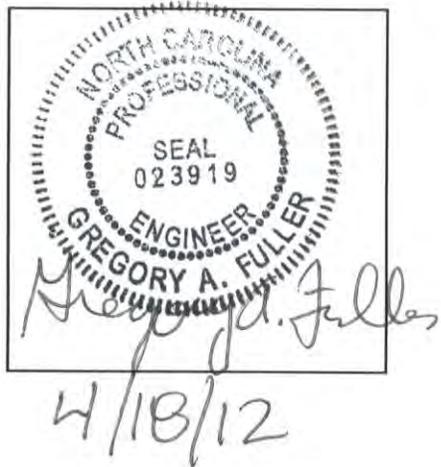


# EDWARDS MILL ROAD REVERSIBLE LANE SYSTEM UPGRADE OF CONTROLLER, SOFTWARE & LANE CONTROL SIGNS



## Project Special Provisions Intelligent Transportation Systems

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## 1. GENERAL REQUIREMENTS

### 1.1 DESCRIPTION

#### A. Project Overview

This project consists of upgrading several key components of the existing Edwards Mill Road-Reversible Lane System which is currently used to assist the traveling public along Edwards Mill Road for normal daily traffic flow and major traffic events.

This project consists of the following major tasks.

1. Replace the existing CALTRANS TEES compliant Model 170E controllers with new Advance Traffic Controllers (ATC) with Linux operating software and device drivers and install a 170E software emulation program on the new controllers. The software emulation program will allow the ATC controllers to load and execute any firmware image that was designed to run on the standard CALTRAN TEES compliant Model 170 controllers. The new ATC will be installed in new Type 332 controller cabinets.
2. Installing new Type 332 controller cabinets, cabinet pad foundations and installing the necessary conduits, risers, electrical service, grounding systems and communications systems.
3. Replace the existing LED sign faces installed in each of the reversible lane sign enclosures located on the overhead gantries. This work will require keeping the existing lane control sign enclosures, removing the existing LED sign faces and replacing them with new displays.
4. Additionally, this work will involve permanently removing the driver boards and driver racks used to actuate the signs which are currently located inside the lane control sign enclosures. Install new driver boards and driver racks in new pole mounted cabinets (Driver board Cabinet) installed on the gantry upright/support post.

#### B. General

Conform to these Project Special Provisions, Project Plans, and the *2012 Standard Specifications for Roads and Structures* (also referred to hereinafter as the “Standard Specifications”). The current edition of these specifications and publications in effect on the date of advertisement will apply.

In the event of a conflict between these Project Special Provisions and the Standard Specifications, these Project Special Provisions shall govern.

#### C. Real World Coordinates

Provide real world coordinates for all major field devices (structures, lane control cabinets, etc.) installed or worked on under this project. Provide the coordinates in feet units using the North Carolina State Plane coordinate system (1983 North American Datum also known as NAD '83). Furnish coordinates that do not deviate more than 1.7 feet (½ meter) in the horizontal plane and 3.3

feet (1 meter) in the vertical plane. Global positioning system (GPS) equipment able to obtain the coordinate data within these tolerances may be used. Submit cut sheets on the GPS unit proposed to collect the data for approval by the Engineer. For equipment cabinets, obtain and provide the location of the cabinet.

Provide both a digital copy and hard copy of all information regarding the location (including to but not limited to manufacturer, model number, and NCDOT inventory number) in the Microsoft spreadsheet provided by the Department, shown by example below.

| NCDOT Inv # | Name                 | Location                | Latitude | Longitude | Manufacturer | Model #       | Comm Media | Destination |
|-------------|----------------------|-------------------------|----------|-----------|--------------|---------------|------------|-------------|
| 05-7009     | Cam 1                | I-540/I-40              | 35.8625  | -78.8123  | Pelco        | Spectravision | 60 SMFO    | TRTMC       |
| 05-7010     | Cam 2                | NC 54/I-40              | 35.8523  | -78.7631  | Pelco        | Spectravision | 60 SMFO    | TRTMC       |
| 05-7030     | HAR 1 – Johnston Co. | I-40 at NC 42 (mp 312)  | 35.2456  | -77.952   |              |               | Dial-up    | TRTMC       |
| 05-7001     | DMS # 1              | I-85 N/I-40 E, mp 159.1 |          |           | Mark IV      |               | Dial-Up    | TRTMC       |
| 05-7003     | DMS # 3              | I-40 W, mp 307.7        |          |           | Mark IV      |               | Dial-Up    | TRTMC       |
| 05-7004     | DMS # 4              | I-40 E, mp 286.0        |          |           | Mark IV      |               | 60 SMFO    | TRTMC       |

#### D. Qualified Products

Furnish new equipment, materials, and hardware unless otherwise required. Inscribe manufacturer's name, model number, serial number, and any additional information needed for proper identification on each piece of equipment housed in a case or housing.

Furnish factory assembled cables without adapters, unless otherwise approved by the Engineer, for all cables required to interconnect any field or central equipment including but not limited to fiber optic transceivers.

Certain equipment listed in these Project Special Provisions must be pre-approved on the Department's ITS & Signals Qualified Products List (QPL) by the date of installation. Equipment, material, and hardware not pre-approved when required will not be allowed for use on the project.

Furnish detailed electrical schematics showing detailed pin connections for approved equipment used to construct this project for review and approval by the Engineer. Include electronic components with proprietary part numbers. Upon approval by the Engineer furnish a final copy of the applicable electrical schematic at each equipment cabinet installation.

The QPL is available on the Department's website. The QPL website is:  
<http://www.ncdot.org/doh/preconstruct/traffic/ITSS/SMS/qpl/>

## 2. MOBILIZATION

### 2.1 DESCRIPTION

This work consists of preparatory work and operations, including but not limited to the movement of personnel, equipment, supplies, and incidentals to the project site, for the establishment of offices, buildings, and other facilities necessary for work on the project; the removal and disbandment of those personnel, equipment, supplies, incidentals, or other facilities that were established for the prosecution of work on the project; and for all other work and operations which must be performed for costs incurred prior to beginning work on the various items on the project site.

### 2.2 MEASUREMENT AND PAYMENT

“Mobilization” will be measured and paid for at the contract lump sum price for Mobilization.

Partial payments for the item of “Mobilization” will be made with the first and second partial pay estimates paid on the contract, and will be made at the rate of 50% lump sum price for “Mobilization” on each of these partial pay estimates, less than the retainage provided for in Article 109-4 of the Standard Specifications, provided the amount bid for “Mobilization” does not exceed 5 percent of the total amount bid for the contract. Where the amount bid for the item of “Mobilization” exceeds 5 percent of the total amount bid for the contract, 2 ½ percent of the total amount bid will be paid on each of the first two partial pay estimates, and the portion exceeding 5 percent will be paid on the last partial pay estimate. All such payments will be made less the retainage provided for in Article 109-4 of the Standard Specifications.

Payment will be made under:

|                    |          |
|--------------------|----------|
| <b>Pay Item</b>    |          |
| Mobilization ..... | Lump Sum |

## 3. MODIFY ELECTRICAL SERVICE

### 3.1 DESCRIPTION

Modify electrical service at locations shown in the plans. Comply with the National Electrical Code (NEC), the National Electrical Safety Code (NESC), the NCDOT 2012 Standard Specifications, the project special provisions and all local ordinances.

The Contractor shall be responsible for applying and paying for all fees associated with any electrical permits and inspections if required by the local utility

### 3.2 MATERIAL

#### A. Feeder Conductors for Type 332 Controller Cabinet

Furnish 2 #8 AWG and 1 #4 AWG stranded copper feeder conductors with THWN rating for supplying power to the new Type 332 controller cabinet. Provide #8 AWG conductors with black, white insulation. Provide the #4 AWG conductor with green insulation. Provide conductors intended for power circuits at 600 Volts or less and comply with the following:

- Listed as meeting UL Standard UL-83

- Meets ASTM B-3 and B-8 or B-787 standards.

### **B. Feeder Conductors for Driver Board Cabinet**

Furnish 3 #10 AWG stranded copper feeder conductors with THWN rating for supplying power to the new Driver Board Cabinet. Provide #10 AWG conductors with black, white and green insulation. Provide conductors intended for power circuits at 600 Volts or less and comply with the following:

- Listed as meeting UL Standard UL-83
- Meets ASTM B-3 and B-8 or B-787 standards.

### **C. Service Disconnect Panel**

Furnish new service disconnect panels rated at 125 Ampere minimum and provides for a minimum of 4 disconnects. Ensure the disconnect panels are listed as meeting UL Standard UL-67 and marked as being suitable for use as service equipment. Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint finish, light gray in color, to yield a minimum thickness of 2.4 mils. Provide ground bus and neutral bus with a minimum of four terminals with minimum wire capacity range of number 14 through number 4 AWG. Furnish a 1" watertight hub for threaded rigid conduit with each service disconnect panel.

For Type 332 controller cabinet installations furnish as the main disconnect a single pole 50 ampere circuit breaker with a minimum of 10,000 RMS symmetrical amperes short circuit current rating.

For Driver Board Cabinet installations furnish as the main disconnect a single pole 30 ampere circuit breaker with a minimum of 10,000 RMS symmetrical amperes short circuit current rating.

## **3.3 CONSTRUCTION METHODS**

### **A. Feeder Conductors**

At locations shown in the plans, install two new 1-inch steel conduits leaving the bottom of the service disconnect to 18" below grade. Extend one 1- inch conduit to the Type 332 controller cabinet and extend the second 1-inch conduit to the Driver Board Cabinet.

Vertical segments of conduit above ground must be rigid galvanized steel. Horizontal runs of conduit below ground may be PVC. To convert from vertical runs to horizontal runs install 1-inch steel 90° or 45°sweeping elbows to transition from steel to PVC.

Route the new feeder conductors from the service disconnect to the new Type 332 controller cabinet. Route the new feeder conductors from the service disconnect to the Driver Board Cabinet.

### **B. Modify Electrical Service**

Disconnect power from the existing electrical service and install the new service disconnect panel. Ensure the existing grounding electrode system is in compliance with the 2012 Standard Specifications. Upgrade the current grounding system and test the grounding electrode resistance for a maximum of 20 ohms. Furnish and install additional ground rods to grounding electrode system as necessary to meet test requirements.

Grounding electrode resistance test must be verified or witnessed by the Engineer or the Engineer’s designated representative. Furnish and install additional ground rods to grounding electrode system as necessary to meet the Project Special Provisions and test requirements.

Follow test equipment’s procedures for measuring grounding electrode resistance. When using clamp-type ground resistance meters, readings of less than 1 ohm typically indicate a ground loop. Rework bonding and grounding circuits as necessary to remove ground loop circuits and retest. If a ground loop cannot be identified and removed to allow the proper use of a clamp-type ground resistance meter, use the three-point test method.

Submit a completed Inductive Loop & Grounding Test Form available on the Department’s website. The form is located on the Department’s website at:

[www.ncdot.gov/doh/preconstruct/traffic/ITSS/ws/signal\\_data.xls](http://www.ncdot.gov/doh/preconstruct/traffic/ITSS/ws/signal_data.xls)

Provide a length of marker tape 12 inches below finished grade directly over grounding electrodes and conductors.

Once the new Type 332 controller cabinet is brought on line and the existing 170E controller cabinet is ready to be removed from service, remove the original feeder conduit and feeder wires from the existing service disconnect enclosure to 24 inches below grade. Abandon in place all underground, horizontal runs of cables and conduits.

**3.4 MEASUREMENT AND PAYMENT**

*Modify Electrical Service* will be measured and paid as the actual number of complete and functional modified Electrical Service locations furnished, installed and accepted. Modifications along with removal and disposal of existing cables and conduits is considered incidental.

*Feeder Conductor* will be measured and paid as the actual linear feet of “2-Wire #8 AWG/ 1-Wire #4AWG THWN copper” OR “3-Wire #10 AWG THWN copper” feeder conductors furnished, installed and accepted. Payment is for all three conductors. Measurement will be for the actual linear footage of combined conductors after all terminations are complete. No separate payment will be made for each individual conductor. No payment will be made for excess wire in the cabinets.

Conduit will be reimbursed as described elsewhere in these Project Special Provisions.

Payment will be made under:

|   |                    |
|---|--------------------|
| <b>Modify Electrical Service</b> .....                                | <b>Each</b>        |
| <b>Feeder Conductor 2-Wire #8 AWG/ 1-Wire #4AWG THWN copper</b> ..... | <b>Linear Feet</b> |
| <b>Feeder Conductor 3-Wire #10 AWG THWN copper</b> .....              | <b>Linear Feet</b> |

**4. RISER ASSEMBLIES**

**4.1 DESCRIPTION**

Furnish and install riser assemblies as shown in the Plans. Comply with Standard Specifications:

Page 17-19, Section 1722, “Riser Assemblies”.

**4.2 MATERIALS**

Comply with Standard Specifications:

Page 17-19, Article 1722-2, "Materials".

**4.3 CONSTRUCTION METHODS**

Comply with Standard Specifications:

Page 17-19, Article 1722-3, "Construction Methods".

**4.4 MEASUREMENT AND PAYMENT**

" " Riser with " " will be measured and paid as the actual number of risers of each type and size furnished, installed and accepted. No separate payment will be made for weatherheads, conduit outlet bodies such as condulets, elbows, conduit fittings, pole attachment fittings, and grounding as these will be considered incidental to furnishing and installing risers.

No measurement will be made for horizontal sections of underground conduit that connect the riser to stub-outs in an adjacent cabinet foundation and that measure 10 feet or less in horizontal length from the center of the riser to the center of the vertical sweep through the controller cabinet foundation. Such conduit will be considered incidental to furnishing and installing the riser assembly.

Payment will be made under:

**Pay Item**

2" Riser with Weatherhead..... Each

**5. SIGNAL CABINET FOUNDATIONS & CABINET BASE ADAPTER**

**5.1 DESCRIPTION**

Furnish and install signal cabinet foundations and all necessary hardware. Comply with Standard Specifications:

Page 17-36, Section 1750, "Signal Cabinet Foundations".

Furnish and install cabinet base adapter and all necessary hardware.

**5.2 MATERIALS**

Comply with Standard Specifications:

Page 17-36, Article 1750-2, "Materials".

Comply with Standard Specifications:

Page 10-221, Section 1098-16, “Cabinet Base Adapter/Extender”.

**5.3 CONSTRUCTION METHODS**

Comply with Standard Specifications:

Page 17-36, Article 1750-3, “Construction Methods”.

**5.4 MEASUREMENT AND PAYMENT**

*Signal Cabinet Foundations* will be measured and paid as the actual number of cabinet foundations, furnished, installed and accepted.

*Cabinet Base Adapter* will be measured and paid as the actual number of cabinet base adapter/extender, furnished, installed and accepted.

Payment will be made under:

**Pay Item**

Signal Cabinet Foundation ..... Each

Cabinet Base Adapter .....Each

**6. CONDUIT**

**6.1 DESCRIPTION**

Furnish and install high-density polyethylene conduit (HDPE) or PVC conduit at locations shown in the Plans and in accordance with these Project Special Provisions. Comply with Standard Specifications:

Page 17-10, Section 1715, “Underground Cable Installation”.

**6.2 MATERIALS**

For conduit comply with the Standard Specifications:

Page 17-11, Article 1715-2, “Materials”.

**6.3 CONSTRUCTION METHODS**

Install HDPE or PVC conduit as noted in the Plans. Comply with the Standard Specifications:

**6.4 MEASUREMENT AND PAYMENT**

"Unpaved trenching (qty) (size)" will be measured horizontal linear feet of trenching for underground conduit installation furnished, installed, and accepted. Measurement will be along the approximate centerline of the conduit system. Payment will be in linear feet.

No separate measurement will be made for seeding, mulching, excavation of rock, conduit duct plugs, mechanical sealing devices, graded stone, paving materials, nuts and bolts or any other hardware or materials required for installation of underground conduit as these will be considered incidental.

Payment will be made under:

**Pay Item**

|                                 |             |
|---------------------------------|-------------|
| Unpaved Trenching (1) (1")..... | Linear Foot |
| Unpaved Trenching (1) (2")..... | Linear Foot |

**7. SIGNAL CABLE**

**7.1 DESCRIPTION**

Furnish signal cable to make connections between the output file of the controller cabinet and the lane control signs.

**7.2 MATERIALS**

Furnish 16 AWG-4, 16 AWG-7 signal cable, that complies with IMSA specification 20-1 except provide the following conductor insulation colors:

- For 16 AWG-4 cable: white, yellow, red, and green
- For 16 AWG-7 cable: white, yellow, red, green, yellow with black stripe tracer, red with black stripe tracer, and green with black stripe tracer. Apply continuous stripe tracer on conductor insulation with a longitudinal or spiral pattern.

Furnish 16 AWG-12 /6 pair signal cable, manufactured with concentric stranded conductors that complies with IMSA specification 20-2 except provide the following conductor insulation colors:

- For 16 AWG-12 /6 pair cable: blue wire twisted with white wire, orange wire twisted with a white wire, green wire twisted with a white wire, brown wire twisted with a white wire, gray wire twisted with a white wire, blue wire twisted with a red wire.

Provide a ripcord to allow the cable jacket to be opened without using a cutter. IMSA specification 19-1 will not be acceptable. Provide a cable jacket labeled with the IMSA specification number and provide conductors constructed of stranded copper.

### 7.3 CONSTRUCTION METHODS

Install signal cable 16 AWG-4 and 16 AWG-7 to make electrical connections between the output file of the cabinet and the input side of the driver boards.

Install signal cable 16 AWG-12/6 pair between the output side of the driver boards and the terminal connection of the PCB in the Lane Control Signs. Install two 16 AWG-12 conductor/6 pair cables per lane control sign. Each cable will represent one display side of the lane control sign and its corresponding drive board located in the driver board cabinet.

Terminate cables with spade lugs to the appropriate terminal strips. Use a ratchet type crimping tool to ensure that the crimp is installed correctly.

Terminate the 16 AWG-12/6 pair cables to the appropriate lane control sign display as listed below:

| PAIRING | CONDUCTOR | CONDUCTOR | FUNCTION   |
|---------|-----------|-----------|--|
| PAIR 1  | Orange    | White     | RED "X"  |
| PAIR 2  | Blue      | White     | Yellow "X"   |
| PAIR 3  | Green     | White     | Green Arrow  |
| PAIR 4  | Brown     | White     | White Through Arrow<br>(MUTCD "R3-5A")   |
| PAIR 5  | Gray      | White     | or<br>White Through Arrow<br>with Turn Arrow<br>(MUTCD "R3-6L" or<br>"R3-6R")<br>or<br>White Turn Arrow<br>(MUTCD "R3-5L" or<br>"R3-5R")<br>or<br>Two Way Left Turn<br>Only (MUTCD "R3-9A) |
| PAIR 6  | Red       | Blue      | "ONLY" Message   |

Cable Pairs 4 & 5 may be applied to any of the various regulatory arrow messages as needed. Permanently label each cable to identify which sign enclosure it connects to. Additionally, label each paired cable with the type of sign display it operates in the sign enclosure.

Lash exposed horizontal sections of signal cable to the gantry support every 12 – 16 inches using aluminum wrapping tape.

Make electrical connections inside the cabinets. Do not splice connections at any point between the output file and the appropriate terminal strips.

**7.4 MEASUREMENT AND PAYMENT**

*Signal Cable* will be measured and paid as the actual linear feet of signal cable furnished, installed and accepted. Measurement will be made from point to point, horizontally. Twenty-five feet will be allowed for vertical segments of each cable ran up or down the structure.

Payment will be made under:

| <b>Pay Item</b>                       |             |
|---------------------------------------|-------------|
| Signal Cable.....                     | Linear Foot |
| Signal Cable (16 AWG -12/6 Pair)..... | Linear Foot |

**8. INTERCONNECT CENTERS**

**8.1 DESCRIPTION**

This item of work involves back-pulling the existing fiber optic drop cable out of the existing 170E cabinet and re-pulling/reworking the cable to the new Type 332 controller cabinet. Additionally this item of work also includes installing a new interconnect center in the new Type 332 controller cabinet and terminating the relocated fiber optic drop cable.

Page 17-25, Section 1731, “Fiber Optic Splice Enclosures”.

**8.2 MATERIALS**

Furnish new interconnect centers. Comply with the Standard Specifications:

Page 10-216, Section 1098-11, “(A) Interconnect Centers”.

**8.3 CONSTRUCTION METHODS**

Prior to back pulling the existing fiber optic cable out of the existing interconnect center, record the existing splicing and jumper arrangements. Re-splice the fiber optic cable back to what was recorded in the field.

Use caution in removing the existing fiber optic drop cable and do not damage the cable. Back pull the existing fiber optic drop cable out of the existing 170E controller cabinet and re-install the fiber optic cable in new conduit in to the new type 332 controller cabinet. Terminate the fiber in a new interconnect center and make connections to the field hardened Ethernet Switch.

Should the removed drop cable become damaged during the removal and re-installation process the Contractor will be responsible for making repairs to the drop cable, at no cost to the project, up to and including replacement of this section of drop cable and re-termination in the existing aerial splice enclosure.

Comply with Standard Specifications:

Page 17-25, Article 1731-3, "Construction Methods".

Re-use the existing riser assembly and install new section of heat shrink tubing at the top of the riser and rework the new conduit to the new Type 332 controller cabinet.

#### 8.4 MEASUREMENT AND PAYMENT

"Interconnect Center" will be measured and paid as the actual number of fiber optic interconnect centers furnished, installed and accepted.

No measurement will be made for back pulling and reworking the fiber optic cable into the new Type 332 controller cabinet. No measurement will be made of splice trays, pigtails, jumpers, connector panels, heat shrink tubing, testing and any corrective actions, repairs and replacements needed for exceeding the maximum allowable attenuation or other defects, as these will be considered incidental to furnishing and installing fiber optic interconnect centers.

Conduit will be reimbursed as described elsewhere in these Project Special Provisions.

Payment will be made under:

##### Pay Item

Interconnect Center ..... Each

### 9. ETHERNET SWITCH

#### 9.1 DESCRIPTION

Install Field Hardened Ethernet Switches at each Type 332 controller cabinet as shown in the Plans.

#### 9.2 MATERIALS

Furnish field hardened Ethernet switches in accordance with these Project Special Provisions. Ensure the industrial Ethernet Switches meet the following minimum functional requirements:

- Standards IEEE 802.3.10BaseT Ethernet; IEEE 802.3U 100BaseTX Ethernet; IEEE 802.3x Flow Control and Back Pressure
- Protocol CSMA/CD
- Switch Architecture Store and Forward
- Transfer Rate 14.880pps for Ethernet Port; 148.800pps for Fast Ethernet Port
- MAC Address 1K MAC Address Table
- Memory Buffer 512 Kb
- LED Unit Master, Power, Power 1, Power 2; Port: Link/Activity,

- |                      |   |
|----------------------|---|
|                      | Full-Duplex/Collision   |
| • Packet Throughput  | 0.74Mpps @ 64bytes (5TX)  |
| • Power Supply       | 12 to 48 VDC  |
| • Temperature        | 14° F to 158° F   |
| • Operating Humidity | 5% to 95% (Non-condensing)  |
| • EMI                | FCC Class A; CE EN6100-4-2/EN6100-4-3<br>EN6100-4-4/EN6100-4-5/EN6100-4-6 |
| • Safety             | UL, cUL, CE EN60950   |

Ensure each industrial Ethernet switch has a minimum of 4 ports.

**9.3 CONSTRUCTION**

Install and integrate the field hardened Ethernet switch with the single mode fiber optic cable and 2070 ATC controller. Provide all necessary hardware and cables. Install according to manufacturer’s recommended instructions.

Provide and leave all wiring schematics, data interface cables, installation manuals, and specifications and materials used to program any equipment in the Cabinet.

**9.4 MEASUREMENT AND PAYMENT**

“Ethernet Switch” will be measured and paid as the actual number of field hardened Ethernet Switches furnished, installed and accepted.

Payment will be made under:

|                       |      |
|-----------------------|------|
| <b>Pay Item</b>       |      |
| Ethernet Switch ..... | Each |

**10. CONTROLLERS WITH CABINET**

**10.1 MATERIALS – TYPE “ATC CONTROLLERS”**

Furnish Advanced Transportation Controller (ATC) that conforms to ITE/AASHTO/NEMA specification ATC Version 5.2b. Conform to CALTRANS *Transportation Electrical Equipment Specifications* (TEES) (dated August 16, 2002, plus Errata 1 dated October 27, 2003 and Errata 2 dated June 08, 2004) except as required herein.

Furnish ATC controllers. Ensure that removal of the CPU module from the controller will place the intersection into flash.

Provide model ATC controllers with the latest version of Linux operating software and device drivers, composed of the unit chassis and at a minimum the following modules and assemblies:

- MODEL 2070 ATC chassis
- MODEL 2070-1C CPU module with 60 MIPS microprocessor, 16MB DRAM, 8 MB Flash and 1MB non-volatile SRAM
- MODEL 2070-2A, Field I/O Module (FI/O)

- MODEL-4B Power Supply Module
- MODEL 2070-3B, Front Panel Module (FP), Display B (8x40)
- MODEL 2070-2A Communications Module

Furnish two (2) MODEL 2070-2A, Communications Modules for each ATC Controller.

Ensure that the ATC controller supports all the input and output functions of the C1 connector.

Ensure that the 4 serial ports of the Model 170E platform are supported as well as an Ethernet interface that can be mapped to one of the ATC controller's serial ports.

For each ATC Controller furnish and install a field hardened Ethernet switch as described elsewhere in these Specifications. Include all necessary hardware to ensure communications.

Provide a moisture resistant coating on all circuit boards.

## 10.2 EMULATION SOFTWARE

Furnish 170E emulation software that is to be installed on the ATC controller. Ensure the emulation software program will allow the ATC controllers to load and execute any firmware image that was designed to run on the standard CALTRAN TEES compliant Model 170 controllers using the original Motorola 6802 series microprocessors.

Ensure the emulation software executes the existing Lane Control Firmware which was designed for the Model 170E controller when run in a 170E emulation environment on the ATC controller. Operation on the lane control firmware on the ATC platform shall be indistinguishable from operation on the native Model 170E platform, with the exception that normal ATC startup time shall be acceptable. All features and functions, inputs and outputs, and communications interfaces of the original Model 170E platform shall be fully supported. It shall have the same form factor as the existing Model 170E controller.

Ensure the emulation software supports full keyboard operations and shall support the complete 6802 instruction set and interrupts. The emulation software shall produce a simulation of the Model 170E character and Call/Active light display using the LCD display of the Model 2070-3B front panel.

Ensure that the transfer of any binary file designed for execution on CALTRANS TEES compliant Model 170E controllers to the Model ATC controller and have it execute under the emulation program without any discernible operational differences. All inputs and outputs and program operations supported by the original binary program when running in the native Model 170E environment shall be supported when running under the 170E emulation software in the ATC hardware.

Ensure the emulation software supports the generation of a menu driven text-based user interface and access to that UI via web services. However, generation of the additional text-based user interface is not part of the scope of the work.

Controllers shall be delivered complete with all required hardware and the Model 170E emulation software. NCDOT will provide the executable application software image to be loaded on the controllers. Vendor shall load the executable image on the ATC to provide a complete working unit.

**10.3 MATERIALS – GENERAL TYPE 332 CONTROLLER CABINETS**

Provide a moisture resistant coating on all circuit boards.

Provide one 20 mm diameter radial lead UL-recognized metal oxide varistor (MOV) between each load switch field terminal and equipment ground. Electrical performance is outlined below.

| PROPERTIES OF MOV SURGE PROTECTOR            |                          |
|--|--------------------------|
| Maximum Continuous Applied Voltage at 185° F | 150 VAC (RMS)<br>200 VDC |
| Maximum Peak 8x20µs Current at 185° F        | 6500 A                   |
| Maximum Energy Rating at 185° F              | 80 J                     |
| Voltage Range 1 mA DC Test at 77° F          | 212-268 V                |
| Max. Clamping Voltage 8x20µs, 100A at 77° F  | 395 V                    |
| Typical Capacitance (1 MHz) at 77° F         | 1600 pF                  |

Provide a power line surge protector that is a two-stage device that will allow connection of the radio frequency interference filter between the stages of the device. Ensure that a maximum continuous current is at least 10A at 120V. Ensure that the device can withstand a minimum of 20 peak surge current occurrences at 20,000A for an 8x20 microsecond waveform. Provide a maximum clamp voltage of 395V at 20,000A with a nominal series inductance of 200µh. Ensure that the voltage does not exceed 395V. Provide devices that comply with the following:

| Frequency (Hz) | Minimum Insertion Loss (dB) |
|----------------|-----------------------------|
| 60             | 0                           |
| 10,000         | 30                          |
| 50,000         | 55                          |
| 100,000        | 50                          |
| 500,000        | 50                          |
| 2,000,000      | 60                          |
| 5,000,000      | 40                          |
| 10,000,000     | 20                          |
| 20,000,000     | 25                          |

**10.4 MATERIALS – TYPE 332 CONTROLLER CABINETS**

**A. Type 332 Controller Cabinets General:**

Conform to the city of Los Angeles’ Specification No. 54-053-08, *Traffic Signal Cabinet Assembly Specification* (dated July 2008), except as required herein.

Furnish model 332 base mounted cabinets configured for 8 vehicle phases, 4 pedestrian phases, and 6 overlaps. When overlaps are required, provide auxiliary output files for the overlaps. Do not reassign load switches to accommodate overlaps unless shown on electrical details.

Provide model 200 load switches, model 252 AC isolators, and model 242 DC isolators according to the electrical details. As a minimum, provide one (1) model 2018 conflict monitor, one (1) model 206L power supply unit, two (2) model 204 flashers, one (1) DC isolator (located in slot I14), and four (4) model 430 flash transfer relays (provide seven (7) model 430 flash transfer relays if auxiliary output file is installed) with each cabinet.

**B. Type 332 Controller Cabinet Electrical Requirements:**

Provide a cabinet assembly designed to ensure that upon leaving any cabinet switch or conflict monitor initiated flashing operation, the controller starts up in the programmed start up phases and start up interval.

Furnish two sets of non-fading cabinet wiring diagrams and schematics in a paper envelope or container and placed in the cabinet drawer.

All AC+ power is subject to radio frequency signal suppression.

Provide surge suppression in the cabinet for each type of cabinet device. Provide surge protection for the full capacity of the cabinet input file. Provide surge suppression devices that operate properly over a temperature range of -40° F to +185° F. Ensure the surge suppression devices provide both common and differential modes of protection.

Provide a pluggable power line surge protector that is installed on the back of the PDA (power distribution assembly) chassis to filter and absorb power line noise and switching transients. Ensure the device incorporates LEDs for failure indication and provides a dry relay contact closure for the purpose of remote sensing. Ensure the device meets the following specifications:

|  |                      |
|--|----------------------|
| Peak Surge Current (Single pulse, 8x20µs)..... | 20,000A              |
| Occurrences (8x20µs waveform).....             | 10 minimum @ 20,000A |
| Maximum Clamp Voltage.....                     | 395VAC               |
| Operating Current.....                         | 15 amps              |
| Response Time.....                             | < 5 nanoseconds      |

Provide a loop surge suppressor for each set of loop terminals in the cabinet. Ensure the device meets the following specifications:

|                                      |                |
|--------------------------------------|----------------|
| Peak Surge Current (6 times, 8x20µs) |                |
| (Differential Mode).....             | 400A           |
| (Common Mode).....                   | 1,000A         |
| Occurrences (8x20µs waveform).....   | 500 min @ 200A |

|                                |                 |
|--------------------------------|-----------------|
| Maximum Clamp Voltage          |                 |
| (Differential Mode @400A)..... | 35V             |
| (Common Mode @1,000A).....     | 35V             |
| Response Time.....             | < 5 nanoseconds |
| Maximum Capacitance.....       | 35 pF           |

Provide a data communications surge suppressor for each communications line entering or leaving the cabinet. Ensure the device meets the following specifications:

|  |                               |
|--|-------------------------------|
| Peak Surge Current (Single pulse, 8x20µs)..... | 10,000A                       |
| Occurrences (8x20µs waveform).....             | 100 min @ 2,000A              |
| Maximum Clamp Voltage.....                     | Rated for equipment protected |
| Response Time.....                             | < 1 nanosecond                |
| Maximum Capacitance.....                       | 1,500 pF                      |
| Maximum Series Resistance.....                 | 15Ω                           |

Provide a DC signal surge suppressor for each DC input channel in the cabinet. Ensure the device meets the following specifications:

|  |                |
|--|----------------|
| Peak Surge Current (Single pulse, 8x20µs)..... | 10,000A        |
| Occurrences (8x20µs waveform).....             | 100 @ 2,000A   |
| Maximum Clamp Voltage.....                     | 30V            |
| Response Time.....                             | < 1 nanosecond |

Provide a 120 VAC signal surge suppressor for each AC+ interconnect signal input. Ensure the device meets the following specifications:

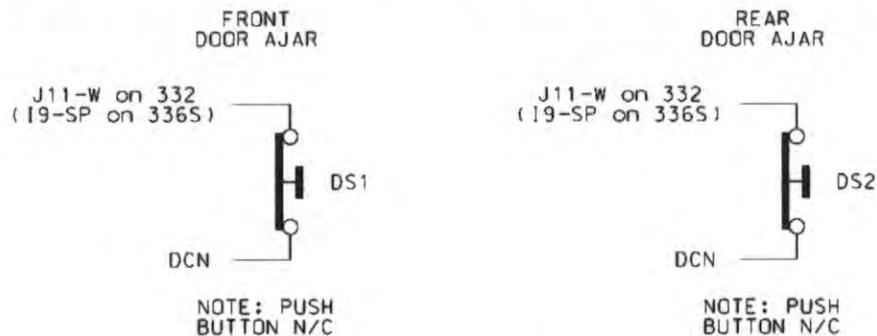
|  |                     |
|--|---------------------|
| Peak Surge Current (Single pulse, 8x20µs)..... | 20,000A             |
| Maximum Clamp Voltage.....                     | 350VAC              |
| Response Time.....                             | < 200 nanoseconds   |
| Discharge Voltage.....                         | <200 Volts @ 1,000A |
| Insulation Resistance.....                     | ≥100 MΩ             |

Provide conductors for surge protection wiring that are of sufficient size (ampacity) to withstand maximum over currents which could occur before protective device thresholds are attained and current flow is interrupted.

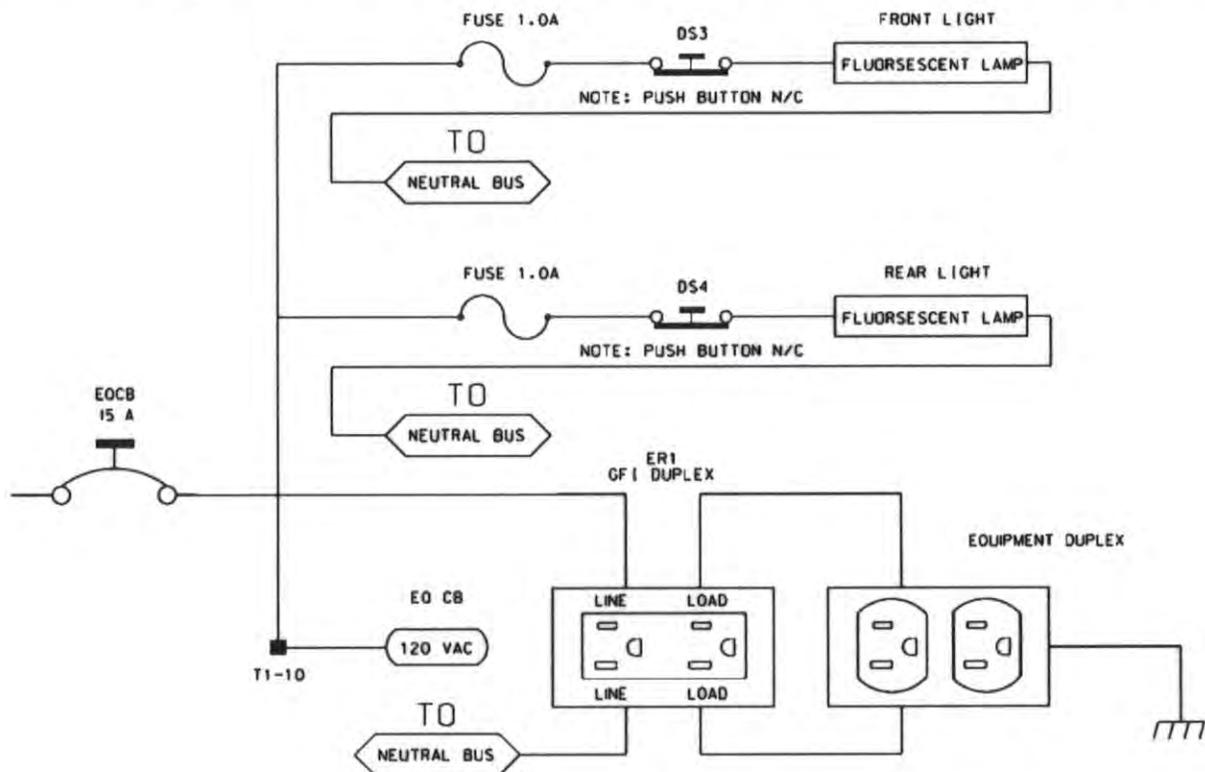
If additional surge protected power outlets are needed to accommodate fiber transceivers, modems, etc., install a UL listed, industrial, heavy-duty type power outlet strip with a minimum rating of 15 A / 125 VAC, 60 Hz. Provide a strip that has a minimum of 3 grounded outlets. Ensure

the power outlet strip plugs into one of the controller unit receptacles located on the rear of the PDA. Ensure power outlet strip is mounted securely; provide strain relief if necessary.

Provide a door switch in the front and a door switch in the rear of the cabinet that will provide the controller unit with a Door Ajar alarm when either the front or the rear door is open. Ensure the door switches apply DC ground to the Input File when either the front door or the rear door is open.



Furnish a fluorescent fixture in the rear across the top of the cabinet and another fluorescent fixture in the front across the top of the cabinet at a minimum. Ensure that the fixtures provide sufficient light to illuminate all terminals, labels, switches, and devices in the cabinet. Conveniently locate the fixtures so as not to interfere with a technician's ability to perform work on any devices or terminals in the cabinet. Provide a protective diffuser to cover exposed bulbs. Install 16 watt T-4 lamps in the fluorescent fixtures. Provide a door switch to provide power to each fixture when the respective door is open. Wire the fluorescent fixtures to the 15 amp ECB (equipment circuit breaker).



Furnish a police panel with a police panel door. Ensure that the police panel door permits access to the police panel when the main door is closed. Ensure that no rainwater can enter the cabinet even with the police panel door open. Provide a police panel door hinged on the right side as viewed from the front. Provide a police panel door lock that is keyed to a standard police/fire call box key. In addition to the requirements of LA Specification No. 54-053-08, provide the police panel with a toggle switch connected to switch the intersection operation between normal stop-and-go operation (AUTO) and manual operation (MANUAL). Ensure that manual control can be implemented using inputs and software such that the controller provides full programmed clearance times for the yellow clearance and red clearance for each phase while under manual control.

Provide a 1/4-inch locking phone jack in the police panel for a hand control to manually control the intersection. Provide sufficient room in the police panel for storage of a hand control and cord.

Ensure the 336S cabinet Input File is wired as follows:

| 336S Cabinet<br>Port-Bit/C-1 Pin Assignment |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Slot #                                      | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  |
| C-1 (Spares)                                | 59  | 60  | 61  | 62  | 63  | 64  | 65  | 66  | 75  | 76  | 77  | 78  | 79  | 80  |
| Port  | 3-2 | 1-1 | 3-4 | 1-3 | 3-1 | 1-2 | 3-3 | 1-4 | 2-5 | 5-5 | 5-6 | 5-1 | 5-2 | 6-7 |
| C-1   | 56  | 39  | 58  | 41  | 55  | 40  | 57  | 42  | 51  | 71  | 72  | 67  | 68  | 81  |
| Port  | 2-1 | 1-5 | 2-3 | 1-7 | 2-2 | 1-6 | 2-4 | 1-8 | 2-6 | 5-7 | 5-8 | 5-3 | 5-4 | 6-8 |
| C-1   | 47  | 43  | 49  | 45  | 48  | 44  | 50  | 46  | 52  | 73  | 74  | 69  | 70  | 82  |

For model 332 base mounted cabinets, ensure terminals J14-E and J14-K are wired together on the rear of the Input File. Connect TB9-12 (J14 Common) on the Input Panel to T1-2 (AC-) on the rear of the PDA.

Provide detector test switches mounted at the top of the cabinet rack or other convenient location which may be used to place a call on each of eight phases based on the chart below. Provide three positions for each switch: On (place call), Off (normal detector operation), and Momentary On (place momentary call and return to normal detector operation after switch is released). Ensure that the switches are located such that the technician can read the controller display and observe the intersection.

Connect detector test switches for cabinets as follows:

| 332 Cabinet            |           |
|------------------------|-----------|
| Detector Call Switches | Terminals |
| Phase 1                | I1-W      |
| Phase 2                | I4-W      |
| Phase 3                | I5-W      |
| Phase 4                | I8-W      |
| Phase 5                | J1-W      |
| Phase 6                | J4-W      |
| Phase 7                | J5-W      |
| Phase 8                | J8-W      |

Provide the PCB 28/56 connector for the conflict monitor unit (CMU) with 28 independent contacts per side, dual-sided with 0.156 inch contact centers. Provide the PCB 28/56 connector contacts with solder eyelet terminations. Ensure all connections to the PCB 28/56 connector are soldered to the solder eyelet terminations.

Ensure that all cabinets have the CMU connector wired according to the 332 cabinet connector pin assignments (include all wires for auxiliary output file connection). Wire pins 13, 16, R, and U of the CMU connector to a separate 4 pin plug, P1, as shown below. Provide a second plug, P2, which will mate with P1 and is wired to the auxiliary output file as shown below. Provide an additional plug, P3, which will mate with P1 and is wired to the pedestrian yellow circuits as shown below. When no auxiliary output file is installed in the cabinet, provide wires for the green and yellow inputs for channels 11, 12, 17, and 18, the red inputs for channels 17 and 18, and the wires for the P2 plug. Terminate the two-foot wires with ring type lugs, insulated, and bundled for optional use.

| PIN | P1       |         | P2       |         | P3       |         |
|-----|----------|---------|----------|---------|----------|---------|
|     | FUNCTION | CONN TO | FUNCTION | CONN TO | FUNCTION | CONN TO |
| 1   | CH-9G    | CMU-13  | OLA-GRN  | A123    | 2P-YEL   | 114     |
| 2   | CH-9Y    | CMU-16  | OLA-YEL  | A122    | 4P-YEL   | 105     |
| 3   | CH-10G   | CMU-R   | OLB-GRN  | A126    | 6P-YEL   | 120     |
| 4   | CH-10Y   | CMU-U   | OLB-YEL  | A125    | 8P-YEL   | 111     |

Connect the P20 terminal assembly (red monitor board) to a connector installed on the front of the type 2018 enhanced conflict monitor through a 3-1/2 foot 20-wire ribbon cable. Ensure that the ribbon cable connector and the connector on the conflict monitor are keyed to ensure proper connection. Ensure that removal of the P20 ribbon cable will cause the conflict monitor to recognize a latching fault condition and place the cabinet into flashing operation.

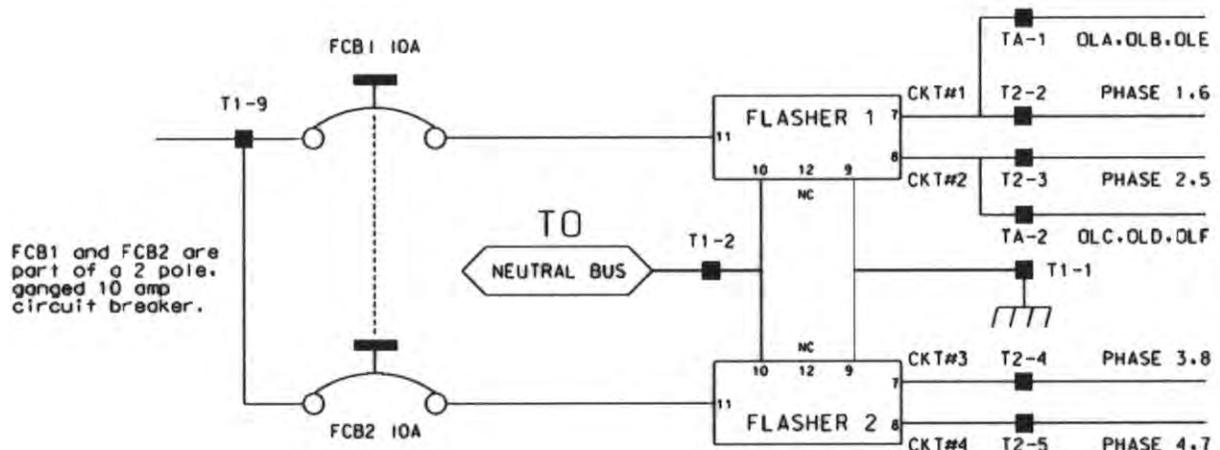
Wire the P20 connector to the traffic signal red displays to provide inputs to the conflict monitor as shown below. Ensure the pedestrian Don't Walk circuits are wired to channels 13 through 16 of the P20 connector. When no auxiliary output file is installed in the cabinet, provide wires for channels 9 through 12 reds. Terminate the two-foot wires with ring type lugs, insulated, and bundled for optional use.

| Pin # | Function           | Pin # | Function      |
|-------|--------------------|-------|---------------|
| 1     | Channel 15 Red     | 11    | Channel 9 Red |
| 2     | Channel 16 Red     | 12    | Channel 8 Red |
| 3     | Channel 14 Red     | 13    | Channel 7 Red |
| 4     | GND                | 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    |

Ensure the controller unit outputs to the auxiliary output file are pre-wired to the C5 connector. When no auxiliary output file is installed in the cabinet, connect the C5 connector to a storage socket located on the Input Panel or on the rear of the PDA.

In addition to the requirements of LA Specification No. 54-053-08, ensure relay K1 on the Power Distribution Assembly (PDA) is a four pole relay and K2 on the PDA is a two pole relay.

Provide a two pole, ganged circuit breaker for the flash bus circuit. Ensure the flash bus circuit breaker is an inverse time circuit breaker rated for 10 amps at 120 VAC with a minimum of 10,000 RMS symmetrical amperes short circuit current rating. Do not provide the auxiliary switch feature on the flash bus circuit breaker. Ensure the ganged flash bus circuit breaker is certified by the circuit breaker manufacturer to provide gang tripping operation.



Ensure auxiliary output files are wired as follows:

| AUXILIARY OUTPUT FILE<br>TERMINAL BLOCK TA ASSIGNMENTS |   |
|--|---|
| POSITION   | FUNCTION  |
| 1  | Flasher Unit #1, Circuit 1/FTR1 (OLA, OLB)/FTR3 (OLE) |
| 2  | Flasher Unit #1, Circuit 2/FTR2 (OLC, OLD)/FTR3 (OLF) |
| 3  | Flash Transfer Relay Coils                            |
| 4  | AC -  |
| 5  | Power Circuit 5                                       |
| 6  | Power Circuit 5                                       |
| 7  | Equipment Ground Bus                                  |
| 8  | NC  |

Provide four spare load resistors mounted in each cabinet. Ensure each load resistor is rated as shown in the table below. Wire one side of each load resistor to AC-. Connect the other side of each resistor to a separate terminal on a four (4) position terminal block. Mount the load resistors and terminal block either inside the back of Output File No. 1 or on the upper area of the Service Panel.

| ACCEPTABLE LOAD RESISTOR VALUES |           |
|---------------------------------|-----------|
| VALUE (ohms)                    | WATTAGE   |
| 1.5K – 1.9 K                    | 25W (min) |
| 2.0K – 3.0K                     | 10W (min) |

Provide Model 200 load switches, Model 204 flashers, Model 242 DC isolators, Model 252 AC isolators, and Model 206L power supply units that conform to CALTRANS' "Transportation Electrical Equipment Specifications" dated March 12, 2009 with Erratum 1.

**C. Type 332 Controller Cabinet Physical Requirements:**

Do not mold, cast, or scribe the name "City of Los Angeles" on the outside of the cabinet door as specified in LA Specification No. 54-053-08. Do not provide a Communications Terminal Panel as specified in LA Specification No. 54-053-08. Do not provide terminal block TBB on the Service Panel. Do not provide Cabinet Verification Test Program software or associated test jigs as specified in LA Specification No. 54-053-08.

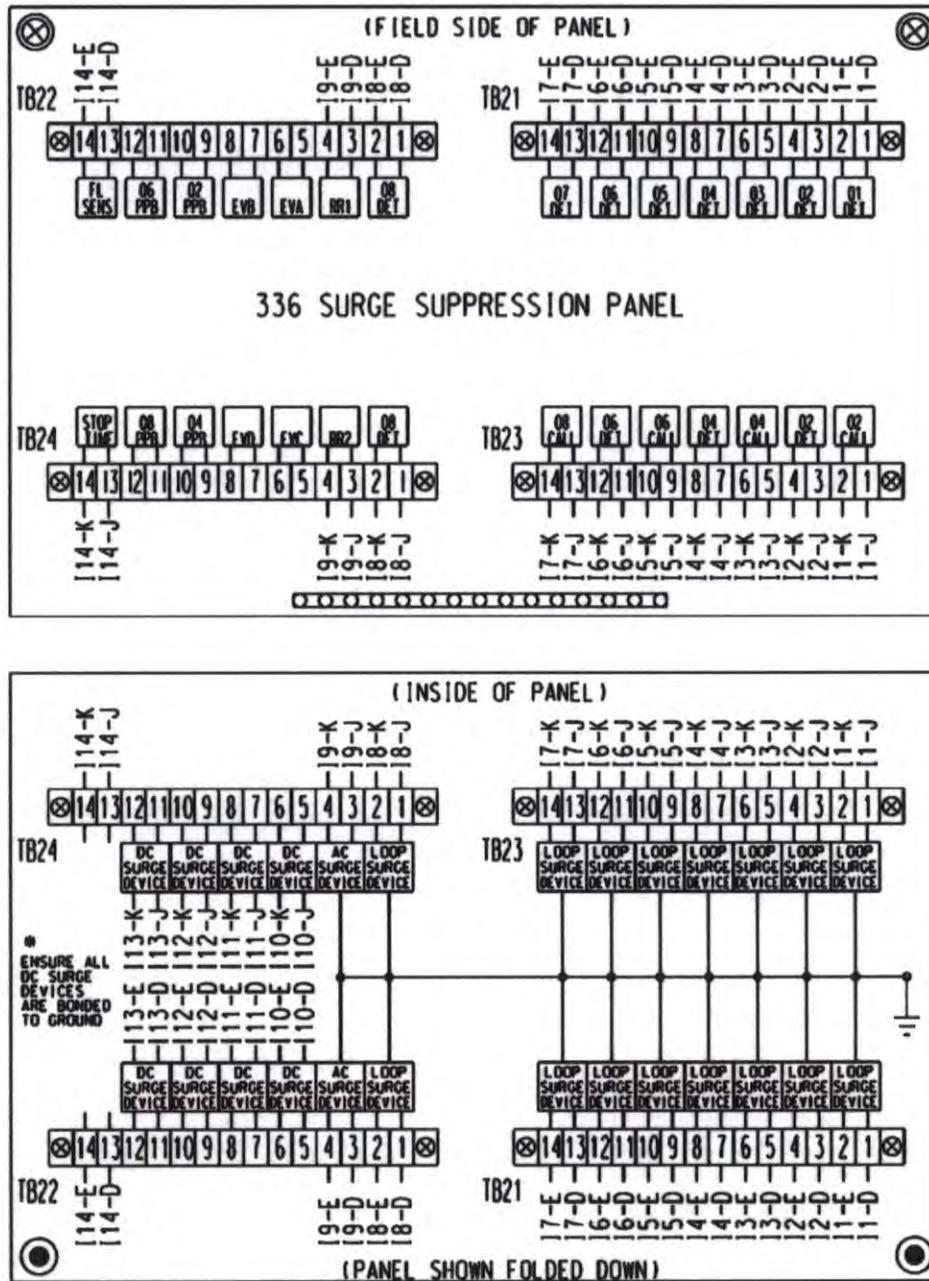
Furnish unpainted, natural, aluminum cabinet shells. Ensure that all non-aluminum hardware on the cabinet is stainless steel or a Department approved non-corrosive alternate.

Ensure the lifting eyes, gasket channels, police panel, and all supports welded to the enclosure and doors are fabricated from 0.125 inch minimum thickness aluminum sheet and meet the same standards as the cabinet and doors.

Provide front and rear doors with latching handles that allow padlocking in the closed position. Furnish 0.75 inch minimum diameter stainless steel handles with a minimum 0.5 inch shank. Place the padlocking attachment at 4.0 inches from the handle shank center to clear the lock and key. Provide an additional 4.0 inches minimum gripping length.

Provide Corbin #2 locks on the front and rear doors. Provide one (1) Corbin #2 and one (1) police master key with each cabinet. Ensure main door locks allow removal of keys in the locked position only.

Provide a surge protection panel with 16 loop surge protection devices and designed to allow sufficient free space for wire connection/disconnection and surge protection device replacement. For model 332 cabinets, provide an additional 20 loop surge protection devices. Provide an additional two AC+ interconnect surge devices to protect one slot and eight DC surge protection devices to protect four slots. Provide no protection devices on slot I14.



For base mounted cabinets, mount surge protection panels on the left side of the cabinet as viewed from the rear. Attach each panel to the cabinet rack assembly using bolts and make it easily removable. Mount the surge protection devices in vertical rows on each panel and connect the devices to one side of 12 position, double row terminal blocks with #8 screws. For each surge protection panel, terminate all grounds from the surge protection devices on a copper equipment ground bus attached to the surge protection panel. Wire the terminals to the rear of a standard input file using spade lugs for input file protection.

Provide permanent labels that indicate the slot and the pins connected to each terminal that may be viewed from the rear cabinet door. Label and orient terminals so that each pair of inputs is next to each other. Indicate on the labeling the input file (I or J), the slot number (1-14) and the terminal pins of the input slots (either D & E for upper or J & K for lower).

Provide a minimum 14 x 16 inch pull out, hinged top shelf located immediately below controller mounting section of the cabinet. Ensure the shelf is designed to fully expose the table surface outside the controller at a height approximately even with the bottom of the controller. Ensure the shelf has a storage bin interior which is a minimum of 1 inch deep and approximately the same dimensions as the shelf. Provide an access to the storage area by lifting the hinged top of the shelf. Fabricate the shelf and slide from aluminum or stainless steel and ensure the assembly can support the ATC controller plus 15 pounds of additional weight. Ensure shelf has a locking mechanism to secure it in the fully extended position and does not inhibit the removal of the ATC controller or removal of cards inside the controller when fully extended. Provide a locking mechanism that is easily released when the shelf is to be returned to its non-use position directly under the controller.

**D. Model 2018 Enhanced Conflict Monitor:**

Furnish Model 2018 Enhanced Conflict Monitors that provide monitoring of 18 channels. Ensure each channel consists of a green, yellow, and red field signal input. Ensure that the conflict monitor meets or exceeds CALTRANS' Transportation Electrical Equipment Specifications dated March 12, 2009 with Erratum 1 (hereafter referred to as CALTRANS' 2009 TEES) for a model 210 monitor unit and other requirements stated in this specification.

Ensure the conflict monitor is provided with an 18 channel conflict programming card. Pin EE and Pin T of the conflict programming card shall be connected together. Pin 16 of the conflict programming card shall be floating. Ensure that the absence of the conflict programming card will cause the conflict monitor to trigger (enter into fault mode), and remain in the triggered state until the programming card is properly inserted and the conflict monitor is reset.

Provide a conflict monitor that incorporates LED indicators into the front panel to dynamically display the status of the monitor under normal conditions and to provide a comprehensive review of field inputs with monitor status under fault conditions. Ensure that the monitor indicates the channels that were active during a conflict condition and the channels that experienced a failure for all other per channel fault conditions detected. Ensure that these indications and the status of each channel are retained until the Conflict Monitor is reset. Furnish LED indicators for the following:

- AC Power (Green LED indicator)
- VDC Failed (Red LED indicator)
- WDT Error (Red LED indicator)
- Conflict (Red LED indicator)
- Red Fail (Red LED indicator)
- Dual Indication (Red LED indicator)
- Yellow/Clearance Failure (Red LED indicator)
- PCA/PC Ajar (Red LED indicator)
- Monitor Fail/Diagnostic Failure (Red LED indicator)

- 54 Channel Status Indicators (1 Red, 1 Yellow, and 1 Green LED indicator for each of the 18 channels)

Provide a switch to set the Red Fail fault timing. Ensure that when the switch is in the ON position the Red Fail fault timing value is set to 1350 +/- 150ms (2018 mode). Ensure that when the switch is in the OFF position the Red Fail fault timing value is set to 850 +/- 150ms (210 mode).

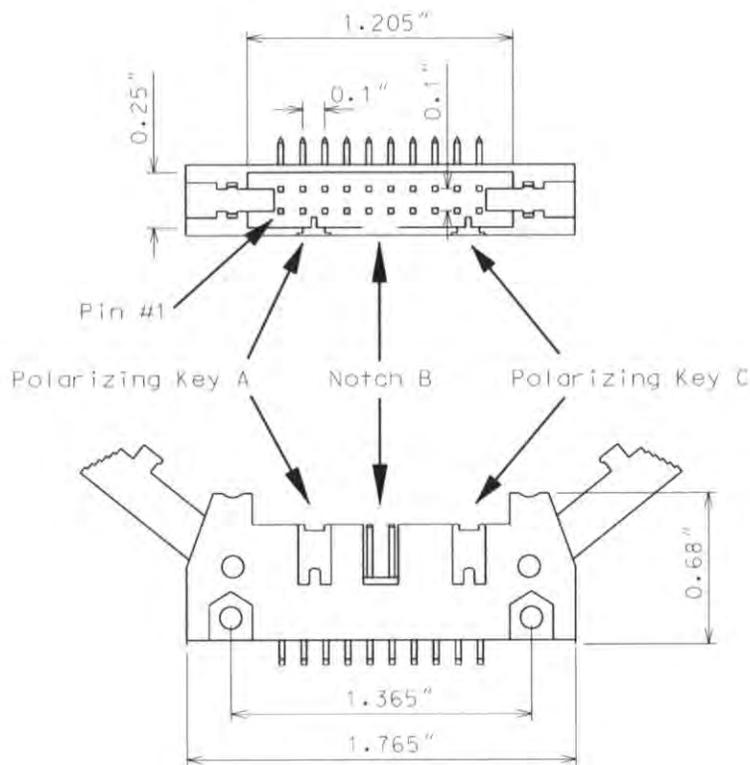
Provide a switch to set the Watchdog fault timing. Ensure that when the switch is in the ON position the Watchdog fault timing value is set to 1.0 +/- 0.1s (2018 mode). Ensure that when the switch is in the OFF position the Watchdog fault timing value is set to 1.5 +/- 0.1s (210 mode).

Provide a jumper or switch to set the AC line brown-out levels. Ensure that when the jumper is present or the switch is in the ON position the AC line dropout voltage threshold is 98 +/- 2 Vrms, the AC line restore voltage threshold is 103 +/- 2 Vrms, and the AC line brown-out timing value is set to 400 +/- 50ms (2018 mode). Ensure that when the jumper is not present or the switch is in the OFF position the AC line dropout voltage threshold is 92 +/- 2 Vrms, the AC line restore voltage threshold is 98 +/- 2 Vrms, and the AC line brown-out timing value is set to 80 +/- 17ms (210 mode).

Provide a jumper or switch that will enable and disable the Watchdog Latch function. Ensure that when the jumper is not present or the switch is in the OFF position the Watchdog Latch function is disabled. In this mode of operation, a Watchdog fault will be reset following a power loss, brownout, or power interruption. Ensure that when the jumper is present or the switch is in the ON position the Watchdog Latch function is enabled. In this mode of operation, a Watchdog fault will be retained until a Reset command is issued.

Provide a jumper that will reverse the active polarity for pin #EE (output relay common). Ensure that when the jumper is not present pin #EE (output relay common) will be considered 'Active' at a voltage greater than 70 Vrms and 'Not Active' at a voltage less than 50 Vrms (Caltrans mode). Ensure that when the jumper is present pin #EE (output relay common) will be considered 'Active' at a voltage less than 50 Vrms and 'Not Active' at a voltage greater than 70 Vrms (Failsafe mode).

In addition to the connectors required by CALTRANS' 2009 TEES, provide the conflict monitor with a red interface connector mounted on the front of the monitor. Ensure the connector is a 20 pin, right angle, male connector with latching clip locks and polarizing keys. Ensure the right angle solder tails are designed for a 0.062" thick printed circuit board. Keying of the connector shall be between pins 3 and 5, and between 17 and 19. Ensure the connector has two rows of pins with the odd numbered pins on one row and the even pins on the other row. Ensure the connector pin row spacing is 0.10" and pitch is 0.10". Ensure the mating length of the connector pins is 0.24". Ensure the pins are finished with gold plating 30μ" thick.



Ensure the red interface connector pins on the monitor have the following functions:

| Pin # | Function       | Pin # | Function           |
|-------|----------------|-------|--------------------|
| 1     | Channel 15 Red | 2     | Channel 16 Red     |
| 3     | Channel 14 Red | 4     | Chassis Ground     |
| 5     | Channel 13 Red | 6     | Special Function 2 |
| 7     | Channel 12 Red | 8     | Special Function 1 |
| 9     | Channel 10 Red | 10    | Channel 11 Red     |
| 11    | Channel 9 Red  | 12    | Channel 8 Red      |
| 13    | Channel 7 Red  | 14    | Channel 6 Red      |
| 15    | Channel 5 Red  | 16    | Channel 4 Red      |
| 17    | Channel 3 Red  | 18    | Channel 2 Red      |
| 19    | Channel 1 Red  | 20    | Red Enable         |

Ensure that the removal of the P-20 red interface ribbon cable will cause the monitor to recognize a latching fault condition and place the cabinet into flashing operation.

Provide Special Function 1 and Special Function 2 inputs to the unit which shall disable only Red Fail Monitoring when either input is sensed active. A Special Function input shall be sensed active when the input voltage exceeds 70 Vrms with a minimum duration of 550 ms. A Special Function input shall be sensed not active when the input voltage is less than 50 Vrms or the duration is less than 250 ms. A Special Function input is undefined by these specifications and may or may not be sensed active when the input voltage is between 50 Vrms and 70 Vrms or the duration is between 250 ms and 550 ms.

Ensure the conflict monitor recognizes field signal inputs for each channel that meet the following requirements:

- consider a Red input greater than 70 Vrms and with a duration of at least 500 ms as an “on” condition;
- consider a Red input less than 50 Vrms or with a duration of less than 200 ms as an “off” condition (no valid signal);
- consider a Red input between 50 Vrms and 70 Vrms or with a duration between 200 ms and 500 ms to be undefined by these specifications;
- consider a Green or Yellow input greater than 25 Vrms and with a duration of at least 500 ms as an “on” condition;
- consider a Green or Yellow input less than 15 Vrms or with a duration of less than 200 ms as an “off” condition; and
- consider a Green or Yellow input between 15 Vrms and 25 Vrms or with a duration between 200 ms and 500 ms to be undefined by these specifications.

Provide a conflict monitor that recognizes the faults specified by CALTRANS’ 2009 TEES and the following additional faults. Ensure the conflict monitor will trigger upon detection of a fault and will remain in the triggered (in fault mode) state until the unit is reset at the front panel or through the external remote reset input for the following failures:

1. **Red Monitoring or Absence of Any Indication (Red Failure):** A condition in which no “on” voltage signal is detected on any of the green, yellow, or red inputs to a given monitor channel. If a signal is not detected on at least one input (R, Y, or G) of a conflict monitor channel for a period greater than 1000 ms when used with a 170 controller and 1500 ms when used with a 2070L controller, ensure monitor will trigger and put the intersection into flash. If the absence of any indication condition lasts less than 750 ms when used with a 170 controller and 1200 ms when used with a 2070L controller, ensure conflict monitor will not trigger. Red fail monitoring shall be enabled on a per channel basis by the use of switches located on the conflict monitor. Have red monitoring occur when all of the following input conditions are in effect:
  - a) Red Enable input to monitor is active (Red Enable voltages are “on” at greater than 70 Vrms, off at less than 50 Vrms, undefined between 50 and 70 Vrms), and
  - b) Neither Special Function 1 nor Special Function 2 inputs are active.
  - c) Pin #EE (output relay common) is not active
2. **Short/Missing Yellow Indication Fault (Clearance Error):** Yellow indication following a green is missing or shorter than 2.7 seconds (with  $\pm 0.1$ -second accuracy). If a channel fails to detect an “on” signal at the Yellow input for a minimum of 2.7 seconds ( $\pm 0.1$  second) following the detection of an “on” signal at a Green input for that channel, ensure that the monitor triggers and generates a clearance/short yellow error fault indication. Short/missing yellow (clearance) monitoring shall be enabled on a per channel basis by the use of switches located on the conflict monitor. This fault shall not occur when the channel is programmed for Yellow Inhibit, when the Red Enable signal is inactive or pin #EE (output relay common) is active.
3. **Dual Indications on the Same Channel:** In this condition, more than one indication (R,Y,G) is detected as “on” at the same time on the same channel. If dual indications are detected for a period greater than 500 ms, ensure that the conflict monitor triggers and displays the proper

failure indication (Dual Ind fault). If this condition is detected for less than 200 ms, ensure that the monitor does not trigger. G-Y-R dual indication monitoring shall be enabled on a per channel basis by the use of switches located on the conflict monitor. G-Y dual indication monitoring shall be enabled for all channels by use of a switch located on the conflict monitor. This fault shall not occur when the Red Enable signal is inactive or pin #EE (output relay common) is active.

4. **Configuration Settings Change:** The configuration settings are comprised of (as a minimum) the permissive diode matrix, dual indication switches, yellow disable jumpers, any option switches, any option jumpers, and the Watchdog Enable switch. Ensure the conflict monitor compares the current configuration settings with the previous stored configuration settings on power-up, on reset, and periodically during operation. If any of the configuration settings are changed, ensure that the conflict monitor triggers and causes the program card indicator to flash. Ensure that configuration change faults are only reset by depressing and holding the front panel reset button for a minimum of three seconds. Ensure the external remote reset input does not reset configuration change faults.

Ensure the conflict monitor will trigger and the AC Power indicator will flash at a rate of 2 Hz  $\pm$  20% with a 50% duty cycle when the AC Line voltage falls below the “drop-out” level. Ensure the conflict monitor will resume normal operation when the AC Line voltage returns above the “restore” level. Ensure the AC Power indicator will remain illuminated when the AC voltage returns above the “restore” level. Should an AC Line power interruption occur while the monitor is in the fault mode, then upon restoration of AC Line power, the monitor will remain in the fault mode and the correct fault and channel indicators will be displayed.

Provide a flash interval of at least 6 seconds and at most 10 seconds in duration following a power-up, an AC Line interruption, or a brownout restore. Ensure the conflict monitor will suspend all fault monitoring functions, close the Output relay contacts, and flash the AC indicator at a rate of 4 Hz  $\pm$  20% with a 50% duty cycle during this interval. Ensure the termination of the flash interval after at least 6 seconds if the Watchdog input has made 5 transitions between the True and False state and the AC Line voltage is greater than the “restore” level. If the watchdog input has not made 5 transitions between the True and False state within 10  $\pm$  0.5 seconds, the monitor shall enter a WDT error fault condition.

Ensure that the conflict monitor will log at least nine of the most recent events detected by the monitor in non-volatile EEPROM memory (or equivalent). For each event, record at a minimum the time, date, type of event, status of each field signal indication with RMS voltage, and specific channels involved with the event. Ensure the conflict monitor will log the following events: monitor reset, configuration, previous fault, and AC line. Furnish the signal sequence log that shows all channel states (Greens, Yellows, and Reds) and the Red Enable State for a minimum of 2 seconds prior to the current fault trigger point. Ensure the display resolution of the inputs for the signal sequence log is not greater than 50 ms.

Provide a RS-232C/D compliant port (DB-9 female connector) on the front panel of the conflict monitor in order to provide communications from the conflict monitor to the 170/2070L controller or to a Department-furnished laptop computer. Electrically isolate the port interface electronics from all monitor electronics, excluding Chassis Ground. Ensure that the controller can receive all event log information through a controller Asynchronous Communications Interface Adapter (Type 170E) or

Async Serial Comm Module (2070L). Provide a Windows based graphic user interface software to communicate directly through the same monitor RS-232C/D compliant port to retrieve and view all event log information to a Department-furnished laptop computer. The RS-232C/D compliant port on the monitor shall allow the monitor to function as a DCE device with pin connections as follows:

| <b>Conflict Monitor RS-232C/D (DB-9 Female) Pinout</b> |                 |            |
|--|-----------------|------------|
| <b>Pin Number</b>                                      | <b>Function</b> | <b>I/O</b> |
| 1  | DCD             | O          |
| 2  | TX Data         | O          |
| 3  | RX Data         | I          |
| 4  | DTR             | I          |
| 5  | Ground          | -          |
| 6  | DSR             | O          |
| 7  | CTS             | I          |
| 8  | RTS             | O          |
| 9  | NC              | -          |

**MONITOR BOARD EDGE CONNECTOR**

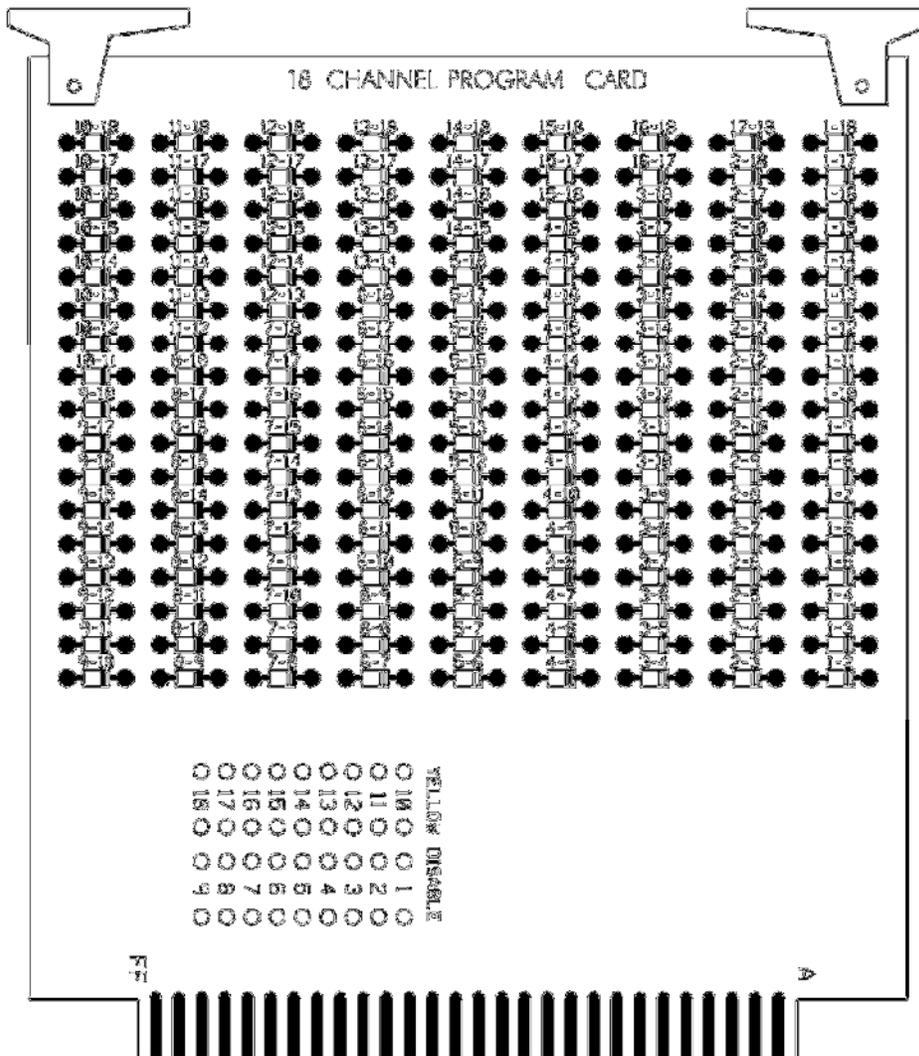
| <b>Pin #</b> | <b>Function (Back Side)</b> | <b>Pin #</b> | <b>Function (Component Side)</b> |
|--------------|-----------------------------|--------------|----------------------------------|
| 1            | Channel 2 Green             | A            | Channel 2 Yellow                 |
| 2            | Channel 13 Green            | B            | Channel 6 Green                  |
| 3            | Channel 6 Yellow            | C            | Channel 15 Green                 |
| 4            | Channel 4 Green             | D            | Channel 4 Yellow                 |
| 5            | Channel 14 Green            | E            | Channel 8 Green                  |
| 6            | Channel 8 Yellow            | F            | Channel 16 Green                 |
| 7            | Channel 5 Green             | H            | Channel 5 Yellow                 |
| 8            | Channel 13 Yellow           | J            | Channel 1 Green                  |
| 9            | Channel 1 Yellow            | K            | Channel 15 Yellow                |
| 10           | Channel 7 Green             | L            | Channel 7 Yellow                 |
| 11           | Channel 14 Yellow           | M            | Channel 3 Green                  |
| 12           | Channel 3 Yellow            | N            | Channel 16 Yellow                |
| 13           | Channel 9 Green             | P            | Channel 17 Yellow                |
| 14           | Channel 17 Green            | R            | Channel 10 Green                 |
| 15           | Channel 11 Yellow           | S            | Channel 11 Green                 |
| 16           | Channel 9 Yellow            | T            | Channel 18 Yellow                |
| 17           | Channel 18 Green            | U            | Channel 10 Yellow                |
| --           |                             | --           |                                  |
| 18           | Channel 12 Yellow           | V            | Channel 12 Green                 |
| 19           | Channel 17 Red              | W            | Channel 18 Red                   |
| 20           | Chassis Ground              | X            | Not Assigned                     |
| 21           | AC-                         | Y            | DC Common                        |
| 22           | Watchdog Timer              | Z            | External Test Reset              |
| 23           | +24VDC                      | AA           | +24VDC                           |
| 24           | Tied to Pin 25              | BB           | Stop Time (Output)               |
| 25           | Tied to Pin 24              | CC           | Not Assigned                     |
| 26           | Not Assigned                | DD           | Not Assigned                     |
| 27           | Relay Output, Side #3, N.O. | EE           | Relay Output, Side #2, Common    |
| 28           | Relay Output, Side #1, N.C. | FF           | AC+                              |

-- Slotted for keying between Pins 17/U and 18/V

**CONFLICT PROGRAM CARD PIN ASSIGNMENTS**

| <b>Pin #</b> | <b>Function (Back Side)</b> | <b>Pin #</b> | <b>Function (Component Side)</b> |
|--------------|-----------------------------|--------------|----------------------------------|
| 1            | Channel 2 Green             | A            | Channel 1 Green                  |
| 2            | Channel 3 Green             | B            | Channel 2 Green                  |
| 3            | Channel 4 Green             | C            | Channel 3 Green                  |
| 4            | Channel 5 Green             | D            | Channel 4 Green                  |
| 5            | Channel 6 Green             | E            | Channel 5 Green                  |
| 6            | Channel 7 Green             | F            | Channel 6 Green                  |
| 7            | Channel 8 Green             | H            | Channel 7 Green                  |
| 8            | Channel 9 Green             | J            | Channel 8 Green                  |
| 9            | Channel 10 Green            | K            | Channel 9 Green                  |
| 10           | Channel 11 Green            | L            | Channel 10 Green                 |
| 11           | Channel 12 Green            | M            | Channel 11 Green                 |
| 12           | Channel 13 Green            | N            | Channel 12 Green                 |
| 13           | Channel 14 Green            | P            | Channel 13 Green                 |
| 14           | Channel 15 Green            | R            | Channel 14 Green                 |
| 15           | Channel 16 Green            | S            | Channel 15 Green                 |
| 16           | N/C                         | T            | PC AJAR                          |
| 17           | Channel 1 Yellow            | U            | Channel 9 Yellow                 |
| 18           | Channel 2 Yellow            | V            | Channel 10 Yellow                |
| 19           | Channel 3 Yellow            | W            | Channel 11 Yellow                |
| 20           | Channel 4 Yellow            | X            | Channel 12 Yellow                |
| 21           | Channel 5 Yellow            | Y            | Channel 13 Yellow                |
| 22           | Channel 6 Yellow            | Z            | Channel 14 Yellow                |
| 23           | Channel 7 Yellow            | AA           | Channel 15 Yellow                |
| 24           | Channel 8 Yellow            | BB           | Channel 16 Yellow                |
| --           |                             | --           |                                  |
| 25           | Channel 17 Green            | CC           | Channel 17 Yellow                |
| 26           | Channel 18 Green            | DD           | Channel 18 Yellow                |
| 27           | Channel 16 Green            | EE           | PC AJAR (Program Card)           |
| 28           | Yellow Inhibit Common       | FF           | Channel 17 Green                 |

-- Slotted for keying between Pins 24/BB and 25/CC



**10.5 MATERIALS – TYPE 170 DETECTOR SENSOR UNITS**

Furnish detector sensor units that comply with Chapter 5 Section 1, “General Requirements,” and Chapter 5 Section 2, “Model 222 & 224 Loop Detector Sensor Unit Requirements,” of the CALTRANS “Transportation Electrical Equipment Specifications” dated March 12, 2009 with Erratum 1.

**10.6 CONSTRUCTION METHODS**

Install ATC Controllers with type 332 controller cabinets as noted in the Plans. Comply with the Standard Specifications:

Page 17-37, Section 1751-3, “Construction Methods”.

At each gantry location install a new cabinet foundation at a location approved by the Engineer. Install necessary conduits and risers for signal cabling, power, communications and grounding. Install a new Type 332, base mount, controller cabinet with base extender along with the ATC

controller and make all connections to the field equipment, driver board cabinets, communications system, power service, and grounding system. Once all connections are made to the driver board cabinet and the new lane control sign displays, test the operations of the new type 332 controller cabinet and ATC controller to ensure that all programming and field connections are accurate and functioning properly.

Prior to removing the existing 170E controller and cabinet from service, ensure that all available firmware and software programs are copied and saved. Remove the existing Type 170E controller and cabinet and install the new Type 332 controller cabinet and new ATC Controller with the 170E emulation software pre-loaded.

Set-up and program the field harden Ethernet switch, as addressed elsewhere in the Project Special Provisions and test to ensure that it is functioning properly. Test the operation of the system from the Central Control Center located at the NCDOT Statewide Operations Center, 1636 Gold Star Dr., Raleigh, NC. Ensure that the user can connect and operate the system from the Central Control Center and via a laptop standing at the controller cabinet.

Return the used 170E controller and Type 170E cabinet removed from service to the Engineer and deliver them to the C. T. Bowers Building located at 4105 Reedy Creek Road, Raleigh, NC. Coordinate delivery of these devices with the Engineer.

**10.7 MEASUREMENT AND PAYMENT**

Actual number of “*ATC Controller*” furnished, installed, tested and accepted. Payment for this item includes the 170E emulation software and all integration associated with providing a function system. ATC controller shall include the ATC controller hardware, with all required ATC Linux operating system and driver files in addition to the 170 Emulation software. NCDOT shall provide the 170 firmware image which shall be loaded on the CPU module.

Actual number of “*Type 332, Base Mount, Controller Cabinet*” furnished, installed, tested and accepted.

No measurement will be made for any additional equipment listed above that is considered to be part of a Type 332 Controller Cabinet. Burn-in and workshop testing of the controllers and cabinets are considered incidental.

Cabinet base adapter/extenders will be reimbursed as described elsewhere in these Project Special Provisions.

Payment will be made under:

|   |             |
|---|-------------|
| <b>ATC Controller.....</b>                            | <b>Each</b> |
| <b>Type 332, Base Mount, Controller Cabinet .....</b> | <b>Each</b> |

## **11. DRIVER BOARD CABINET**

### **11.1 DESCRIPTION**

Furnish a pole mounted cabinet to house the Lane Control Sign's, Driver Boards and their respective Power Distribution Rack assemblies. Ensure the cabinet is designed such that the rack assemblies can be installed back to back so that one rack assembly represents all the lane displays on one side of the gantry and the second rack assembly represents all the lane displays on its corresponding side of the gantry.

Ensure all materials meet the standards of the National Electrical Manufacturers Association, UL, The National Electrical Code, and the American Society for Testing and Materials.

### **11.1 CABINET**

Provide a Type 336 aluminum cabinet with a 19" EIA rack assembly or approved equivalent. The cabinet will have two doors with continuous stainless steel hinges and be gasket-sealed. Ensure the cabinet is designed for mounting on the gantry's upright support post.

Ensure the cabinet is designed to accommodate a minimum of 2 (28 position) Driver Rack assemblies. Additionally ensure the 1<sup>st</sup> driver rack assembly faces one door opening and represents all the displays on one side of the gantry. While the 2<sup>nd</sup> driver rack assembly faces the other door opening and represents all the displays on the opposite side of the gantry.

Ensure that the cabinet is of sufficient size to accommodate the Power Distribution Racks for the Lane Control Sign and such that no more than 80% of the cabinet volume is occupied. Ensure that the cabinet has vents that accept standard size furnace type filters. Size the filter tray to adequately house and secure the filter in place. Ensure there are no obstructions on the interior face of the door to interfere with easy removal and replacement of filters.

Provide an enclosure that is fabricated with unpainted, natural, aluminum. Ensure the equipment cabinet enclosure shell is fitted with one (1) Corbin Number 2 Key on each door, lifting handles, and exhaust ports.

Provide roof with slope (from side to side) at a minimum ratio of 1" drop per 2 feet. Ensure roof is flush with front of the door. Ensure each exterior cabinet plane surface is constructed of a single sheet of seamless aluminum.

Provide a handle and three point latching mechanism designed to be disassembled using hand tools. Provide a shaft connecting the latching plate to the door handle by passing through the door within a bushing, bearing, or equivalent device. Provide a latching plate at least 1/8 inch thick and that mates securely with the lock bolt. Provide a lock bolt with a flat end (no bevel) and that has at least 1/4 inch of length in contact with the latching plate.

Ensure that the handle and lock are positioned so that the lock does not lie in the path of the rotating handle, as the door is unlatched and that the handle points down in the latched position.

Provide door openings that encompass the full frontal area of the cabinet shell. Ensure that the cabinet shell is sturdy and does not exhibit noticeable flexing, bending or distortion under normal conditions, except that a minor amount of flexing is permitted in the main door when the cabinet is open. In such case, the flexing must not result in permanent deformation of the door.

A police panel door is **not** required for these cabinets.

Provide surge suppression in the cabinet and ensure that all devices operate over the temperature range of -40 to 185 degrees F.

Arrange equipment and terminals within the cabinet so that they will not interfere with the entrance, tracing and connection of conductors or other cables. Ensure all incoming and outgoing conductors are connected to terminal blocks. Ensure all field terminals are readily accessible without having to remove equipment to gain access. Ensure terminals are not located on the underside of shelf or at any other place where they are not readily visible or where they may present a hazard to personnel who might inadvertently touch them.

Provide terminal blocks that are made of electrical grade thermoplastic or thermosetting plastic. Ensure each terminal block is of closed back design and has recessed-screw terminals with molded barriers between terminals. Ensure each terminal consists of two terminal screws with removable shorting bar between them. Ensure all terminal blocks and terminals are labeled with their intended functions. Provide labels that are visible and easy to read when the terminal blocks are wired.

## **11.2 DRIVER BOARD and RACK ASSEMBLY**

### **A. Rack Assembly:**

Provide driver board rack assemblies capable of operating 28 individual driver boards. Ensure the driver board rack assembly a single part, self-contained module consisting of an interconnect PCB and anodized aluminum frame. Ensure the aluminum rack is vented from top to bottom and includes latches to lock the modules in place. Ensure the rack enclosure is secured inside the cabinet by a minimum of 4 captive type spring-loaded thumbscrews.

Ensure the interconnect PCB shall include connectors for 28 driver boards and capable of operating 28 display messages. Ensure the interconnect PCB includes terminals for all field wiring: 120VAC controls, external photocell, and alarm signals. Ensure all connections to the driver board rack assembly are accomplished through the PCB, no internal wiring shall be permitted with the exception of the signal cables originating from the Lane Control Cabinet and the signal cabling running up to the PCB located in the lane control sign.

All connectors and terminals shall be identified via a silk screen identifier on the surface of the PCB. Ensure the design of the rack assembly allows the PCB to be mounted vertically to facilitate air-cooling and prevent the collection of moisture and dust on the boards. Ensure the driver board rack assembly is CSA/UL certified.

## **B. Driver Boards:**

Furnish a driver board for each message to be displayed in the lane control sign. Ensure the driver boards are designed to be “rack mounted” as per industry standards 6.5” x 4.5” and will fit inside the supplied rack assembly. Ensure the driver boards consist of a PCB (0.62" thick) with an aluminum front plate and handle as commonly used for vehicle detectors.

Ensure the driver boards are designed to drive the LED's at a DC current not exceeding the maximum rating recommended by the LED manufacturer (20mA). Ensure the driver boards regulates the drive current to compensate for line voltage fluctuations over the range of 90VAC to 135 VAC. The luminous output of the display shall not vary more than 1% over the voltage range and shall not be perceptible to the human eye. Ensure the driver boards can produce up to 25 watts of power and maintain a constant LED drive current regardless of outside temperature (-30°C to +40°C).

Ensure the driver boards are fused protected and include voltage surge protection to withstand high -repetition noise transients and low- repetition high-energy transients as stated in section 2.1.6, NEMA Standard TS-2, 1992. Additionally ensure the on-board circuitry meets FCC title 47, sub-part B, section 15 regulations concerning the emission of electronic noise. Ensure the driver board's circuitry is designed to operate with the load switches and conflict monitors associated with the 170E Cabinet and 2070 ATC Controller.

Ensure the driver boards are designed to provide automatic dimming when connected to an external photocell. In order to assure optimal legibility of the sign displays in all ambient lighting conditions, the system shall provide “progressive” dimming by reducing the drive current progressively based on the linear signal output of the photocell. Ensure the driver board is capable of reducing the driver current on the display up to 90% if necessary. Ensure the dimming circuit has a minimum of a 30 second delay to prevent interference caused by shadows or headlights. Ensure the LED Driver current is regulated just as effectively when in the "dimmed state" and shall maintain a power factor > 90% and a THD < 20% over the entire dimming range. Ensure the LED intensity range (fluctuation %) is user selectable to provide optimal illumination efficiency for all types of LED's and colors. Ensure the illumination range level can also be user selectable to increase or decrease the intensity level of the entire illumination range.

Ensure the driver boards include a flashing output option with 2 flash rate options and can be selected to either be in synch or wig/wag mode.

Ensure the driver modules are capable of providing a “confirmation” or “alarm” signal that can be configured for 120 VAC or 24 VDC PLC applications (sinking or sourcing type).

Provide driver modules with a green LED for power status a yellow LED for dimming status and a red LED for alarm status.

## **11.3 POWER SYSTEM**

### **A. Power Distribution System**

Furnish an AC power distribution system which includes a main circuit breaker and distribution breakers for equipment and convenience outlets and cabinet lighting and fan.

## **B. Surge Protection 120 VAC**

Furnish and install a 120 volt AC single phase surge protector as a precautionary measure against possible damage resulting from voltage surges on all incoming power lines. In addition, the surge protector will remove high energy surges and block high speed transients. Provide the surge protector with the following specifications:

- Peak Current: 20,000 amps (8x20  $\mu$ s waveshape)
- Occurrences: 20 times at peak current
- Clamp Voltage: 340 Volts, Max.
- Response Time: 5 Nanoseconds or less
- Minimum Series Inductance: 200 microhenries
- Continuous Series Current: 10 amps
- Temperature Range: to -40 °F to +185 °F

## **C. Surge Protection for Driver Boards and Lane Control Sign Displays**

Furnish and install a surge protector as a precautionary measure against possible damage resulting from voltage surges on the signal cable lines. In addition, the surge protector will remove high energy surges and block high speed transients. Provide the surge protector with the following specifications:

- Clamping Voltage: 200 V  $\pm$ 10%
- Energy rating (Minimum): 400 J
- Series Resistance: 30  $\Omega$
- Response Time (maximum): 5 ns

## **11.4 CONSTRUCTION METHODS**

### **A. Driver board Cabinet**

Install the cabinet to the upright post of the gantry such that both doors are readily accessible. Furnish stainless steel hardware approved by the Engineer to secure the cabinet to the pole. Ensure the centers of the cabinet doors are no more than 4 feet above grade level.

Install a new power feeder conduit between the service disconnect and the Driver Board Cabinet to supply power to the Driver Rack Assembly and internal components (lights, fan, convenience receptacles, etc.). Install new 2" rigid metallic steel conduit/risers with weatherheads from the bottom of the Driver Board Cabinet and up the structure to the existing Lane Control Signs. Use 90° sweeping elbows and LB – Type condulets to gain access into the bottom of the new Driver Board Cabinet. Strap the conduit/risers to the pole so secure them in place by a method approved by the Engineer.

Install new signal wiring between the Type 332 controller cabinet and the Driver Board Cabinet and between the Driver Board Cabinet and the individual Lane Control Signs and make the system operational.

Once all connections and terminations are made between the Driver Board Cabinet and the lane control signs, remove all existing above grade sections of 2” conduit that contained the existing signal cable.

Return the used Driver Boards and Driver Rack Assemblies removed from service to the Engineer and deliver them to the C. T. Bowers Building located at 4105 Reedy Creek Road, Raleigh, NC. Coordinate delivery of these devices with the Engineer.

**11.5 MEASUREMENT AND PAYMENT**

Actual number of “*Driver Board Cabinet*” as described above furnished, installed and accepted. Payment includes the cabinet, cabinet installation, power distribution system, driver rack assemblies, surge protection and removal of the existing 2” conduit.

No separate measurement will be made for testing, or any other equipment or labor required for installing the Driver Board Cabinet as described above.

Actual number of “*Driver Boards*” furnished installed and accepted. This item includes all items of work associated with installing the Driver Board inside the cabinet, and testing of the system.

All work associated with installing Conduits, Risers, 90° sweeping elbows, LB – Type condulets, strapping are covered elsewhere in the project Special Provisions. All work associated with installing signal cabling in the conduit/risers and strapping the signal cabling to the structure, including termination of the cables are covered elsewhere in the Project Special Provisions.

Feeder conductors will be reimbursed as described elsewhere in these Project Special Provisions.

Payment will be made under:

|                                  |             |
|----------------------------------|-------------|
| <b>Driver Board Cabinet.....</b> | <b>Each</b> |
| <b>Driver Board .....</b>        | <b>Each</b> |

**12. MESSAGE DISPLAY BOARDS**

**12.1 DESCRIPTION**

Furnish new LED lane control sign message display boards (2 per sign) to mount inside of the existing lane control sign housings. Ensure the message display boards are fabricated to fit inside the existing sign housing which were manufactured by Tassimco Technologies, Inc. Contact Tassimco, Inc. (Mr. Conrad Di Pietro @ 800-363-5913 ext. 203) to obtain necessary dimensions for manufacturing the new LED lane control sign message display boards. The outside dimensions of the lane control sign housing are 28 ½” (w) x 38 ½” (h) x 8” (d).

**12.2 MATERIALS**

Furnish message display boards that can display a minimum of 1 message and up to a maximum of 6 messages. Ensure the messages are clear and legible under any lightning conditions at a distance of up to 1000 ft. Ensure the message display board is modular in construction and can be

easily removed without the use of power tools. No self-tapping fasteners may be used to secure the message board to the inside of the lane control sign and all fasteners shall be stainless steel.

### 12.3 CHROMATICITY

The measured chromaticity coordinates for the red, amber, green and lunar white messages shall conform to the chromaticity requirements of section 8.04 and figure 1 of the VTCSH Standard. The chromaticity measurements shall remain unchanged over the input line voltage range of 90 VAC to 135 VAC being feed into the driver boards.

### 12.4 LED MESSAGE DISPLAYS

Furnish message display boards that consist of LED's mounted on a PCB matrix with a matte black solder mask. The "universal" PCB matrix shall have the capabilities to display up to 11 messages: 1- red X, 2- green ↓, 3- yellow ↘, 4- yellow ↙, 5- yellow X, 6- \*R3-9a, 7- \*R3-5-1, 8- \*R3-5-2, 9- \*R3-5a, 10- \*R3-6L, 11- \*R3-6R, (\*MUTCD) graphical representation of the messages are shown on the plans or drawings. The red, yellow X's, and green ↓ shall use a double stroke LED pattern and arrows messages and "ONLY" messages shall use a single stroke pattern. The red, yellow X's, green ↓ shall have a minimum height of 18 inches (the R3-6L and 6R messages shall be 30 inches high and the size of the housing will be 28"x38"). Only the LED's for the required messages shall be installed on the display matrix (minimum one (1) message, maximum six (6) messages).

The LED's shall be arranged in a manner to form an outline of the symbols and shall be distributed evenly. The maximum distance between consecutive LED's shall be 0.5 inches and shall not vary more than 10%. The PCB matrix shall have a minimum thickness of .093 inches. The PCB shall have a component identifier silk screen and shall be conformal coated.

The red and amber LED's shall be of the latest AlIn GaP Technology, the green and lunar white LED's shall be of the latest In GaN Technology. The minimum nominal luminous intensity of the LED's shall be 6,000 mcd at 20mA. Ensure the individual LED light sources are interconnected so that a catastrophic failure of a single LED will result in a total loss of not more than 5% of total number of LED's.

There shall be no electronic components visible on the front of the display. The display face shall consist solely of LED's mounted on a mat black PCB. Ensure the rear side of the PCB is protected by a molded polymeric back cover to seal and protect it from any possible damages.

The display PCB with back cover shall fit into front door which consist of an aluminum frame and face lens. The face lens shall be made of .250 inches (1/4") non glare matte-finish polycarbonate with UV resistant surface treatment. The lens shall have light transmission properties of at least 82%. Ensure the entire display face shall be assembled as a one piece self-contained module that can be easily removed from the sign housing in less than one minute without the need for any tool.

The door face shall be mounted on the sign housing on two (2) stainless steel "lift-off" type hinges and shall be latched using two (2) stainless steel 1/4 turn link locks. Ensure the display module is provided with a multi-conductor cable with an individual 2 pin connector for each message.

Ensure each display module is supplied with a multi-conductor cable with individual 2 pin connectors for each message. Provide a new PCB terminal board with terminal strips to receive the multi-conductor cable. Ensure the PCB also has provisions to terminate on barrier type terminal strips the new signal cable that will be originating from the Driver Board Cabinet. Ensure the 2 pin connectors and terminal stripes have an engineering approved method for labeling what message is being displayed.

## 12.5 CONSTRUCTION METHOD

Remove the existing message display boards, driver cards and driver board rack assembly from the lane control sign housing. Install the new PCB terminal board inside the lane control sign using stainless steel fasteners and install the new message display boards inside the face assembly of the lane control sign. Terminate the individual 2 pin connectors for each message on the PCB terminal board and the signal conductors originating from the new driver board cabinet. Label and identify all wires and cabling as to their intended function to aid in future servicing of the sign enclosures. Provide a labeling method that is approved by the Engineer.

Return the used LED Display Boards removed from service to the Engineer and deliver them to the C. T. Bowers Building located at 4105 Reedy Creek Road, Raleigh, NC. Coordinate delivery of these devices with the Engineer.

## 12.6 BASIS OF PAYMENT

Actual number of LED message display boards as described above furnished, installed and accepted. Payment includes the LED message display boards, removal of the existing message display boards, driver boards and driver rack assemblies and the installation of the PCB terminal board, termination of the cabling, and testing of the signs.

Payment will be based on the number of LED message display boards and the number of messages displayed on each board as follows:

|   |      |
|---|------|
| LED Message Display Board (1 Message) ..... | EACH |
| LED Message Display Board (2 Message) ..... | EACH |
| LED Message Display Board (3 Message) ..... | EACH |
| LED Message Display Board (5 Message) ..... | EACH |
| LED Message Display Board (6 Message) ..... | EACH |

## 13. SYSTEM SUPPORT EQUIPMENT

### 13.1 DESCRIPTION

Furnish System Support Equipment with all necessary hardware in accordance with the Plans and these Project Special Provisions. Comply with the provisions of Section 1700 of the NCDOT Standard Specifications.

**13.2 MATERIAL**

Prior to the 30-day Observation Period, furnish all system support equipment.

Furnish new, unused equipment with test probes/leads, batteries (for battery-operated units).  
Furnish all cords and carrying cases. Furnish the following System Support Equipment:

- fully functioning ATC Controllers with all modules as identified elsewhere in these Project Special Provisions
- Driver Board Modules for the Lane Control Sign
- Driver Board Rack Assembly for the Lane Control Sign Driver Boards

**13.3 MEASUREMENT AND PAYMENT**

Actual number of “*Furnish ATC Controllers*” furnished and accepted.

Actual number of “*Furnish Driver Boards*” furnished and accepted.

Actual number of “*Furnish Driver Board Rack Assembly*” furnished and accepted.

Payment will be made under:

**Pay Items**

|  |      |
|--|------|
| Furnish ATC Controller.....              | Each |
| Furnish Driver Board.....                | Each |
| Furnish Driver Board Rack Assembly ..... | Each |

**14. SYSTEM TESTING**

**14.1 DESCRIPTION**

**A. General**

The Contractor is responsible for documenting the results of all tests and for furnishing the documented testing results to the Engineer. The Contractor is responsible for correcting all deficiencies in performance discovered during system testing.

Submit to the Engineer for review a test plan for the system testing. The Engineer will either approve or indicate changes that are required for approval within forty (40) calendar days of receipt of the test plan. Submit a revised test plan to the Engineer for review within forty (40) calendar days

following receipt of the review of the initial plan. The review and re-submittal process described above will continue until the Engineer approves a final test plan. Multiple submittals of the test plan, if required, will be supplied at no additional cost. Testing will commence at a time mutually agreed by the Contractor and the Engineer.

The Testing will be executed on the basis of the approved test plan only. The Engineer or his representative will witness all tests. If any component has been modified due to system testing performance failure, a report must be prepared by the Contractor and delivered to the Engineer prior re-testing.

### **B. On-Street Testing**

Test the system at each gantry location using software loaded on a laptop connected straight in to the Controllers Model 2070-2A Communications Module. Testing will ensure that each gantry is wired correctly and that commands initiated through the laptop programming will cause the gantry to sequence properly through all of its programmed phasing sequences. Additionally connect the laptop to the Ethernet Switch to ensure that proper command of the controller is maintained and established.

Demonstrate that the controller can be programmed and manipulated through the front panel display of the controller.

Submit a test plan to demonstrate these functions and capabilities to the Engineer for approval.

### **C. Central Control Center Testing**

Test the system from the Central Control Center to ensure that communications to each gantry has not been effected and is operating correctly. Demonstrate that the system will function using the control software as originally designed and installed.

Demonstrate uploading and downloading of information to the controllers. As a minimum show updating the time clocks, uploading various data pages and downloading new data to various data pages. Submit a test plan to demonstrate these functions and capabilities to the Engineer for approval.

## **14.2 MEASUREMENT AND PAYMENT**

There will be no direct payment for the work covered by this section.

Payment for this work will be covered in the applicable sections of these Project Special Provisions at the contract unit price, and will be full compensation for all work listed above.

## **15. 30-DAY OBSERVATION PERIOD**

### **15.1 DESCRIPTION**

Upon completion of all project work, the successful completion of all tests, and the correction of all deficiencies, including minor construction items, a 30-day observation period will commence. This observation period consists of 30 days of continuous operation of the new field equipment and central equipment without any failure. The 30-Day Observation Period will be warranted by the payment and performance bond. The purpose of this observation period is to ensure that all components of the system function in accordance with the Project Special Project Provisions over an extended length of time.

**Complete all documentation prior to the end of the 30-Day Observation Period. The 30-Day Observation Period will not be considered part of the contract time.**

Respond to failures that occur during the 30-Day Observation Period within twenty-four (24) hours. Correct said failures within forty-eight (48) hours. Failures that affect any of the major system components defined below for more than forty-eight (48) hours will suspend the timing of the 30-Day Observation Period beginning at the time when the failure occurred. After the cause of such failures has been corrected, timing of the 30-Day Observation Period will resume. System or components failures that necessitate a redesign of any component and failures in any of the major system components exceeding a total of three (3) occurrences, will terminate the 30-Day Observation Period and cause the 30-Day Observation Period to be restarted from zero when the redesigned components have been installed and/or the failures corrected. The major system components are:

- Type 332 Controller Cabinet
- ATC Controller
- Ethernet Switch
- Lane Control Signs
- Driver Boards
- Driver rack Assembly
- Emulation Software

### **15.2 MEASUREMENT AND PAYMENT**

There will be no direct payment for the work covered by this section.

Payment for this work will be covered in the applicable sections of these Project Special Provisions at the contract unit price, and will be full compensation for all work listed above.