traffic Signal Controller System shall meet the applicable specifications detailed in "TSCES, published by the California Business, Transportation and Housing Agency, Department of Transportation (Caltrans), Jan. 1989 edition. AS modified by TSCES, Addendum 8, Nov. 1993, as well as the additional requirements noted below.

A. Controller Unit

The Model 170 controller unit shall contain a single MPU with at least 2K of RAM memory on a separate board apart from the Input/Output logic board.

Output interface – The output interface shall consist of a minimum of 80 bits of buffered storage. Output data shall be latched at the time of writing from the MPU. This interface shall provide an NPN open collector output capable of driving up to 40 volts DC and sinking up to 100 milliamperes. A logic state one from the MPU shall be presented as a grounded collector (0 to 2 volts), and a logic state zero presented as an open circuit. Once a port is written into, the data will remain present and stable until either another port is written into it, or until the power is turned off. The state of these output ports at the time of power up or power down shall be an open circuit.

Provide adjustable AC threshold voltage indicator on power supply.

All IC's integral to controller unit shall be socket mounted.

The Model 170 controller shall include a Model 41282 System memory module of same manufacturer as specified in Traffic Signal Control Equipment Specifications published by the California Business, Transportation and Housing Agency, Department of Transportation (Caltrans), January, 1989 edition. The specifications are available from the Caltrans Publication Unit, telephone (916) 445-3520. The Model 412 System Memory Module shall include lithium cell for backup power to retain data in the volatile RAM devices. The lithium cell shall be replaceable and switched to disconnect cell while module is not in use. Switch to be accessible without removing system memory module. The Model 412 System Memory Module to be provided with WAPITI Micro Systems W41KS Program (latest revision) on 27258 EPROM.

B. Conflict Monitor

The Model 210 conflict monitor(s) supplied shall meet requirements outlined in Chapter 3 of the Traffic Signal Control Hardware Specifications detailed in FHWA-IP-78-16 published by the Federal Highway Administration and dated December, 1978, and the following requirements:

1. Any dark signal head (that is, loss of signal output to field terminals) shall cause the monitor to trip.
2. Any yellow time less than 2.8 seconds shall cause the monitor to trip.
3. The green, yellow and red indications for each phase shall be brought into the monitor individually and shall be monitored separately with respect to a loss of signal on any of the three inputs per channel.
4. The monitor shall have the required circuitry to allow the early detection of a conflict caused by a green or yellow signal "hang up" (that is, any green or yellow output which shall remain on when the controller has transferred to a yellow or all red output) by starting the fault timers as soon as yellow appears with the corresponding green still energized. The monitor shall not wait until a conflicting green is displayed to time the conflict. This shall preclude the presentation of a conflicting signal display at the intersection.
5. During the "all red" clearance period (if used), the monitor shall check all inputs for faulty signal display and shall react to these faulty indications during the all red clearance period. Since during this period the only inputs that should be active would be the reds, the monitor shall detect any faults such as red/green, red/yellow, green/yellow and green/red/yellow.
6. The monitor shall be capable of monitoring for incorrect signals applied at the field terminals of each vehicular movement (green, yellow, red). Should a voltage be present on more than one, or none, of the inputs (green, yellow, red) of a channel, the unit shall begin timing the duration of this condition. If this condition exists for less than 700 milliseconds, the unit shall not trigger. If this condition exists for 700 milliseconds or more, but less than 1,000 milliseconds, the unit may or may not trigger.
7. When the unit triggers, it shall cause the output relay contacts to transfer. These contacts shall remain in this state until the unit is reset by the activation of the panel control, or the activation of the external reset input. Power interruption shall not reset the conflict monitor when it has been triggered by detection of a faulty load switch output.
8. The minimum indicators shall be as follows:
   a. Power – shall be illuminated when the 24VDC input from the controller is present and the AC+ is applied to the monitor.
   b. Watch Dog Error – shall illuminate when the monitor detects a watch dog error.
   c. Conflict – shall illuminate when a conflict has been detected by the monitor.
   d. Red Failure – shall illuminate when a red failure has been detected by the monitor.
   e. Switch Fail – shall illuminate when a faulty load switch has been detected by the monitor.
   f. PCA – shall illuminate when the program board if not installed or is not installed properly.
   g. PWF – shall illuminate when the unit has detected a failure and then experiences a power interruption.
   h. The monitor shall include signal status indicators. These indications (one per channel) shall illuminate when a proceed signal is present on the corresponding channel during normal operation. If the unit trips due to a conflict, the signal status shall lock up, displaying the status of each channel at the time the conflict occurred. Should the monitor trip due to the absence of red or a faulty load switch output, the signal status indicators shall display the channel (channels) which is (are) at fault.
   i. Yellow or Sequence – shall illuminate when a short yellow time has been detected.
9. If the monitor detects a load switch fault condition, the switch failure indicator shall be illuminated and the signal status indicators will display the exact channel of the load switch that failed.
10. The red inputs shall be brought into the monitor via a front panel connector.
11. The Red Enable shall be brought into the monitor via the same front panel connector as the red inputs.
12. A Red Interface Adapter shall be wired in and tested. Red interface block to be programmable without the use of tools or the lowering of any access panels.
13. Conflict monitor to be capable of monitoring four (4) red, yellow and green outputs from the Model 420 auxiliary output file.
14. Communications software shall be compatible with W4IKS software.

C. Detectors

The Model 222 Two-Channel Loop Detector as specified in Chapter 4 FHWA-IP-78-16 shall provide for a "failsafe" continuous output in response to an open loop or open lead-in wire.

Each detector unit shall provide interface capability with 22 and 44 pin 170 type input file.

Each detector unit shall provide sixteen sensitivity settings via thumbwheel switches.

Each detector unit shall be provided with a test switch position to verify loop system integrity. The open loop test position shall indicate a previous fault via the front panel indicator. The memory shall remain intact and can be queried repeatedly. Existing detections shall not be reset and the memory shall only be reset by removing and reinserting the detector unit.

Each detector unit shall provide for selection of delay time of 0 to 30 seconds in 2.0 second increments and/or extension time of 0 to 7 1/2 seconds in 0.5 second increments or off if no timing is desired.

Each timer (delay and extension) shall be provided with buffer circuitry to enable or disable the timer based on an external signal output. Each channel shall include an external input to gate the timing. Provide for cross-talk elimination with only one channel on at a time while scanning.

D. Controller Cabinet

The Model 332B Cabinet and Model 336A Cabinet cabinets shall meet the applicable specifications detailed in the Caltrans Specifications* as well as additional requirements that follow. The cabinets shall be unpainted natural aluminum. The output file must be capable of flashing all 8 phases red or yellow. The three-point locking mechanism shall be fabricated so that it may be actuated by rotating a removable 15 mm hex key. The hex socket and locking cam shall rotate on a 19 mm minimum diameter shaft.

The socket and shaft shall be field-replaceable with common tools. The socket head shall be protected from being rotated with a pipe wrench or similar tool. One aluminum hex wrench shall be provided with each cabinet.

The cabinet assembly shall be provided with a Power Distribution Assembly (PDA) number 2 and the circuit option (Section 8.4.3.3 of the Caltrans Specifications*).

All #8 conductors from service panel (IBS) and mercury contactor to signal bus and main equipment bus shall be 133 strand #29 AWG electronic hook-up wire.

A hybrid power line surge protection device such as the EDCO Surrestor SHA-1210 or equal shall be furnished in each controller cabinet. The protector shall be installed between the applied line voltage and earth ground. The surge protector shall be capable of reducing the effects of transient voltages spilled to the AC line. The protector shall be mounted inside the PDA#2. The Equipment Line Out shall provide filtered power to the controller, 24 VDC power supply, input file and conflict monitor through shielded cable or twisted pair to the units AC plus and AC minus inputs.

The protector shall include the following features and functions:

Maximum AC line voltage: 140 VAC.

Twenty pulses of peak current, each of which will rise in 8 microseconds and fall in 20 microseconds to one-half the peak: 20,000 Amperes.

The protector shall be provided with the following terminals:

Main line (AC Line first stage terminal).

Main Neutral (AC Neutral input terminals).

Equipment Line Out (AC Line second stage output terminal, 10 Amps.).

Equipment Neutral Out (Neutral terminal to protected equipment).

GND (Earth connection).

The Main AC line in and the Equipment Line out terminals shall be separated by a 200 Microhenry (minimum) inductor rated to handle 10 Amp AC Service.

The first stage clamp shall be between Main Line and Ground terminals.

The second stage clamp shall be between Equipment Line Out and Equipment Neutral.

Each cabinet shall be furnished with a communications terminal block, C2P harness and connector, voice jack harness, and voice jack, conforming to the requirements detailed in the Caltrans Specifications*.

TBO/Communications Termination Block – This terminal block will serve as the termination block for the communication conductors, overvoltage protection devices, and the termination points for the C2P harness and conductors. Install over voltage protection ground bus and hard wire to equipment ground bus with #8AWG wire.

C2P Harness and Connector – A four-conductor, jacketed cable shall be attached to the terminal block with locking spade lugs. The cable shall terminate in a standard C2P connector and shall be routed through the cabinet and be of sufficient length to reach the C2S connector on the back of the 170 controller unit when the unit is installed in the equipment rack.

Voice Jack Harness – A two-conductor twisted, jacketed cable shall be attached to the terminal block with locking spade lugs. The cable shall be routed to the voice jack.

Voice Jack – A voice communications jack shall be installed with solder lugs extending out of the side of the jack housing and shall have a cover.

Each terminal on output terminal blocks to be marked as per phase function.

Jumper I 13-K to I 13-E to I 12-E to I 12-K to I 16-2.

Provide Fiberglas disposable filters in lieu of metal filters.

The input file printed circuit board must be accessible without removing or lowering panel.

The lifting eyes shall be removable.

Interchangeability of the Isolation Relay and Logic Relay shall not be possible.

Flash blocks to be accessible without lowering or opening any service panels and marked as per phase.

Red interface adapter to be programmable without tools.

Red interface adapter to be accessible without lowering or opening access panels.

Provide cable tie down (Richo #CFC C-8) or equivalent to secure red interface adapter cable to the bottom of the output file.

Anchor bolts to be provided with 332B Cabinet.

Additional Model 336A Cabinet Specifications:

The cabinet shall be a weatherproof, outdoor, pole-mounted or pedestal-mounted type with overall dimensions not to exceed 910 mm high by 560 mm wide by 510 mm deep. The cabinet will utilize all the standard plug-in modules that are utilized by the Type 336 Caltrans cabinets.

The bottom of all 336A cabinets shall be solid plate and be reinforced with a 510 mm x 560 mm 9.5 mm aluminum base plate continuously welded to the inside bottom of the cabinet.

Cabinets shall be attached to the pole using two aluminum mounting brackets, mounted top and bottom, for each cabinet. The brackets shall be secured to the cabinets using appropriate stainless steel mounting bolts and washers. The brackets shall be secured to the pole by appropriate banding buckles and couplings.

Door opening flange around the door opening shall be 190 mm wide.

Steel rails shall be provided in lieu of the rack cage for mounting of the controller and cabinet assemblies. The rail assembly shall consist of 4 EIA threaded rails bolted to the two sides at the front and rear of the cabinet. The rails shall be threaded in the same manner and pattern as the Model 332 cabinet cage. The rails shall be plated as specified in Caltrans Specifications*, Section 1.2.8.3.2.

The cabinet, if used for school signal control, shall be modified to operate flashing beacons by time-of-day, day-of-week through controller output.

E. Switch Pack

The components of the three solid state switches, enclosed in the load switch, shall be of interchangeable, modular cube design.

Cube to be mounted separate from circuit board for ease of replacement.

Housing and handle to be constructed of metal, suitably protected against corrosion.

F. Flasher Unit

Each of the two load circuits contained in the Flasher Unit shall be of interchangeable cube design.

Cube to be mounted separate from circuit board for ease of replacement.

Housing and handle to be constructed of metal, suitably protected against corrosion.

G. Zonal Master Controllers

The zonal master controller shall conform to the Type 170 specifications.

Insofar as possible, the boards from the master shall be interchangeable with those in the local 170's.

1. The zonal master 170's shall be configured with a second serial port. The second serial port shall be the same type as the primary serial port and address mapped to location 6002 (Hex) for control functions and location 6003 (Hex) for data functions. The second serial port shall be capable of operating at a clock rate of 300, 600, 1200, 2400, 4800, or 9600 baud. This selection shall be independent of the primary ACIA.

   The signals from the second ACIA shall be routed to the rear panel of the 170 chassis and terminated in a 14-position connector identical to the C2 connector. This connector shall be marked C2OS.

   A three-foot cable shall be provided to interconnect from the C2OS connector to a standard DB25S connector on an auto dial modem.

2. All controllers shall be provided with a Model 400 Modem Module as detailed in Chapter 7 of the Caltrans Specifications*.
3. Each zonal master 170 controller unit shall be supplied with one (1) Model 41282 System Memory Module. The module shall be provided with WAPITI Micro Systems W70SM, latest revision, software package, on 27256 EPROM.

02. AC SERVICE INPUT

Each service disconnect must be furnished with an installed lightning arrestor on the AC service input which meets or exceeds the following requirements:

A. The unit must be capable of withstanding repeated 20,000 ampere surges (minimum of 20).
B. The unit must have internal follow – current limiters (resistive elements).
C. The unit must contain three active clamping stages minimum.
D. The unit must self-extinguish within 8.3 milliseconds after the trailing edge of the surge.
E. The parallel impedance of limiters must be less than 0.15 OHMS.
F. The unit shall be UL approved.

Each service disconnect to have 70 AMP main lugs with no more than 4 circuits.

03. VEHICLE DETECTOR LOOP WIRE SEALANT

A. The saw slot filler and encapsulant shall be a one-part polyurethane, moisture curing, elastomeric compound requiring no mixing, measuring or application of heat prior to or during its installation and designed specifically for sealing and protecting vehicle detector loop wires.

B. The encapsulant is intended to provide compressive yield strength to withstand normal vehicular traffic as well as sufficient flexibility to withstand normal movement in asphaltic and concrete pavements, while protecting the loop wire from moisture penetration, fracture and shear.

C. The encapsulant shall be designed for roadway installation when surface temperature is between 5°C and 60°C and enable vehicular traffic to pass over the sawcut immediately after installation without tracking or stringing of the material. The encapsulant shall form a surface skin allowing exposure to vehicular traffic within 30 minutes at 24°C and completely cure to a tough, rubber-like consistency in two (2) to seven (7) days after installation.

D. Cured encapsulant shall exhibit resistance to effects of weather, vehicular abrasion, motor oils, gasoline, antifreeze solution, brake fluid, deicing chemicals and salt normally encountered, in such a manner that the performance of the vehicle detector loop wire is not adversely affected.

E. Fitting of the sawcut shall be in accordance with the directions of the manufacturer.

04. PEDESTRIAN PUSHBUTTON ASSEMBLY

This specification is intended to provide minimum requirements for pedestrian pushbuttons that will be acceptables

1. A one-piece cast aluminum raised sign legend with pushbutton housing.
2. Weatherproof and dustproof pedestrian pushbutton with silver contacts rated a minimum of 35 amps at 12 volts.
3. The legend "Push Button – Wait For Walk Signal" shall be cast into the face of the assembly.
4. Assembly to have 100 mm radius bracket mount for bonding to pole.

05. AERIAL SPLICE BOX

The contractor shall furnish and install aerial enclosures for splicing overhead interconnect cable. Spliced enclosures shall be of polyethylene construction and be capable of accommodating up to a 12-pair cable. The enclosure shall provide easy access to aerial cable, while providing weather protection for the splice. No aerial splice boxes shall be installed at locations that cannot be accessed by a maintenance truck, or that require the climbing of a pole for service.

The enclosure shall have the following overall maximum exterior dimensions: 760 mm long, 250 mm high, and 100 mm wide. Minimum dimensions of 400 mm long, 150 mm high, and 85 mm wide shall be provided for the interior compartment.

The enclosure cover shall be capable of easy removal for splicing the interconnect cable and easily stored for typical maintenance activity, such as replacement of interior termination blocks or cable diagnostics.

All communication cable conductors shall be accommodated on termination blocks provided within the enclosure. The aerial enclosure shall be capable of being installed while enclosing the overhead supporting messenger strand. Once installed, the enclosed messenger strand and interconnect cable shall appear as one unit under the splice cover.

Bonding and Grounding of the splice enclosure shall be accomplished through attachment to the messenger support strand.

Cable binding posts shall be configured to allow up to three-wire conductors each.

06 TRAFFIC SIGNAL LAMPS

Lamps for vehicular and pedestrian signals shall meet the following requirements:

A. 300 mm Signals

A nominal 135 watt, 120 volt, A21 clear traffic signal lamp of 6,000 hour life rating guaranteed by the manufacturer, to be used in all 300 mm vehicular and pedestrian indications. Lamps shall be 80% Krypton filled with heat reflection.

B. Candlepower

All traffic signal lamps must meet beam candlepower specification of ITE-1110(1970).

C. Mass Spectrometry Analysis

Mass Spectrometry Analysis to verify percent Krypton shall be provided with catalog cut sheets.

NO.	DATE	REVISIONS	BY	APP'D
3				
2				
1				

TRAFFIC SIGNAL SPECIFICATION

FHWA APPROVAL	SCALE	APP'D	
DESIGNED	DETAILED	QUANTITIES	
DESIGN OK	DETAIL OK	QUAL OK	DATE