



Project Special Provisions

(Version 06.7)

Signals and Intelligent Transportation Systems

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1. 2006 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES

The 2006 Standard Specifications are revised as follows:

1.1. General Requirements (1098-1)

Page 10-268, Subarticle 1098-1(H)

In the first paragraph, revise the second sentence to “Ensure service disconnects are listed as meeting UL Standard UL-489 and marked as being suitable for use as service equipment.”

In the second paragraph, revise the first sentence to “Furnish NEMA Type 3R meter base rated 100 Ampere minimum that meets the requirements of the local utility. Provide meter base with sockets’ ampere rating based on sockets being wired with minimum of 167 degrees F insulated wire.”

In the second paragraph, last item on page, revise to “With or without horn bypass.”

Page 10-269, Subarticle 1098-1(H)

Revise the second line to “Listed as meeting UL Standard UL-414.”

In the first full paragraph on page, remove the first sentence.

Revise the last paragraph to “If meter base and electrical service disconnect are supplied in the same enclosure, ensure assembly is marked as being suitable for use as service equipment. Ensure combination meter and disconnect mounted in a pedestal for underground service is listed as meeting UL Standard UL-231. Otherwise, ensure combination meter and disconnect is listed as meeting UL Standard UL-67.

Page 10-269, Subarticle 1098-1 (J)

ADD new Subarticle 1098-1 (J) Performance of Warranty Repair and Maintenance

Provide authorization to the Traffic Electronics Center of the North Carolina Department of Transportation (NCDOT) to perform all warranty repairs after project acceptance. The decision to perform warranty work at the Traffic Electronics Center by NCDOT electronics technicians or to have warranty work performed by the vendor shall be at the discretion of the State. Provide any training required by the manufacturer to authorize the Traffic Electronics Center to perform warranty work and ensure manufacturer will furnish parts to the Traffic Electronics Center for all warranty repairs at no cost to the State. In addition, ensure the manufacturer agrees to provide prompt technical support to the NCDOT electronics technicians for a period of one year after the end of the warranty period at no cost to the State. Defective parts replaced under warranty by the Traffic Electronics Center will be returned to the vendor at the vendor’s request. Provide schematics, part lists, and other documentation to perform bench repair to the Traffic Electronics Center within two weeks upon request. The Department agrees not to divulge any proprietary information in the schematics, part lists, and other documentation upon request from the vendor. After project acceptance and at the request of the State, manufacturer shall perform warranty repairs to equipment which fails during the warranty period at no cost to the State including freight costs to ship repaired equipment back to the Traffic Electronics Center. Ensure all equipment is repaired and returned to the Traffic Electronics Center within twenty-one calendar days of receipt by the manufacturer.

Page 10-269, Subarticle 1098-1 (K)

ADD new Subarticle 1098-1 (K) Maintenance and Repair of Materials

Perform maintenance (testing) on all Traffic Signal Conflict Monitors every twelve (12) months for the life of the project beginning with the initial test and every twelve (12) months thereafter. Provide the initial test date via the manufacturer’s certification or via testing prior to installation of

the conflict monitor at an intersection. Use the ATSI Incorporated Model PCMT-2600 Conflict Monitor Tester, or an Engineer approved equivalent. Ensure that the Conflict Monitor Tester is maintained and calibrated per the manufacturer's recommendation. Provide to the Engineer a copy of the manufacturer's certification that the Conflict Monitor Tester is in proper working order before testing the Traffic Signal Conflict Monitors. Perform the test on the Traffic Signal Conflict Monitors per the manufacturer's recommendation. For each Traffic Signal Conflict Monitor tested, provide two (2) dated copies of the test results: one (1) copy for the Engineer and one (1) copy for the traffic signal cabinet.

1.2. Loop Lead-in Cable (1098-8)

Page 10-274, Delete article and replace with the following:

Furnish lead-in cable with two conductors of number 14 AWG fabricated from stranded tinned copper that complies with IMSA Specification 50-2 except as follows:

Ensure conductor is twisted with a maximum lay of 2.0 inches, resulting in a minimum of 6 turns per foot.

Provide a ripcord to allow cable jacket to be opened without using a cutter.

Provide length markings in a contrasting color showing sequential feet and within one percent of actual cable length. Ensure character height of the markings is approximately 0.10 inch.

1.3. Pedestals (1098-13)

Page 10-279, Subarticle 1098-13, Replace the last paragraph with the following:

For each pedestal, provide four anchor bolts in accordance with ASTM F 1554 Grade 55 with outside diameter of 3/4" and length of 18" each having two heavy hex nuts with two washers at the top and two heavy hex nuts with one washer at the bottom. Provide anchor bolts with coarse threads at 10 threads per inch for a minimum length of 4 inches from each end of the bolt. Ensure anchor bolts are hot-dipped galvanized in accordance with ASTM A 153 with completely galvanized nuts and washers. Provide hex nuts with coarse threads. Ensure hex nuts are in accordance with ASTM A 563 Grade DH, ASTM A 194 Grade 2H, or equivalent. Ensure washers are in accordance with ASTM F 436 or equivalent. As a minimum, provide standard size washers.

1.4. Underground Conduit – Construction Methods (1715-3)

Page 17-10, Subarticle 1715-3(B) Section (1), Revise 1st paragraph, 2nd sentence to:

Install rigid metallic conduit for all underground runs located inside railroad right-of-way.

1.5. Junction Boxes – Construction Methods (1716-3)

Page 17-15, Subarticle 1716-3, add the following information at the end of the subarticle:

Provide real world coordinates for all junction boxes and equipment cabinets installed or utilized 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 in the horizontal plane and 3.3 feet 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.

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 #
05-0134	Equipment Cabinet	US 70 at Raynor Rd/ Auburn-Knightdale	-78.5500	35.6873	McCain	Type-332
05-0134	Junction Box # 1 (Phase 2 Side)	US 70 at Raynor Rd/ Auburn-Knightdale	-78.5516	35.6879	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 2 (Phase 2 Side)	US 70 at Raynor Rd/ Auburn-Knightdale	-78.5506	35.6876	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 3 (Near Cabinet)	US 70 at Raynor Rd/ Auburn-Knightdale	-78.5501	35.6873	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 4 (Phase 6 Side)	US 70 at Raynor Rd/ Auburn-Knightdale	-78.5486	35.6873	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 5 (Phase 6 Side)	US 70 at Raynor Rd/ Auburn-Knightdale	-78.5493	35.6876	Quazite	PG1118BA12(Box) PG118HA00(Cover)
05-0134	Junction Box # 6 (Phase 4 Side)	US 70 at Raynor Rd/ Auburn-Knightdale	-78.5503	35.6879	Quazite	PG1118BA12(Box) PG118HA00(Cover)

1.6. Loop Lead-in Cable – Measurement and Payment (1726-4)

Page 17-20, Delete first paragraph and replace with the following:

Lead-in cable will be measured and paid as the actual linear feet of lead-in cable furnished, installed, and accepted. Measurement will be made by calculating the difference in length markings located on outer jacket from start of run to end of run for each run. Terminate all cables before determining length of cable run.

2. ELECTRICAL REQUIREMENTS

Ensure that an IMSA certified, or equivalent, Level II traffic qualified signal technician is standing by to provide emergency maintenance services whenever work is being performed on traffic signal controller cabinets and traffic signal controller cabinet foundations. Stand by status is defined as being able to arrive, fully equipped, at the work site within 30 minutes ready to provide maintenance services.

3. SIGNAL HEADS

3.1. MATERIALS

A. General:

Fabricate vehicle signal head housings, end caps, and visors from virgin polycarbonate material. Fabricate 16-inch pedestrian signal head housings, end caps, and visors from virgin polycarbonate material. Fabricate 9-inch pedestrian signal head housings, end caps, and visors from virgin polycarbonate material. Provide U.V. stabilized polycarbonate plastic with a minimum thickness of 0.1±0.01 inches that is black. Ensure the color is incorporated into the plastic material before molding the signal head housings, end caps, and visors. Ensure the plastic formulation provides the following physical properties in the assembly (tests may be performed on separately molded specimens):

Test	Required	Method
Specific Gravity	1.17 minimum	ASTM D 792
Vicat Softening Temperature, °F	305-325	ASTM D 1525
Brittleness Temperature, °F	Below -200	ASTM D 746
Flammability	Self-extinguishing	ASTM D 635
Tensile Strength, yield, PSI	8500 minimum	ASTM D 638
Elongation at yield, %	5.5-8.5	ASTM D 638
Shear, strength, yield, PSI	5500 minimum	ASTM D 732
Izod impact strength, ft-lb/in [notched, 1/8 inch]	15 minimum	ASTM D 256
Fatigue strength, PSI at 2.5 mm cycles	950 minimum	ASTM D 671

Provide visor mounting screws, door latches, and hinge pins fabricated from stainless steel. Provide interior screws, fasteners, and metal parts fabricated from stainless steel or corrosion resistant material.

For pole mounting, provide side of pole mounting assemblies with framework and all other hardware necessary to make complete, watertight connections of the signal heads to the poles and pedestals. Fabricate the mounting assemblies and frames from aluminum with all necessary hardware, screws, washers, etc. to be stainless steel. Provide mounting fittings that match the positive locking device on the signal head with the serrations integrally cast into the brackets. Provide upper and lower pole plates that have a 1 ¼-inch vertical conduit entrance hubs with the hubs capped on the lower plate and 1 ½-inch horizontal hubs. Ensure that the assemblies provide rigid attachments to poles and pedestals so as to allow no twisting or swaying of the signal heads. Ensure that all raceways are free of sharp edges and protrusions, and can accommodate a minimum of ten Number 14 AWG conductors.

For pedestal mounting, provide a post-top slipfitter mounting assembly that matches the positive locking device on the signal head with serrations integrally cast into the slipfitter. Provide stainless steel hardware, screws, washers, etc. Provide a minimum of six 3/8 X 3/4-inch long square head bolts for attachment to pedestal. Provide a center post for multi-way slipfitters.

For light emitting diode (LED) traffic signal modules, provide the following requirements for inclusion on the Department’s Qualified Products List for traffic signal equipment.

1. Sample submittal,
2. Third-party independent laboratory testing results for each submitted module with evidence of testing and conformance with all of the Design Qualification Testing specified in section 6.4 of each of the following Institute of Transportation Engineers (ITE) specifications:
 - Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement
 - Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement
 - Pedestrian Traffic Control Signal Indications – Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules.

(Note: The Department currently recognizes two approved independent testing laboratories. They are Intertek ETL Semko and Light Metrics, Incorporated with Garwood Laboratories.

Independent laboratory tests from other laboratories may be considered as part of the QPL submittal at the discretion of the Department,

3. Evidence of conformance with the requirements of these specifications,
4. A manufacturer's warranty statement in accordance with the required warranty, and
5. Submittal of manufacturer's design and production documentation for the model, including but not limited to, electrical schematics, electronic component values, proprietary part numbers, bill of materials, and production electrical and photometric test parameters.
6. Evidence of approval of the product to bear the Intertek ETL Verified product label for LED traffic signal modules.

In addition to meeting the performance requirements for the minimum period of 60 months, provide a written warranty against defects in materials and workmanship for the modules for a period of 60 months after installation of the modules. During the warranty period, the manufacturer must provide new replacement modules within 45 days of receipt of modules that have failed at no cost to the State. Repaired or refurbished modules may not be used to fulfill the manufacturer's warranty obligations. Provide manufacturer's warranty documentation to the Department during evaluation of product for inclusion on Qualified Products List (QPL).

B. Vehicle Signal Heads:

Comply with the ITE standard "Vehicle Traffic Control Signal Heads". Provide housings with provisions for attaching backplates.

Provide visors that are 8 inches in length for 8-inch vehicle signal head sections. Provide visors that are 10 inches in length for 12-inch vehicle signal heads.

Provide a termination block with one empty terminal for field wiring for each indication plus one empty terminal for the neutral conductor. Have all signal sections wired to the termination block. Provide barriers between the terminals that have terminal screws with a minimum Number 8 thread size and that will accommodate and secure spade lugs sized for a Number 10 terminal screw.

Mount termination blocks in the yellow signal head sections on all in-line vehicle signal heads. Mount the termination block in the red section on five-section vehicle signal heads.

Furnish vehicle signal head interconnecting brackets. Provide one-piece aluminum brackets less than 4.5 inches in height and with no threaded pipe connections. Provide hand holes on the bottom of the brackets to aid in installing wires to the signal heads. Lower brackets that carry no wires and are used only for connecting the bottom signal sections together may be flat in construction.

For messenger cable mounting, provide messenger cable hangers, wire outlet bodies, balance adjusters, bottom caps, wire entrance fitting brackets, and all other hardware necessary to make complete, watertight connections of the vehicle signal heads to the messenger cable. Fabricate mounting assemblies from malleable iron or steel and provide serrated rings made of aluminum. Provide messenger cable hangers and balance adjusters that are galvanized before being painted. Fabricate balance adjuster eyebolt and eyebolt nut from stainless steel or galvanized malleable iron. Provide messenger cable hangers with U-bolt clamps. Fabricate washers, screws, bolts, clevis pins, cotter pins, nuts, and U-bolt clamps from stainless steel.

For mast-arm mounting, provide rigid vehicle signal head mounting brackets and all other hardware necessary to make complete, watertight connections of the vehicle signal heads to the mast arms and to provide a means for vertically adjusting the vehicle signal heads to proper alignment. Fabricate the mounting assemblies from malleable iron or aluminum, and provide serrated rings made of aluminum.

Provide LED vehicular traffic signal modules (hereafter referred to as modules) that consist of an assembly that uses LEDs as the light source in lieu of an incandescent lamp for use in traffic signal sections. Use LEDs that are aluminum indium gallium phosphorus (AlInGaP) technology for red and yellow indications and indium gallium nitride (InGaN) for green indications. Install the ultra bright type LEDs that are rated for 100,000 hours of continuous operation from -40°F to +165°F Design modules to have a minimum useful life of 60 months and to meet all parameters of this specification during this period of useful life.

For the modules, provide spade terminals crimped to the lead wires and sized for a #10 screw connection to the existing terminal block in a standard signal head. Do not provide other types of crimped terminals with a spade adapter.

Ensure the power supply is integral to the module assembly On the back of the module, permanently mark the date of manufacture (month & year) or some other method of identifying date of manufacture.

Tint the red, yellow and green lenses to correspond with the wavelength (chromaticity) of the LED. Transparent tinting films are unacceptable. Provide a lens that is integral to the unit with a smooth outer surface.

1. LED Circular Signal Modules:

Provide modules in the following configurations: 12-inch circular sections, and 8-inch circular sections. All makes and models of LED modules purchased for use on the State Highway System shall appear on the current NCDOT Traffic Signal Qualified Products List (QPL).

Provide the manufacturer’s model number and the product number (assigned by the Department) for each module that appears on the 2006 or most recent Qualified Products List. In addition, provide manufacturer’s certification in accordance with Article 106-3 of the *Standard Specifications*, that each module meets or exceeds the ITE “Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement” dated June 27, 2005 (hereafter referred to as VTCSH Circular Supplement) and other requirements stated in this specification.

Provide modules that meet the following requirements when tested under the procedures outlined in the VTCSH Circular Supplement:

Module Type	Max. Wattage at 165° F	Nominal Wattage at 77° F
12-inch red circular	17	11
8-inch red circular	13	8
12-inch green circular	15	15
8-inch green circular	12	12

For yellow circular signal modules, provide modules tested under the procedures outlined in the VTCSH Circular Supplement to insure power required at 77° F is 22 Watts or less for the 12-inch circular module and 13 Watts or less for the 8-inch circular module.

Note: Use a wattmeter having an accuracy of ±1% to measure the nominal wattage and maximum wattage of a circular traffic signal module. Power may also be derived from voltage, current and power factor measurements.

2. LED Arrow Signal Modules

Provide 12-inch omnidirectional arrow signal modules. All makes and models of LED modules purchased for use on the State Highway System shall appear on the current NCDOT Traffic Signal Qualified Products List (QPL).

Provide the manufacturer’s model number and the product number (assigned by the Department) for each module that appears on the 2006 or most recent Qualified Products List. In addition, provide manufacturer’s certification in accordance with Article 106-3 of the *Standard Specifications*, that each module meets or exceeds the requirements for 12-inch omnidirectional modules specified in the ITE “Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Vehicle Arrow Traffic Signal Supplement” dated July 1, 2007 (hereafter referred to as VTCSH Arrow Supplement) and other requirements stated in this specification.

Provide modules that meet the following requirements when tested under the procedures outlined in the VTCSH Arrow Supplement:

Module Type	Max. Wattage at 165° F	Nominal Wattage at 77° F
12-inch red arrow	12	9
12-inch green arrow	11	11

For yellow arrow signal modules, provide modules tested under the procedures outlined in the VTCSH Arrow Supplement to insure power required at 77° F is 12 Watts or less.

Note: Use a wattmeter having an accuracy of ±1% to measure the nominal wattage and maximum wattage of an arrow traffic signal module. Power may also be derived from voltage, current and power factor measurements.

C. Pedestrian Signal Heads:

Provide pedestrian signal heads with international symbols that meet the MUTCD. Do not provide letter indications.

Comply with the ITE standard for “Pedestrian Traffic Control Signal Indications” and the following sections of the ITE standard for “Vehicle Traffic Control Signal Heads” in effect on the date of advertisement:

- Section 3.00 - “Physical and Mechanical Requirements”
- Section 4.01 - “Housing, Door, and Visor: General”
- Section 4.04 - “Housing, Door, and Visor: Materials and Fabrication”
- Section 7.00 - “Exterior Finish”

Provide a double-row termination block with three empty terminals and number 10 screws for field wiring. Provide barriers between the terminals that accommodate a spade lug sized for number 10 terminal screws. Mount the termination block in the hand section. Wire all signal sections to the terminal block.

Where required by the plans, provide 16-inch pedestrian signal heads with traditional three-sided, rectangular visors, 6 inches long. Where required by the plans, provide 12-inch pedestrian signal heads with traditional three-sided, rectangular visors, 8 inches long.

Design the LED pedestrian traffic signal modules (hereafter referred to as modules) for installation into standard pedestrian traffic signal sections that do not contain the incandescent signal section reflector, lens, eggcrate visor, gasket, or socket. Provide modules that consist of an assembly that uses LEDs as the light source in lieu of an incandescent lamp. Use LEDs that are of the latest aluminum indium gallium phosphorus (AlInGaP) technology for the Portland Orange hand and countdown displays. Use LEDs that are of the latest indium gallium nitride (InGaN) technology for the Lunar White walking man displays. Install the ultra bright type LEDs that are rated for 100,000 hours of continuous operation from -40°F to +165°F. Design modules to have a minimum useful life of 60 months and to meet all parameters of this specification during this period of useful life.

Provide modules in the following configuration: 16-inch displays which have the solid hand/walking man overlay on the left and the countdown on the right, and 12-inch displays which have the solid hand/walking man module as an overlay. All makes and models of LED modules purchased for use on the State Highway System shall appear on the current NCDOT Traffic Signal Qualified Products List (QPL).

Provide the manufacturer’s model number and the product number (assigned by the Department) for each module that appears on the 2006 or most recent Qualified Products List. In addition, provide manufacturer’s certification in accordance with Article 106-3 of the *Standard Specifications*, that each module meets or exceeds the ITE “Pedestrian Traffic Control Signal Indications – Part 2: Light Emitting Diode (LED) Pedestrian Traffic Signal Modules” dated March 19, 2004 (hereafter referred to as PTCSI Pedestrian Standard) and other requirements stated in this specification.

Design all modules to operate using a standard 3 - wire field installation. Provide spade terminals crimped to the lead wires and sized for a #10 screw connection to the existing terminal block in a standard pedestrian signal housing. Do not provide other types of crimped terminals with a spade adapter.

Ensure the power supply is integral to the module assembly. On the back of the module, permanently mark the date of manufacture (month & year) or some other method of identifying date of manufacture.

Provide module lens that is hard coated or otherwise made to comply with the material exposure and weathering effects requirements of the Society of Automotive Engineers (SAE) J576. Ensure all exposed components of the module are suitable for prolonged exposure to the environment, without appreciable degradation that would interfere with function or appearance.

Design the walking man and hand as a solid display. Ensure the hand/walking man symbols for the 16-inch display module meet the dimension requirements cited in PTCSI Pedestrian Standard Table 1 “*Dimensions of Signal Sizes*” for Class 3 or Class 4. Ensure the hand/walking man symbols for the 12-inch display module meet the dimension requirements cited in PTCSI Pedestrian Standard Table 1 “*Dimensions of Signal Sizes*” for Class 2.

Provide the countdown number display that is at least 9 inches high by 6 inches wide. Ensure the minimum luminance value for the countdown number display is 1,400 cd/m². Provide the countdown number display that will conform to the chromaticity requirements of the hand symbol as specified by section 4.2 (Chromaticity) of the PTCSI Pedestrian Standard. Furnish the countdown display to continuously monitor the traffic controller to automatically learn the pedestrian phase time and update for subsequent changes to the pedestrian phase time. Design the countdown display as a double row of LEDs or with a minimum thickness of 0.5 inch. Ensure the countdown display blanks-out during the initial cycle while it records the countdown time. Ensure that the countdown display is operational only during the flashing don’t walk, clearance interval. Blank-out the countdown indication after it reaches zero and until the beginning of the next flashing don’t walk indication. Design the controlling circuitry to prevent the timer from being triggered during the solid hand indication. Ensure the countdown display discontinues and goes dark immediately upon activation of a preemption transition. Ensure the countdown display begins normal operation upon the completion of the preemption sequence and no more than one pedestrian clearance cycle.

Provide modules that meet the following requirements when tested under the procedures outlined in the PTCSI Pedestrian Standard:

Module Type	Max. Wattage at 165° F	Nominal Wattage at 77° F
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Hand Indication	16	13
Walking Man Indication	12	9
Countdown Indication	16	13

Note: Use a wattmeter having an accuracy of $\pm 1\%$ to measure the nominal wattage and maximum wattage of a pedestrian signal module. Power may also be derived from voltage, current and power factor measurements.

Provide 2-inch diameter pedestrian push-buttons with weather-tight housings fabricated from die-cast aluminum and threading in compliance with the NEC for rigid metal conduit. Provide a weep hole in the housing bottom and ensure that the unit is vandal resistant.

Provide push-button housings that are suitable for mounting on flat or curved surfaces and that will accept 1/2-inch conduit installed in the top. Provide units that have a heavy duty push-button assembly with a sturdy, momentary, normally-open switch. Have contacts that are electrically insulated from the housing and push-button. Ensure that the push-buttons are rated for a minimum of 5 mA at 24 volts DC and 250 mA at 12 volts AC.

Provide standard R10-3 signs with mounting hardware that comply with the MUTCD in effect on the date of advertisement. Provide R10-3E signs for countdown pedestrian heads and R10-3B for non-countdown pedestrian heads.

D. Signal Cable:

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

- For 16-4 cable: white, yellow, red, and green
- For 16-7 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.

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.

4. COMMUNICATIONS SYSTEM SUPPORT EQUIPMENT

4.1. DESCRIPTION

Furnish communications system support equipment with all necessary hardware in accordance with the plans and specifications.

4.2. MATERIALS

A. General:

Furnish equipment with test probes/leads, batteries (for battery-operated units), line cords (for AC-operated units), and carrying cases. Provide operating instructions and maintenance manuals with each item.

Before starting any system testing or training, furnish all communications system support equipment.

B. Fiber-Optic Support Equipment

B.1 SMFO Transceiver (For Emergency Restoration):

Furnish SMFO transceivers identical to the type installed in the traffic signal controller cabinets to be used for emergency restoration of the system and the fiber-optic communications system.

4.3. MEASUREMENT AND PAYMENT

Actual number of fiber-optic transceivers furnished and accepted.

Payment will be made under:

Furnish Fiber-optic Transceiver Each

5. TRAFFIC SIGNAL SUPPORTS

5.1 METAL TRAFFIC SIGNAL SUPPORTS

A. General:

Furnish and install metal poles with mast arms, grounding systems, and all necessary hardware. The work covered by this special provision includes requirements for the design, fabrication, and installation of custom/site specifically designed metal traffic signal supports. These poles will be installed where aesthetic appeal and uniform appearance is requested. Special design considerations are defined in the plans and these special provisions that will complement proposed and or existing decorative features common for this area. Special attention to the details and requirements in these provisions is important to facilitate this request.

Provide metal traffic signal support systems that contain no guy assemblies, struts, or stay braces. Provide designs of completed assemblies with hardware that equals or exceeds AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* 4th Edition, 2001 (hereafter called 4th Edition AASHTO), including the latest interim specifications.

Comply with Sub article 1098-1B “General Requirements” of the 2006 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES, hereinafter referred to as the *Standard Specifications* for submittal requirements. Furnish shop drawings for approval. Provide the copies of detailed shop drawings for each type of structure as summarized below. Ensure that shop drawings include material specifications for each component and identify welds by type and size on the drawing details, not in table format. Do not release structures for fabrication until shop drawings have been approved by NCDOT. Provide an itemized bill of materials for all structural components and associated connecting hardware on the drawings.

Comply with Sub article 1098-1A “General Requirements” of the *Standard Specifications* for QPL submittals. All shop drawings must include project location description, signal inventory number(s) and a project number or work order number on the drawings.

Summary of information required for metal pole review submittal:

Item	Hardcopy Submittal	Electronic Submittal	Comments / Special Instructions
Sealed, Approved Signal Plan/Loading Diagram	1	1	All structure design information needs to reflect the latest approved signal plans
Custom Pole Shop Drawings	4 sets	1 set	Submit drawings on 11” x 17” format media Show NCDOT inventory number(s) in or above the title block
Structure Calculations	1 set	1 set	Not required for Standard QPL Poles

NOTE – All shop drawings must be sealed by a Professional Engineer licensed in the State of North Carolina. Include a title block and revision block on the shop drawings showing the NCDOT inventory number.

B. Signal Foundations:

Pile Cap foundation designs for all metal traffic signal poles are included in the signal plans. Some important Micropile design parameters, and pile lengths, are contained in the signal plans and Section 5.4 of this special provision. Refer to MICROPILE special provisions located in the Roadway section of the project plans for specific requirements regarding design, construction and acceptance of all signal pole micropiles. Measurement and payment for Signal Pole Micropiles is included in Section 5.9 of this special provision.

Special emphasis is directed to the Engineer and all contractors who will have any part in the construction of the signal pile cap foundations. All excavation and shoring must be completed before signal pole micropile construction can begin. Micropiles for each signal foundation must be installed and accepted before pile cap construction may begin. Close coordination with all involved contractors and the Engineer is important to ensure that all signal foundations are installed properly and at the appropriate time during construction.

Proper orientation and installation of the signal anchor bolts during pile cap construction is critical to ensure the signal mast arms will provide proper orientation when they are erected. Details are provided in the signal pile cap foundation plans that emphasize differences between the radial orientation of each pile cap and its anchor bolts. Failure to address this could lead to the rejection of the signal pile cap foundation.

C. Materials:

Fabricate metal pole and arm shaft from coil or plate steel to meet the requirement of ASTM A 595 Grade A tubes. For structural steel shapes, plates and bars use A572 Gr 55 or Gr 65. Provide pole and arm shafts that are round in cross section or multisided tubular shapes and have a uniform linear taper of 0.14 in/ft. Construct shafts from one piece of single ply plate or coil so there are no circumferential weld splices. Galvanize in accordance with AASHTO M 111 and or ASTM A 123.

Use the submerged arc process to continuously weld pole shafts and arm shafts along their entire length. Finish the longitudinal seam welds flush to the outside contour of the base metal. Ensure shafts have no circumferential welds except at the lower end joining the shaft to the pole base and arm base. Provide welding that conforms to Article 1072-20 of the *Standard Specifications*, except that no field welding on any part of the pole will be permitted unless approved by a qualified engineer.

Refer to Metal Pole Standard Drawing Sheets M2 thru M5 for metal poles for fabrication details. Fabricate anchor bases from plate steel meeting as a minimum the requirements of ASTM A 36M or cast steel meeting the requirements of ASTM A 27M Grade 485-250, AASHTO M270 grade 36 or an approved equivalent. Conform to the applicable bolt pattern and orientation specified by the design as shown on Metal Pole Standard Drawing Sheet M2 unless otherwise specified in the plans or these special provisions..

Capacity of tapped pole flange plates must be sufficient to develop the full capacity of the connecting bolts. In all incidences the arm and pole flange plates must be at least as thick as the arm connecting bolt's diameter.

Ensure all hardware is galvanized steel or stainless steel. The contractor is responsible for ensuring that his designer/fabricator specifies connecting hardware and/or materials that do not create a dissimilar metal corrosive reaction.

Ensure material used in steel anchor bolts conforms to AASHTO M 314 GR 55 or ASTM F1554 GR 55. Unless otherwise required by the design, ensure each anchor bolt is 2" in diameter and 60" in length. Provide 10" minimum thread projection at the top of the bolt, and 8" minimum at the bottom

of the bolt. Galvanize full length of the anchor bolt. For each structural bolts and other steel hardware, hot deep galvanizing shall conform to the requirements of AASHTO M 232 (ASTM A 153).

Provide a circular anchor bolt lock plate that will be secured to the anchor bolts at the embedded end with 2 washers and 2 nuts. Provide a base plate template that matches the bolt circle diameter of the anchor bolt lock plate. Construct plates and templates from ¼” minimum thick steel with a minimum width of 4”. Galvanizing is not required.

Provide 4 heavy hex nuts and 4 flat washers for each anchor bolt. For nuts, use AASHTO M291 grade 2H, DH, or DH3 or equivalent material. For flat washers, use AASHTO M293 or equivalent material.

Ensure end caps for poles or mast arms are constructed of cast aluminum conforming to Aluminum Association Alloy 356.0F.

D. Construction Methods:

Erect signal supports poles only after concrete has attained a minimum allowable compressive strength of 3000 psi. Follow anchor nut-tightening procedures below to complete the installation of the upright. For further construction methods, see construction methods for Metal Pole with Mast Arm.

Connect poles to grounding electrodes and bond them to the electrical service grounding electrodes.

Perform repair of damaged galvanizing that complies with the *Standard Specifications*, Article 1076-6 “Repair of Galvanizing.”

E. Anchor Nut Tightening Procedure:

Prior to installation

Protect the anchor rod threads from damage prior to installation and during installation.

Prior to installation of the rods in the foundation, turn nuts onto and off the rods, well past the elevation of the bottom of the leveling nuts. Turn by the effort of one worker using an ordinary wrench without a cheater bar. Report to the Engineer any thread damage that requires a significant amount of extra effort to turn any nut.

During installation

1. Place leveling nuts (bottom nuts) on the anchor rods.
2. Place leveling nut washers on top of the anchor rod leveling nuts.
3. Place a rigid template on top of the leveling nuts to check the level of the nuts. If the anchor nut and washer cannot be brought into firm contact with the template, then use beveled washers.
4. Verify that the distance between the bottom of the leveling nut and the top of the concrete foundation is no more than one anchor rod diameter. If an upright is required to be back-raked, then the distance between the bottom of the leveling nut and the top of the concrete foundation should be no more than one anchor rod diameter, averaged over the anchor rod group.
5. Place the base plate and structural element to which it is attached. However, do not attach to the upright element, during tightening of the anchor nuts, cantilever beams or arms with span in excess of 10 feet. Luminaire arms and fixtures may be attached prior to standing the pole on the foundation.

6. Place top nut washers.
7. Do not use lock washers.
8. Lubricate threads and bearing surfaces of top nuts. Lubricant shall be beeswax, stick paraffin, or other approved lubricant.
9. Place top nuts. If the anchor nut and washer cannot be brought into firm contact with the base plate, then use beveled washers.
10. Tighten top nuts to snug tight. A snug-tight condition is defined as the washer and nut being in full contact with the base plate, and the application of the full effort of a workman on a 12-inch wrench. Turn top nuts in increments following a star pattern (using at least two full tightening cycles).
11. To ensure proper pretension, after all top nuts have been brought to snug-tight condition, repeat the procedure on the leveling nuts. Turn leveling nuts in increments following a star pattern (using at least two full tightening cycles).
12. At this point, verify if beveled washers are required. Beveled washers are necessary under the leveling nut or top nut if any face of the base plate has a slope greater than 1:20 and / or any nut can not be brought into firm contact with the base plate.
13. Before further nut turning, mark the reference position of the nut in the snug-tight condition with a suitable marking (ink or paint that is not water-soluble). Mark on the corner at the intersection of two flats with a corresponding reference mark on the base plate at each nut. After tightening, verify the nut rotation.
14. Achieve pretension by turn-of-nut method. Turn the top nuts to 1/6 of a turn. Do so in a star pattern using at least two full-tightening cycles.
15. After installation, ensure that firm contact exists between the anchor rod nuts, washers, and base plate on any anchor rod installed.
16. The messenger cable (span wires) or mast arms may be attached to the upright at this time.
17. After a period of no less than 4 days, and no more than 2 weeks, and in the presence of the Engineer, use a torque wrench to verify that a torque at least equal to 600 foot-pounds is provided on each top nut. For cantilever structures, verify the torque after erection of the remainder of the structure and any heavy attachments to the structure.
18. If any top nut torque reveals less than 600 foot-pounds of effort is required to move the nut, then tighten the nut to no less than 600 foot-pounds.
19. Calibrate, at least annually, the torque indicator on the wrench used for tightening the nuts. Provide the Engineer a certification of such calibration.
20. Because inspection or re-tightening of the leveling nuts would be prevented, and to reduce moisture retention and associated corrosion, do not place grout under the base plate.

5.2 METAL POLE

5.2.1 Materials:

Comply with the following for Steel Poles:

- Have shafts of the tapered tubular type and fabricated of steel conforming to ASTM A-595 Grade A or an approved equivalent.
- Have galvanization in accordance with AASHTO M 111 (ASTM A 123).
- Have shafts that are continuously welded for the entire length by the submerged arc process, and with exposed welds ground or rolled smooth and flush with the base metal.

Provide welding that conforms to Article 1072-20 per Standard Specification except that no field welding on any part of the pole will be permitted.

- Have anchor bases for steel poles fabricated from plate steel meeting as a minimum the requirements of ASTM A 36M or cast steel meeting the requirements of ASTM A 27M Grade 485-250 or an approved equivalent.

Provide assemblies with a round or near-round cross-sectional design consisting of no less than 12 sides. The sides may be straight, convex, or concave.

Heights of the metal signal poles shown on the plans are estimated from available data for bid purposes. Prior to furnishing metal signal poles, use field measurements and adjusted cross-sections to determine if pole heights are sufficient to obtain required clearances. If pole heights are not sufficient, contractor should immediately notify the Engineer of the required revised pole heights.

Ensure that metal signal poles permit cables to be installed inside poles and any required mast arms. For holes in the poles and arms used to accommodate cables, provide full-circumference grommets. Arm flange plate wire access hole should be debarred, non grommited and oversized to fit around the 2" dia. grommited shaft flange plate wire access hole.

After fabrication, have steel poles, required mast arms, and all parts used in the assembly hot-dip galvanized per section 1076. Design structural assemblies with weep holes large enough and sufficiently located to drain molten zinc during galvanization process. Provide hot-dip galvanizing on structures that meets or exceeds ASTM Standard A-123 Provide galvanizing on hardware that meets or exceeds ASTM Standard A-153. Ensure that threaded material is brushed and retapped as necessary after galvanizing. Perform repair of damaged galvanizing that complies with the following: Repair of Galvanizing Article 1076-6

Have poles permanently stamped above the hand holes with the identification tag details as shown on Metal Pole Standard Drawing Sheet M2.

Fabricate poles from a single piece of steel with a single line seam weld with no transverse butt welds. Fabrication of two ply pole shafts is not acceptable except for fluted shafts. Provide tapers for all shafts that begin at base and that have diameters which decrease uniformly at the rate of not more than 0.14 inch per foot (11.7 millimeters per meter) of length.

Ensure that pole deflection does not exceed that allowed by AASHTO Specifications. For mast arm poles (with primarily moment loads), ensure that maximum angular rotation of the top of the pole does not exceed 1° 40'.

Provide four anchor nuts and four washers for each anchor bolt. Have anchor bolts fabricated from steel per AASHTO M 314 or equivalent. Ensure that anchor bolts have required diameters, lengths, and positions, and will develop strengths comparable to their respective poles.

Do not design typical NCDOT required terminal compartments for these poles. Provide designs with a 6 x 8-inch hand hole with a reinforcing frame for each pole. Locate the center of each hand hole 12 inches above the top of the pole base plate with a radial orientation 180 degrees from the center of the mast arm. Provide a cover attached to the pole by a sturdy chain or cable and tamper resistant screws for each hand hole. Ensure that the chain or cable is long enough to permit the cover to hang clear of the compartment opening when the cover is removed, and is strong enough to prevent vandals from being able to disconnect the cover from the pole. Ensure that the chain or cable will not interfere with service to the cables in the pole base.

For each pole, provide a 1/2 inch minimum thread diameter, coarse thread stud and nut for grounding which will accommodate Number 6 AWG ground wire. Ensure that the lug is electrically bonded to the pole and is conveniently located inside the pole at the hand hole.

Provide a removable pole cap with stainless steel attachment screws for the top of each pole. Ensure that the cap is cast aluminum conforming to Aluminum Association Alloy 356.0F. Furnish cap attached to the pole with a sturdy chain or cable approved by the Engineer. Ensure that the chain or cable is long enough to permit the cap to hang clear of the pole-top opening when the cap is removed.

When required by the plans, furnish couplings 42 inches above the bottom of the base for mounting of pedestrian pushbuttons. Provide mounting points consisting of 1-1/2 inch internally threaded half-couplings that comply with the NEC and that are mounted within the poles. Ensure that couplings are essentially flush with the outside surfaces of the poles and are installed before any required galvanizing. Provide a threaded plug in each mounting point. Ensure that the surface of the plug is essentially flush with the outer end of the mounting point when installed and has a recessed hole to accommodate a standard wrench.

5.2.2 Construction Methods:

Install metal poles, hardware, and fittings as shown on the manufacturer's installation drawings. Install metal poles so that when the pole is fully loaded it is within 2 degrees of vertical. Install poles with the manufacturer's recommended "rake." Use threaded leveling nuts to establish rake if required.

5.3 METAL POLE WITH MAST ARM

Provide signal support mast arm assemblies. Comply with Section 5.2 except as noted herein.

Provide pole plates and associated gussets and fittings for attachment of required mast arms. As part of each mast arm attachment, provide a cable passage hole in the pole to allow passage of signal cables from the pole to the arm.

Ensure that allowable mast arm deflection does not exceed that allowed by AASHTO Specifications. Also when arm is fully loaded, tip of the arm shall not go below the arm attachment point with the pole for all load condition per the 4th edition AASHTO Code.

Furnish all arm plates and necessary attachment hardware, including bolts and brackets.

Provide two extra bolts for each arm.

Provide grommet holes on the arms to accommodate cables for the signals.

Provide arms with weatherproof connections for attaching to the shaft of the pole.

Provide hardware that is galvanized steel, stainless steel, or corrosive-resistant aluminum.

Provide a removable end cap with stainless steel attachment screws for the end of each mast arm. Ensure that the cap is cast aluminum conforming to Aluminum Association Alloy 356.0F. Furnish cap attached to the arm with a sturdy chain or cable approved by the Engineer. Ensure that the chain or cable is long enough to permit the cap to hang clear of the arm end opening when the cap is removed.

5.3.1 Materials:

Fabrication of two ply pole shafts and arms is not acceptable except for fluted members.

After all fabricating, cutting, punching, and welding are completed, hot-dip galvanize the structure in accordance with the 4th Edition AASHTO M 111 or equivalent.

5.3.2 Construction Methods:

Install horizontal-type arched arms with sufficient manufactured rise to keep arm tip from deflecting below horizontal.

Attach cap to the mast arm with a sturdy chain or cable. Ensure that the chain or cable is long enough to permit the cap to hang clear of the arm opening when the cap is removed.

For mast arm poles use full penetration welds with back-up ring at the pole base and at the arm base connection.

When structure erection has been completed and accepted, install a removable galvanized wire mesh screen around the base of each pole to seal the gap between the pole base and the top of the pedestal base. Use stainless steel hardware to secure the screen around the pole base.

5.4 TRAFFIC SIGNAL PILE CAP FOUNDATIONS

Analysis procedures and formulas shall be based on AASHTO, ACI code and per FHWA manuals.

Use a Factor of Safety of 1.33 for Torsion and 2.5 for bending for the foundation design.

Foundation design for lateral load shall not to exceed 1.0" lateral deflection at top of foundation.

5.4.1 Description:

The work covered by this provision consists of construction of traffic signal pile cap foundations in accordance with the approved plans and this provision. Construct foundation caps and pedestals of the size and dimensions shown in the traffic signal plans and in accordance with this provision. Refer to the MICROPILE special provisions in the Roadway project plans for specific requirements regarding design, construction and acceptance of all signal pole micropiles. Geotechnical Subsurface Investigation drawings that include soil borings and soil sample results for each proposed traffic signal pile cap foundation location are contained in the project plans or are available upon request. The results of these subsurface investigations were used in preparing Department designed and furnished foundation designs.

Pile cap Construction:**1. Excavation:**

Excavate footings for traffic signal structures in accordance with the applicable provisions of Section 410 of the 2006 *Standard Specifications*. Special emphasis is directed to Section 410-3 regarding excavation in soft material and when pile construction is involved. Schedule and coordinate all excavation of these foundations with the Engineer. Perform excavations for pile caps to the required dimensions and lengths including all miscellaneous grading, shoring and soil stabilization necessary to construct the pile cap. Dispose of drilling spoils as directed and in accordance with Section 802 of the *Standard Specifications*.

Construct pile caps with pedestals within the tolerances specified herein. Comply with applicable portions of Section 420 of the *Standard Specifications*. If tolerances are exceeded, provide additional construction as approved by the Engineer to bring the pile cap and pedestal within the tolerances specified. Construct pile caps such that the axis at the top of the pedestals is no more than 3 inches in

any direction from the specified position. Build pile caps within 1% of the plumb deviation for the total length of the footing. Construct the finished top of pedestal elevation 3 inches above the finished grade elevation. Finished pedestal top elevations may be set to match sidewalk elevations. Form the top of the pedestal such that the concrete is smooth and level.

In wet pour conditions, advise and gain approval from the Engineer as to the planned construction method intended for the complete construction and installation of the pile cap before excavating.

2. Reinforcing Steel:

Completely assemble a cage of Epoxy coated reinforcing steel consisting of longitudinal and spiral / hoop bars and place cage in the pile cap excavation as a unit. Comply with applicable articles of Section 1070 of the *Standard Specification* for material requirements for reinforcing steel, including Section 1070-8 for epoxy coated reinforcing steel.

Securely cross-tie the vertical and spiral / hoops reinforcement at each intersection with double wire. Support or hold down the cage so that the vertical displacement during concrete placement does not exceed 2 inches. Lift the cage so racking and cage distortion does not occur. Do not set the cage on the bottom of the pile cap excavation. Keep the cage plumb during concrete operations. Check the position of the cage before and after placing the concrete. Keep the cage off the bottom of the pile cap excavation a minimum of 3 inches by methods approved by the Engineer. .

In order to ensure a minimum of 3 inches of concrete cover and achieve concentric spacing of the cage within the pedestal sonotube, tie plastic spacer wheels at five points around the cage perimeter. Use spacer wheels that provide a minimum of 3 inches "blocking" from the outside face of the spiral / hoop bars to the outermost surface of the pile cap pedestal. Tie spacer wheels that snap together with wire and allow them to rotate. Use spacer wheels that span at least two adjacent vertical bars. Place a set of spacer wheels beginning just above the base of the pedestal sonotube and a set near the top of the pedestal cage. Supply additional peripheral spacer wheels at closer intervals as necessary or as directed by the Engineer.

No welding of or to reinforcement is permitted. No welding of or to Anchor Bolt is permitted.

3. Conduit:

Install non metallic conduit for electrical purposes. Refer to Typical Foundation Details on drawing M7 of the traffic signal plans for the number and size of conduits required. Conduits should exit the formwork at the base of the pile cap pedestal just above the top of the cap. Gain approval from the Engineer as to the radial orientation of the conduits exiting each pile cap pedestal.

4. Anchor bolt installation and Orientation:

Proper orientation and installation of the signal anchor bolts during pile cap construction is critical to ensure the signal mast arms will provide proper orientation when they are erected. Details are provided in the signal pile cap foundation plans that emphasize differences between the radial orientation of each pile cap and its anchor bolts. Anchor bolt templates are shown on the plan with "V" notches on the 0 and 180 degree that bisect the anchor bolts. These templates should be used to help achieve the proper radial orientation of the bolts.

5. Concrete:

Begin concrete placement immediately after inserting reinforcing steel into the pile cap excavation or at a time approved by the Engineer.

Concrete Mix

Provide the mix design for Drill Pier concrete for approval and, except as modified herein, meeting the requirements of Section 1000 of the *Standard Specifications*.

Designate the concrete as NCDOT AA mix or better with a minimum compressive strength of 4500 psi at 28 days. The Contractor may use a high early strength mix. Make certain the cementitious material content complies with one of the following options:

- Provide a minimum cement content of 640 lbs/yd³ and a maximum cement content of 800 lbs/yd³; however, if the alkali content of the cement exceeds 0.4%, reduce the cement content by 20% and replace it with fly ash at the rate of 1.2 lb of fly ash per lb of cement removed.
- If Type IP blended cement is used, use a minimum of 665 lbs/yd³ Type IP blended cement and a maximum of 833 lbs/yd³ Type IP blended cement in the mix.

Limit the water-cementitious material ratio to a maximum of 0.45. Air-entrain the concrete mix in accordance with Section 1000-3 (B) of the *Standard Specifications*. Produce a workable mix so that vibrating or prodding is not required to consolidate the concrete. When placing the concrete, make certain the slump is between 5 and 7 inches for dry placement of concrete or 7 and 9 inches for wet placement of concrete.

Use Type I or Type II cement or Type IP blended cement and either No. 67 or No. 78M coarse aggregate in the mix. Use an approved water-reducer, water-reducing retarder, high-range water-reducer or high-range water-reducing retarder to facilitate placement of the concrete if necessary. Do not use a stabilizing admixture as a retarder in Pile cap Concrete without approval of the Engineer. Use admixtures that satisfy AASHTO M194 and add admixtures at the concrete plant when the mixing water is introduced into the concrete. Redosing of admixtures is not permitted.

Place the concrete within 2 hours after introducing the mixing water. Ensure that the concrete temperature at the time of placement is 90°F or less.

a) Concrete Placement

Place concrete such that the pile cap is a monolithic structure. The pile cap and pedestal may be constructed in separate pours if approved by the Engineer. Refer to Section 420-8 of the *Standard Specifications* for construction joints. Care should be taken in this case to protect the exposed anchor bolts. Concrete placement may be temporarily stopped when the concrete level is at the top of the cap and the base of the pedestal to allow for placement of conduit. Do not pause concrete placement if unstable caving soils are present at the ground surface.

Do not dewater any pile cap excavations unless the excavation area has been properly shored.

Keep a record of the volume of concrete placed in each pile cap excavation and make it available to the Engineer.

After all the pumps have been removed from the excavation, the water inflow rate determines the concrete placement procedure. If the inflow rate is less than 6 inches per half hour, the concrete placement is considered dry. If the water inflow rate is greater than 6 inches per half hour, the concrete placement is considered wet.

- **Dry Placement:** Before placing concrete, make certain the pile cap excavation is dry so the flow of concrete completely around the reinforcing steel can be certified by visual inspection. Place the concrete by free fall with a central drop method where the concrete is chuted directly down the center of the excavation. In wet conditions, dewatering of a drill shaft prior to concrete

placement does not change the placement method to a “Dry placement” method without approval.

- **Wet Placement:** If applicable, maintain a static water or slurry level in the excavation before placing concrete. Place concrete with a tremie or a pump in accordance with the applicable parts of Sections 420-6 and 420-8 of the *Standard Specifications*. Use a tremie tube or pump pipe made of steel with watertight joints. Passing concrete through a hopper at the tube end or through side openings as the tremie is retrieved during concrete placement is permitted. Use a discharge control to prevent concrete contamination when the tremie tube or pump pipe is initially placed in the excavation. Extend the tremie tube or pump pipe into the concrete a minimum of 5 feet at all times except when the concrete is initially introduced into the pier excavation. If the tremie tube or pump pipe pulls out of the concrete for any reason after the initial concrete is placed, restart concrete placement with a steel capped tremie tube or pump pipe. At no circumstances may concrete mix free fall through water.

Once the concrete in the excavation reaches the same elevation as the static water level, placing concrete with the dry method is permitted. Before changing to the dry method of concrete placement, remove any water or slurry above the concrete and clean the concrete surface of all scum and sediment to expose clean, uncontaminated concrete.

Vibration is only permitted, if needed, as approved by the Engineer. Remove any contaminated concrete from the top of the pile cap and wasted concrete from the area surrounding the pile cap upon completion.

Permanently mark the top of each foundation with a stamp or embedded plate to identify the depth of the foundation, size and number of vertical reinforcements and the concrete strength.

6. Concrete Placement Time:

Place concrete within the time frames specified in Table 1000-2 of the *Standard Specifications* for Class AA concrete except as noted herein. Do not place concrete so fast as to trap air, water, fluids, soil or any other deleterious materials in the vicinity of the reinforcing steel and the annular zone between the rebar cage and the excavation walls. Should a delay occur because of concrete delivery or other factors, reduce the placement rate to maintain some movement of the concrete. No more than 45 minutes is allowed between placements.

7. Scheduling and Restrictions:

During the first 16 hours after a pile cap has achieved its initial concrete set as determined by the Engineer, do not drill adjacent piers, install adjacent piles, or allow any heavy construction equipment loads or “excessive” vibrations to occur at any point within a 20 foot radius of the pile cap.

The foundation will be considered acceptable for loading when the concrete reaches a minimum compressive strength of 3000 psi. Do not remove any formwork until concrete has achieved minimum compressive strength or as directed by the Engineer. Full acceptance will be determined when the concrete meets its full strength at 28 days. Double wrap all concrete surfaces of the pile cap and pedestal with asphalt building paper that will be encapsulated with foam concrete. In the event that the procedures described herein are performed unsatisfactorily, the Engineer reserves the right to shut down the construction operations or reject the pile caps. If the integrity of a pile cap is in question, use core drilling, sonic or other approved methods at no additional cost to the Department and under the direction of the Engineer. Dewater and backfill core drill holes with an approved high strength grout with a minimum compressive strength of 4500 psi. Propose remedial measures for any defective pile caps and obtain approval of all proposals from the Engineer before

implementation. No additional compensation will be paid for losses or damage due to remedial work or any investigation of pile caps found defective or not in accordance with these special provision or the plans.

5.5 CUSTOM DESIGN OF TRAFFIC SIGNAL SUPPORTS

5.5.1 General:

Design traffic signal supports for metal poles with mast arms.

The lengths of the metal signal poles shown on the plans are estimated from available data for bid purposes. Determine the actual length of each pole from field measurements and adjusted cross-sections. Furnish the revised pole heights to the Engineer. Use all other dimensional requirements shown on the plans.

Ensure each pole includes an identification tag with information and location positions as defined on Metal Pole Standard Drawing Sheets M2, M3 and M4. All pole shaft tags must include the NCDOT Inventory number followed by the pole number shown on the traffic signal or ITS (non-signalized locations) plan.

Design all traffic signal support structures using the following 4th Edition AASHTO specifications:

- Design for a 50 year service life as recommended by Table 3-3 per the 4th Edition AASHTO
- Use the wind pressure map developed from 3-second gust speeds, as provided in Article 3.8.
- Ensure signal support structures include natural wind gust loading and truck-induced gust loading in the fatigue design, as provided for in Articles 11.7.3 and 11.7.4, respectively. Designs need not consider periodic galloping forces.
- Assume the natural wind gust speed in North Carolina is 11.2 mph.
- Design for Category II fatigue, as provided for in Article 11.6, unless otherwise specified.
- Calculate all stresses using applicable equations from Section 5. The Maximum allowable stress ratios for all signal support designs are 0.9
- Conform to article 10.4.2 and 11.8 for all deflection requirements.

Ensure that the design permits cables to be installed inside poles and mast arms.

Unless otherwise specified by special loading criteria, the computed surface area for ice load on signal heads is:

- 3-section, 12-inch, Surface area: 26.0 ft²
- 4-section, 12-inch, Surface area: 32.0 ft²
- 5-section, 12-inch, Surface area: 42.0 ft²

The ice loading for signal heads defined above includes the additional surface area that back plates will induce. Special loading criteria may be specified in instances where back plates will not be installed on signal heads. Refer to the Loading Schedule on each Metal Pole Loading Diagram for revised signal head surface areas. The pole designer should revise ice loads accordingly in this instance. Careful examination of the plans when this is specified is important as this may impact sizing of the metal support structure and foundation design which could affect proposed bid quotes. All maximum stress ratios of 0.9 still apply

Assume the combined minimum weight of a messenger cable bundle (including messenger cable, signal cable and detector lead-in cables) is 1.3 lbs/ft. Assume the combined minimum diameter of this cable bundle is 1.3 inches.

5.5.2 Metal Poles:

Submit design drawings for approval including pre-approved QPL poles. Show all the necessary details and calculations for the metal poles including the foundation and connections. Include signal inventory number on design drawings. Include as part of the design calculations the ASTM specification numbers for the materials to be used. Provide the types and sizes of welds on the design drawings. Include a Bill of Materials on design drawings. Ensure design drawings and calculations are signed, dated, and sealed by the responsible Professional Engineer licensed in the State of North Carolina. Immediately bring to the attention of the Engineer any structural deficiency that becomes apparent in any assembly or member of any assembly as a result of the design requirements imposed by these Specifications, the plans, or the typical drawings. Said Professional Engineer is wholly responsible for the design of all poles and arms. Review and acceptance of these designs by the Department does not relieve the said Professional Engineer of his responsibility. Do not fabricate the assemblies until receipt of the Department's approval of the design drawings.

For mast arm poles, provide designs with provisions for pole plates and associated gussets and fittings for mast arm attachment. As part of each mast arm attachment, provide a grommeted 2" diameter hole on the shaft side of the connection to allow passage of the signal cables from the pole to the arm.

Design tapers for all pole shafts that begin at the base with diameters that decrease uniformly at the rate of 0.14 inch per foot of length.

Design a base plate on each pole. The minimum base plate thickness for all poles is determined by the following criteria:

Case 1 Circular or rectangular solid base plate with the upright pole welded to the top surface of base plate with full penetration butt weld, and where no stiffeners are provided. A base plate with a small center hole, which is less than 1/3 of the upright diameter, and located concentrically with the upright pole, may be considered as a solid base plate.

The magnitude of bending moment in the base plate, induced by the anchoring force of each anchor bolt is $M = (P \times D_1) / 2$,

where M = bending moment at the critical section of the base plate induced by one anchor bolt

P = anchoring force of each anchor bolt

D_1 = horizontal distance between the anchor bolt center and the outer face of the upright, or the difference between the bolt circle radius and the outside radius of the upright

Locate the critical section at the face of the anchor bolt and perpendicular to the bolt circle radius. The overlapped part of two adjacent critical sections is considered ineffective.

Case 2 Circular or rectangular base plate with the upright pole socketed into and attached to the base plate with two lines of fillet weld, and where no stiffeners are provided, or any base plate with a center hole that is larger in diameter than 1/3 of the upright diameter.

The magnitude of bending moment induced by the anchoring force of each anchor bolt is $M = P \times D_2$,

where P = anchoring force of each anchor bolt

D_2 = horizontal distance between the face of the upright and the face of the anchor bolt nut

Locate the critical section at the face of the anchor bolt top nut and perpendicular to the radius of the bolt circle. The overlapped part of two adjacent critical sections is considered ineffective.

If the base plate thickness calculated for Case 2 is less than Case 1, use the thickness calculated for Case 1

The following additional owner requirements apply concerning pole base plates.

- Ensure that whichever case governs as defined above, the anchor bolt diameter is set to match the base plate thickness. If the minimum diameter required for the anchor bolt exceeds the thickness required for the base plate, set the base plate thickness equal to the required bolt diameter.
- For dual mast arm supports, or for single mast arm supports 50' or greater, use a minimum 8 bolt orientation with 2" diameter anchor bolts, and a 2" thick base plate.
- For all metal poles with mast arms, use a full penetration groove weld with a backing ring to connect the pole upright component to the base. Refer to Metal Pole Standard Drawing Sheet M4.

Ensure that designs have anchor bolt holes with a diameter 1/4 inch larger than the anchor bolt diameters in the base plate.

Ensure that the anchor bolts have the required diameters, lengths, and positions, and will develop strengths comparable to their respective poles.

Provide designs with a 6 x 12-inch hand hole with a reinforcing frame for each pole.

For each pole, provide designs with provisions for a 1/2 inch minimum thread diameter, coarse thread stud and nut for grounding which will accommodate a Number 6 AWG ground wire. Ensure the lug is electrically bonded to the pole and is conveniently located inside the pole at the hand hole.

Where required, design couplings on the pole for mounting pedestrian pushbuttons at a height of 42 inches above the bottom of the base. Provide mounting points consisting of 1-1/2 inch internally threaded half-couplings that comply with the NEC that are mounted within the poles. Ensure the couplings are essentially flush with the outside surfaces of the poles and are installed before any required galvanizing. Provide a threaded plug for each half coupling. Ensure that the surface of the plug is essentially flush with the outer end of the mounting point when installed and has a recessed hole to accommodate a standard wrench.

5.5.3 Mast Arms:

Design all arm plates and necessary attachment hardware, including bolts and brackets as required by the plans.

Design for grommets holes on the arms to accommodate the cables for the signals if specified.

Design arms with weatherproof connections for attaching to the shaft of the pole.

Always use a full penetration groove weld with a backing ring to connect the mast arm to the pole. Refer to Metal Pole Standard Drawing Sheet M5

5.6 POWDER COATING OF TRAFFIC SIGNAL SUPPORTS

5.6.1 Description:

Powder coat all metal signal poles, mast arms with metal signal poles, pedestrian pedestals, and push button posts, including all necessary attachment hardware for the signalized intersections in accordance with the plans and specifications.

5.6.2 Materials:

Furnish metal poles and metal poles and mast arms that have a high density, low gloss polyester, thermosetting resin powder coat finish that is black in color applied over a hot-dipped galvanized surface, or an approved equivalent

Furnish removable pole and arm caps, all hand hole covers and plates that have a high density, low gloss polyester, thermosetting resin powder coat finish that is black in color applied over a hot-dipped galvanized surface. Provide appropriate powder coating process for pole items and material made of aluminum.

Furnish pedestrian signal pedestals with bases that have a high density, low gloss polyester, thermosetting resin powder coat finish that is black in color applied over the aluminum shaft and base.

Furnish push button posts that have a high density, low gloss polyester, thermosetting resin powder coat finish that is black in color applied over the post surface.

Furnish housings for mounting pedestrian pushbuttons and attachment hardware that has a high density, low gloss polyester, thermosetting resin powder coat finish that is black in color applied over the complete exterior surface of the housing and attachment hardware.

5.7 METAL SIGNAL POLE REMOVALS

A. Description:

Remove and dispose of existing metal signal poles including mast arms, and remove and dispose of existing foundations, associated anchor bolts, electrical wires and connections.

B. Construction Methods:

1. Foundations:

Remove and promptly dispose of the metal signal pole foundations include reinforcing steel, electrical wires, and anchor bolts to a minimum depth of two feet below the finished ground elevation. At the Contractor's option, remove the complete foundation.

2. Metal Poles:

Assume ownership of the metal signal poles, remove the metal signal poles, and promptly transport the metal signal poles from the project. Use methods to remove the metal signal poles and attached traffic signal equipment that will not result in damage to other portions of the project or facility. Repair damages that are a result of the Contractor's actions at no additional cost to the Department.

Transport and properly dispose of the materials.

Backfill and compact disturbed areas to match the finished ground elevation. Seed unpaved areas.

Use methods to remove the foundations that will not result in damage to other portions of the project or facility. Repair damages that are a result of the Contractor's actions at no cost to the Department.

5.8 POLE NUMBERING SYSTEM

Metal Poles:

Attach an identification tag to each pole shaft and mast arm section as shown on Metal Pole Standard Drawing Sheet M2 "Typical Fabrication Details Common to All Metal Poles"

5.9 MEASUREMENT AND PAYMENT

Actual number of metal poles with single mast arms furnished, installed, and accepted.

Actual number of metal poles with dual mast arms furnished, installed, and accepted.

Actual number of *Signal Pole Micropiles* furnished installed and accepted. No payment will be made for any costs associated with unacceptable micropiles. Refer to the MICROPILE special provisions located in the Roadway Section of the project plans for micropile acceptance. The contract unit price bid for *Signal Pole Micropiles* will be full compensation for submittals, design, monitoring and recording, labor, tools, equipment, casings, and reinforcement complete and in place and all incidentals necessary to drill through any material and construct micropiles in accordance with the MICROPILES special provision. The contract unit price bid for *Signal Pole Micropiles* will be full compensation for all grout used to construct Signal pole Micropiles. *Signal Pole Micropile Proof Tests* will be measured and paid for in units of each. Load tests will be measured as the number of initial tests required by the Engineer or as shown on the plans. No payment will be made for subsequent load tests performed on the same micropiles or replacement piles. The contract unit price bid for *Signal Pole Micropile Proof Tests* will be full compensation for load testing in accordance with Section 8 of the MICROPILE Special Provision.

Actual volume of concrete poured in cubic yards of pile cap foundation furnished, installed and accepted.

Actual number of designs for mast arms with metal poles furnished and accepted.

Actual number of black powder coating for single mast arm assemblies furnished, installed, and accepted.

Actual number of black powder coating for double mast arm assemblies furnished, installed, and accepted.

Actual number of black powder coating for pedestrian pedestal assemblies furnished, installed, and accepted.

Actual number of black powder coating for pedestrian push button post assemblies furnished, installed, and accepted.

Actual number of metal signal pole foundations removed and disposed.

Actual number of metal signal poles removed and disposed.

Payment will be made under:

Metal Pole with Single Mast Arm	Each
Metal Pole with Dual Mast Arm	Each
Signal Pole Micropiles.....	Each
Signal Pole Micropile Proof Test.	Each
Signal Pile Cap Foundation	Cubic Yard
Mast Arm with Metal Pole Design	Each
Powder Coat for Single Mast Arm with Metal Pole.	Each
Powder Coat for Double Mast Arm with Metal Pole	Each
Powder Coat for Pedestrian Pedestal.	Each
Powder Coat for Push Button Post.	Each
Metal Pole Foundation Removal	Each
Metal Pole Removal.....	Each

6. CONTROLLERS WITH CABINETS

6.1. MATERIALS – TYPE 2070L CONTROLLERS

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 Model 2070L controllers. Ensure that removal of the CPU module from the controller will place the intersection into flash.

The Department will provide software at the beginning of the burning-in period. Contractor shall give 5 working days notice before needing software. Program software provided by the Department.

Provide model 2070L controllers with the latest version of OS9 operating software and device drivers, composed of the unit chassis and at a minimum the following modules and assemblies:

- MODEL 2070 1B, CPU Module, Single Board
- MODEL 2070-2A, Field I/O Module (FI/O)
- MODEL 2070-3B, Front Panel Module (FP), Display B (8x40)
- MODEL 2070-4A, Power Supply Module, 10 AMP
- MODEL 2070-7A, Async Serial Com Module (9-pin RS-232)

Furnish one additional MODEL 2070-7A, Async Serial Com Module (9-pin RS-232) for all master controller locations.

For each master location and central control center, furnish a U.S. Robotics V.92 or approved equivalent auto-dial/auto-answer external modem to accomplish the interface to the Department-furnished microcomputers. Include all necessary hardware to ensure telecommunications.

6.2. MATERIALS – GENERAL CABINETS

Provide a moisture resistant coating on all circuit boards.

Provide one V150LA20 MOV or equal protection on each load switch field terminal.

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 280V at 20,000A with a nominal series inductance of 200μh. Ensure that the voltage does not exceed 280V. 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

6.3. MATERIALS – TYPE 170E CABINETS

A. Type 170 E Cabinets General:

Conform to CALTRANS *Traffic Signal Control Equipment Specifications* except as required herein.

Furnish CALTRANS Model 336S pole mounted cabinets configured for 8 vehicle phases with power distribution assemblies (PDAs) number 2, and 4 pedestrian phases or overlaps.

Furnish CALTRANS Model 332A base mounted cabinets with PDAs #2 and configured for 8 vehicle phases, 4 pedestrian phases, and 4 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 a mercury contactor or solid state relay (normally closed) in the PDAs #2 that is rated at a minimum of 50A, 120VAC.

B. Type 170 E 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.

Provide surge suppression in the cabinet for each type of cabinet device. Provide surge protection for the full capacity of the cabinet input file.

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

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

Connect detector test switches for cabinets as follows:

336S Cabinet		332A Cabinet	
Detector Call Switches	Terminals	Detector Call Switches	Terminals
Phase 1	I1-F	Phase 1	I1-W
Phase 2	I2-F	Phase 2	I4-W
Phase 3	I3-F	Phase 3	I5-W
Phase 4	I4-F	Phase 4	I8-W
Phase 5	I5-F	Phase 5	J1-W
Phase 6	I6-F	Phase 6	J4-W
Phase 7	I7-F	Phase 7	J5-W
Phase 8	I8-F	Phase 8	J8-W

Provide a terminal mounted loop surge suppresser device for each set of loop terminals in the cabinet. For a 10x700 microsecond waveform, ensure that the device can withstand a minimum of 25 peak surge current occurrences at 100A, in both differential and common modes. Ensure that the maximum breakover voltage is 170V and the maximum on-state clamping voltage is 30V Provide a

maximum response time less than 5 nanoseconds. Ensure that off-state leakage current is less than 10 μ A. Provide a nominal capacitance less than 220pf for both differential and common modes.

Provide surge suppression on each communications line entering or leaving a cabinet. Ensure that the communications surge suppresser can withstand at least 80 occurrences of an 8x20 microsecond wave form at 2000A and a 10x700 microsecond waveform at 400A. Ensure that the maximum clamping voltage is suited to the protected equipment. Provide a maximum response time less than 1 nanosecond. Provide a nominal capacitance less than 1500pf and a series resistance less than 15 Ω .

Provide surge suppression on each DC input channel in the cabinet. Ensure that the DC input channel surge suppresser can withstand a peak surge current of at least 10,000 amperes in the form of an 8x20 microsecond waveform and at least 100 occurrences of an 8x20 microsecond wave form at 2000 A. Ensure that the maximum clamping voltage is 30V. Provide a maximum response time less than 1 nanosecond and a series resistance less than 15 Ω per line.

Provide protection for each preemption or 120 Vrms single phase signal input by an external stud mounted surge protector. Ensure that a minimum stud size of 1/3 inch, and Number 14 AWG minimum sized wire leads with 1 foot minimum lengths. Ensure that a peak surge trip point less than 890 volts nominal for a 600 volt rise per microsecond impulse, and 950 volts nominal for a 3000 volt per microsecond rise impulse. Provide a maximum surge response time less than 200 nanoseconds at 10 kV per microsecond. Ensure that the AC isolation channel surge suppresser can withstand at least 25 occurrences of a 8x20 waveform of 10,000 amperes and a peak single pulse 8x20 microsecond wave form of 20,000 amperes. Provide a maximum clamping voltage of 30V Provide a maximum response time less than 1 nanosecond. Ensure that the discharge voltage is under 200 volts at 1000 amperes and the insulation resistance is 100 megaohms. Provide an absolute maximum operating line current of one ampere at 120 Vrms.

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

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. Furnish all bulbs with the cabinet. Provide door switch actuation for the fixtures.

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 CALTRANS Specifications, 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.

Provide detector test switches inside the cabinet on the door or other convenient location which may be used to place a call on each of eight phases based on standard CALTRANS input file designation for detector racks. 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.

Provide a shorting jack inside cabinet that functions exclusively to call the controller and cabinet assembly into the automatic diagnostics functions. Ensure shorting jack will mate with a Switchcraft Model 190 plug or equivalent. Place jack in a convenient, unobstructed location inside cabinet. When the mating plug is inserted into the jack, ensure controller enters the diagnostic test mode and a controller generated monitor reset signal is placed on Pin C1-102 (monitor external reset) of the model 210 conflict monitor which causes the monitor to automatically reset.

Equip cabinet with a connector and terminal assembly designated as P20 (Magnum P/N 722120 or equivalent) for monitoring the absence of any valid AC+ signal display (defined here as red, yellow, or green) input on any channel of the conflict monitor. Connect the terminal through a 3 1/2 feet 20 wire ribbon cable which mates on the other end to a connector (3M-3428-5302 or equivalent) installed in the front of the Type 210 enhanced conflict monitor. Ensure that the female connector which mates with the connector on the conflict monitor has keys to ensure that proper connection. Ensure that the cabinet enters the flash mode if the ribbon cable is not properly connected. Provide a P20 connector and terminal assembly that conforms to Los Angeles City DOT "Traffic Signal Specification DOT 170 ATSAC Universal and Related Equipment #54-053-02"

Terminate ribbon cable at the P20 connector and terminal assembly. Ensure the P20 connector and mating ribbon cable connector is keyed to prevent cable from being improperly installed. Wire the P20 connector to the traffic signal red displays to provide inputs to conflict monitor as shown:

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

Provide a convenient means to jumper 120 VAC from the signal load switch AC+ supply bus to any channel Red input to the P20 connector in order to tie unused red inputs high. Ensure that easy access is provided to the jumper connecting terminals on the back side of cabinet. Locate the jumper terminals connecting to all 16 channel Red inputs in the same terminal block. For each channel Red input terminal, provide a companion terminal supplying AC+ from the signal bus. Provide one of the following two methods for providing Signal AC+ to the channel red input:

- Place a commercially available jumper plug between the channel Red input and its companion Signal Bus AC+ terminal.
- Place a jumper wire between a channel red input screw terminal and its companion Signal Bus AC+ screw terminal.

Connection between channel Red input terminal and its companion Signal Bus AC+ terminal must not require a wire greater than 1/2 inch in length.

Conform to the following Department wiring requirements:

- Wire the Red Enable monitor input to the Signal Bus AC+ terminal TB01-1
- Do not connect either the special function 1 or the special function 2 monitor input to the red monitor card.
- Ensure that removal of the P-20 ribbon cable will cause the monitor to recognize a latching fault condition and place the cabinet into flashing operation and that this is implemented in the conflict monitor software.

Ensure that removal of the conflict monitor from the cabinet will cause the cabinet to revert to flashing operation.

Provide Model 200 load switches and Model 204 flashers.

C. Type 170 E Cabinet Physical Requirements:

Provide a surge protection panel with 16 loop protection devices and designed to allow sufficient free space for wire connection/disconnection and surge protection device replacement. Provide an additional three slots protected with six AC+ interconnect surge devices and two protected by four DC surge protection devices. Provide no protection devices on slot 14 Attach flash sense and stop time to the upper and lower slot as required.

- i) For pole mounted cabinets, mount surge protection devices for the AC+ interconnect cable inputs, inductive loop detector inputs, and low voltage DC inputs on a fold down panel assembly on the rear side of the input files. Fabricate the surge protection devices from sturdy aluminum and incorporate a swing down back panel to which the surge protection devices are attached. Attach the swing down panel to the assembly using thumb screws. Have the surge protection devices mounted horizontally on the panel and soldered to the feed through terminals of four 14 position terminal blocks with #8 screws mounted on the other side.
- ii) For base mounted cabinets, attach separate surge protection termination panels to each side of the cabinet rack assembly Mount the surge protection termination panel for AC isolation devices on the same side of the cabinet as the AC service inputs. Install the surge protection termination panel for DC terminals and loop detector terminals on the opposite side of the cabinet from the AC service inputs. Attach each panel to the rack assembly using bolts and make it easily removable. Mount the surge protection devices in horizontal rows on each panel and solder to the feed through terminals of 14 position terminal blocks with #8 screws mounted on the other side. 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. Ensure the top row of terminals is connected to the upper slots and the bottom row of terminals is connected to the bottom slots. Indicate on the labeling the slot number (1-14) and the terminal pins of the input slots (either D & E for upper or J & K for lower). Terminate all grounds from the surge protection on a 15 position copper equipment ground bus attached to the rear swing down panel. Ensure that a Number 4 AWG green wire connects the surge protection panel assembly ground bus to the main cabinet equipment ground. Provide a standard input file and surge protection panel assembly that fits outside and behind the input file. Ensure the fold down panel allows for easy removal of the input file without removing the surge protection panel assembly or its parts.

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 170E 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 170E 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. Type 170 E Model 2010 Enhanced Conflict Monitor:

Furnish Model 2010 Enhanced Conflict Monitors that provide monitoring of 16 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 August 16, 2002 with Erratum 1 and 2 (hereafter referred to as CALTRANS's 2002 TEES) for a model 210 monitor unit and other requirements stated in this specification.

Ensure the conflict monitor is provided with a 16 channel conflict programming card. Pin 16 and Pin T of the programming card shall be connected together. 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
- VDC Failed
- WDT Error
- Conflict
- Red Fail
- Dual Indication
- Short Yellow/Sequence Failure
- Program Card/PC Ajar
- Monitor Fail/Diagnostic Failure
- Channel Indicators (One indicator for each green, yellow, and red field signal input for each channel)

In addition to the connectors required by CALTRANS's 2002 TEES, provide the conflict monitor with a red interface connector mounted on the front of the monitor (3M-3428-5302 or equivalent with polarizing keys) which ensures proper mating with a 20 pin ribbon cable connector that conducts the signals from the P20 connector on the cabinet assembly. Keying of the connector shall be between

pins 3 and 5, and between 17 and 19. The odd numbered pins are on one side, and the even pins are on the other. Provide connector pins on the monitor with 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’s 2002 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. Have red monitoring occur when both 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.
2. **Short/Missing Yellow Indication Error (Sequence Error):** Yellow indication following a green is missing or shorter than 2.7 seconds (with ± 0.1 -second accuracy). If a channel fails to detect an “on” signal at the Yellow input for a minimum of 2.7 seconds (± 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 sequence/short yellow error fault indication. This fault shall not occur when the channel is programmed for Yellow Inhibit or when the Red Enable signal is inactive.
 - 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 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.
 - 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 five 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. The “drop-out” level is at 98 Vrms and the “restore” level is at 103 Vrms with timing at 400 ms. 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 ± 0.5 seconds, the monitor shall enter a WDT error fault condition.

Ensure to monitor an intersection with up to four approaches using the four-section Flashing Yellow Arrow (FYA) vehicle traffic signal as outlined by the NCHRP 3-54 research project for protected-permissive left turn signal displays. Ensure the conflict monitor will operate in the FYA mode and FYAc (Compact) mode as specified below to monitor each channel for the following fault conditions: Conflict, Red Fail, Dual Indication, and Clearance. Provide a switch to select between the FYA mode and FYAc mode. Provide a switch to select each FYA phase movement for monitoring.

FYA mode

FYA Signal Head	Phase 1	Phase 3	Phase 5	Phase 7
Red Arrow	Channel 9 Red	Channel 10 Red	Channel 11 Red	Channel 12 Red
Yellow Arrow	Channel 9 Yellow	Channel 10 Yellow	Channel 11 Yellow	Channel 12 Yellow
Flashing Yellow Arrow	Channel 9 Green	Channel 10 Green	Channel 11 Green	Channel 12 Green
Green Arrow	Channel 1 Green	Channel 3 Green	Channel 5 Green	Channel 7 Green

FYAc mode

FYA Signal Head	Phase 1	Phase 3	Phase 5	Phase 7
Red Arrow	Channel 1 Red	Channel 3 Red	Channel 5 Red	Channel 7 Red
Yellow Arrow	Channel 1 Yellow	Channel 3 Yellow	Channel 5 Yellow	Channel 7 Yellow
Flashing Yellow Arrow	Channel 1 Green	Channel 3 Green	Channel 5 Green	Channel 7 Green
Green Arrow	Channel 9 Green	Channel 9 Yellow	Channel 10 Green	Channel 10 Yellow

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:

Conflict Monitor RS-232C/D (DB-9 Female) Pinout		
Pin Number	Function	I/O
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	-

6.4. MATERIALS – TYPE 170 DETECTOR SENSOR UNITS

Furnish detector sensor units that comply with Chapter 5, “General Requirements for Detector Sensor Units,” of the CALTRANS Specifications, and the requirements for Model 222 and Model 224 loop detector sensor units.

7. WIRELESS MAGNETIC SENSOR VEHICLE DETECTION SYSTEM

7.1. DESCRIPTION

Furnish a vehicle detection system that uses battery-powered magnetic field sensors for pavement installation that communicate traffic detection data by wireless communication to a transceiver for a local traffic signal cabinet. Ensure each sensor responds to the change in the earth's local magnetic field resulting from the presence and passage of a vehicle. Ensure the system contains sensor(s), transceiver(s), and any other device(s) to provide detection data to a traffic signal controller.

7.2. MATERIALS

Provide magnetic sensors to detect vehicle traffic such as cars, trucks, and motorcycles. Ensure each sensor is sized for an installation into a 4-inch diameter by 3-inch deep hole. Ensure the sensor provides vehicle traffic data for volume and occupancy. Ensure the sensor holds a detection call when a vehicle is stopped in its detection field. Provide a sensor to simulate a detection zone of a 6' x 6' inductive loop. Provide a combination of sensors to simulate a detection zone of a 6' x 40' quadrupole inductive loop and a 6' x 60' quadrupole inductive loop. Ensure the sensors operate as specified by the intersection design plans.

Provide two-way wireless communication between the sensors and the transceiver devices. Ensure no disruption to the wireless communication when the transceiver devices are located on the side of the road surface. Ensure that the sensors can communicate with the transceiver devices for a minimum distance of 100 feet. Ensure all wireless communications within the system operate in an unlicensed frequency band and avoid interference with other devices operating in the unlicensed frequency band. Provide at least 16 frequency channels that are user-configurable.

Provide each sensor to transmit its detection data within 150 ms of a detected event. Ensure the sensor samples the earth's magnetic field at a rate of 128 Hz or faster. Ensure that each sensor transmits a unique identifying code. Ensure that each sensor automatically recalibrates its threshold values in response to changes in the ambient magnetic field based on user-programmed criteria.

Furnish each sensor that is manufactured as a single housing module that conforms to NEMA Type 6P enclosure. Ensure that the components of the sensor are fully encapsulated within the housing to prevent moisture from degrading the components. Ensure the sensor operates at temperatures from -37 degrees F to 176 degrees F. Provide battery-power with an average life expectancy of 10 years when the sensor is operating under normal traffic conditions.

Provide a clear injection molded clamshell style case made of polypropylene for protecting the sensor in the roadway. Ensure case protects the sensor from sealant material. Ensure the case holds the sensor in place and is form-fitting to ensure cured sealant does not collapse when exposed to traffic loads.

Furnish the transceiver to provide detection data to the traffic signal cabinet and ensure the traffic signal controller receives each sensor detection call. Ensure the traffic signal controller receives both presence mode and pulse mode detection calls.

Provide indications inside the traffic signal cabinet to display each channel detection status and fault condition. Provide a switch inside the traffic signal cabinet to select presence mode and pulse mode for each channel. Provide user-selectable sensitivity levels for vehicle detection. Furnish equipment to operate in Type 332 and 336S traffic signal cabinets.

Provide software for installation and use on personal computers to upload and download configuration data to each sensor. Ensure application software is compatible with Windows 2000 and Windows XP operating systems. Ensure software does not require administrative permissions to load and operate. Ensure the software can retrieve and store detection data from the sensors. Ensure the software on the personal computer transmits data from the personal computer to each sensor through the transceiver by wireless communication. Also, provide any update to the firmware in each sensor by wireless communication. Provide a license to the Department to allow the duplication of the personal computer software as needed to design, install and maintain these systems.

7.3. CONSTRUCTION METHODS

Install the wireless magnetic sensor vehicle detector system in accordance with the manufacturer's recommendations. Enclose the wireless magnetic sensor in a molded clamshell style case before installation into the roadway. When installing each sensor into the hole, ensure epoxy sufficiently covers the sensor in the road surface.

Arrange and conduct site surveys with the system manufacturer's representative and Department personnel to determine proper sensor and transceiver selection and placement. Provide the Department at least 3 working days notice before conducting site surveys. The Engineer will approve final locations of sensors, transceivers and any necessary repeaters.

Install the transceiver in such a manner that avoids conflicts with other utilities and as specified in the manufacturer's recommendations. Secure the transceiver mounting hardware to the pole and route the cabling such that no strain is placed on connectors.

Before beginning work at locations that require a wireless magnetic sensor vehicle detector system, furnish system software. Upon activation of the system, provide detector configuration files.

Place system into operation. Configure wireless magnetic sensor vehicle detector system to achieve required detection in designated areas. Have a certified manufacturer's representative on site to supervise and assist with installation, set up, and testing of the system.

Install the necessary processing and communications equipment in the signal controller cabinet. Make all necessary modifications to install equipment in cabinet. Ensure the traffic signal controller receives each sensor detection call.

Place a copy of all manufacturer equipment specifications and instruction and maintenance manuals in the equipment cabinet.

Provide at least 4 hours of training on the set up, operation, troubleshooting, and maintenance of the wireless magnetic sensor vehicle detector system to a maximum of ten Department personnel. Arrange for training to be conducted by the manufacturer's representative at an approved site within the Division responsible for administration of the project. Thirty days before conducting training submit a detailed course curriculum, draft manuals and materials, and resumes. Obtain approval of the submittal before conducting the training. At least one week before beginning training, provide three sets of complete documentation necessary to maintain and operate the system. Do not perform training until installation of the wireless magnetic sensor vehicle detector system is complete.

7.4. MEASUREMENT AND PAYMENT

Actual number of wireless magnetic sensor vehicle detector systems furnished, installed, and accepted.

No measurement will be made of cables or hardware, as these will be considered incidental to furnishing and installing wireless magnetic sensor vehicle detector system.

Payment will be made under:

Wireless Magnetic Sensor Vehicle Detector System.....Each

8. EMERGENCY VEHICLE INITIATED PREEMPTION SYSTEMS

8.1. DESCRIPTION

Furnish and install emergency vehicle initiated preemption systems (hereafter referred to as preemption systems) with all necessary hardware and software in accordance with the plans and specifications. Ensure the preemption systems consist of both a means to place a preemption call and a receiver/processor to receive the call that will properly initiate the desired signal preemption and is compatible with the existing preemption system. Ensure the preemption systems comply with all applicable FCC regulations and conform to NEMA TS2-2003 Section 2, "Environmental Requirements."

8.2. MATERIALS

Furnish preemption systems that are compatible with NEMA TS-1, NEMA TS-2 Type 2, and 170/2070 equipment. Ensure the preemption systems can transmit information serially by a RS-485 connector in a NEMA TS-2 Type 1 cabinet. Ensure the equipment is compatible for use in a NEMA TS-2 detector card rack and a Caltrans 332/336 input file. Ensure the operation of the preemption systems are not affected by the following conditions:

- Snow
- Rain
- Ambient light conditions such as bright sunlight, twilight, shadows, vehicle headlights, etc.
- Fog which can be penetrated by traffic signal indications
- Ambient noise levels below 70 db
- Ambient electromagnetic interference

Provide preemption systems that will log and retain a minimum of 1,000 preemption occurrences that include the direction of preemption, time, and date. Ensure that it is impossible to delete a logged preemption event manually using equipment switches or other manual input and controls. Furnish the ability to upload and download all data and operating parameters using a DB-9 communication port or Department approved alternative. Ensure the logged data is maintained in memory until the data is downloaded. When the maximum number of occurrences is recorded, ensure preemption systems retain data from the most recent event and lose data from the oldest event as new preemption calls occur.

Furnish preemption systems with a time clock that utilize the following features:

- provide time clock to adjust the time for the transition between Daylight Saving Time and Standard Time,
- provide time clock with the option to record and report occurrences using a 24 hour clock time stamp,
- provide internal battery or capacitor backup power source to continue the operation of the time clock and memory during a power outage. Ensure the backup power source

will supply power for a single outage for a minimum of 48 hours and automatically recharge within 24 hours after power is resumed.

Provide preemption systems with a minimum of four separate preemption inputs and outputs or as specified by the bid list or plans. Ensure preemption system receivers differentiate between any two approaches as the source of a call signal if those approaches intersect at an angle greater than 20 degrees. Furnish preemption systems that will detect a preempt call at distances between 250 feet (76m) to 1,500 feet (457m). Ensure ambient signal sources will not cause the preemption system to place the intersection in the preemption mode. Also, provide the means to prevent false calls resulting from emergency vehicles passing through nearby locations or nearby intersections such as at cross streets near the signal.

Provide preemption systems to automatically select the programmed output call to the traffic signal controller based on the approach of the emergency vehicle placing the call. Provide a call extension timer that will hold the preempt call for a user selectable time after the preempt call terminates. Furnish preemption systems to display indications for the receipt of a call for each approach to allow a servicing technician to determine proper or improper operation. Ensure the indications last as long as that call is being received by the system. Provide a test switch or push-button for each channel on the control unit to manually place a preemption call to the traffic signal controller.

Provide all necessary software to the State for the operation of the preemption systems. Ensure the software can operate on a personal computer and is compatible with Windows 2000 and Windows XP. Furnish software that is licensed for use by State personnel and personnel of other agencies that are responsible for maintaining State signals. Ensure the State is licensed to duplicate and distribute the software as necessary for design and maintenance support. Furnish software to have the programming of all user application functions to be displayed in a menu format and show like parameters, functions, or data in a group to provide a coherent order.

Provide preemption systems that have control circuitry of solid-state construction. Ensure active devices for logic, timing, and control functions are solid state and sufficiently rated to have no material shortening of life under conditions of maximum power dissipation at maximum ambient temperature. Furnish timing functions using digital devices. Ensure the memory for event data and program data is stored in an electronically erasable memory device which has 100,000 write cycles (minimum) and is designed to retain data for 10 years. Furnish memory that is not required to have an external battery backup to retain data or other programmed entries unless otherwise specified. Ensure each system component unit requires input power by either 120 VAC from the controller cabinet or separate equipment power supply that is powered by the 120 VAC from the controller cabinet.

Ensure the components of the preemption systems do not exceed the dimension and weight as specified below

- Control Unit – 8” (203mm) width x 10” (254mm) height x 10” (254mm) depth, 10 lbs. (4.5kg)
- Detector Unit or Antenna – 15 lbs. (6.8kg)

Ensure all equipment of the preemption systems which are exposed to weather be weatherproof and suitable for operation in wet locations. Provide moisture resistant coating on all circuit boards.

Provide all required mounting hardware to install the preemption systems that are suitable for use with wood pole or metal structure application. Ensure the mounting hardware provides a secure position to prevent shifting after the initial alignment of the preemption systems.

8.3. CONSTRUCTION METHODS

Place into operation emergency vehicle initiated preemption systems. Configure emergency vehicle initiated preemption systems to achieve required activation by emergency vehicles within required ranges.

Install the necessary processing and communications equipment in the signal controller cabinet. Make all necessary modifications to install equipment, cabling harnesses, and phase selector with surge suppression.

Install the necessary cables from each optical detector to the signal controller cabinet along signal cabling routes. Install surge protection where required and terminate all cable conductors.

8.4. MEASUREMENT AND PAYMENT

Actual quantity of optical preemption detectors furnished, installed, and accepted.

Actual quantity of optical preemption phase selectors furnished, installed, and accepted.

Payment will be made under:

Optical Preemption Detector	Each
Optical Preemption Phase Selector.....	Each

9. PUSH BUTTON POST

9.1. DESCRIPTION

Furnish and install pedestrian push button posts that include pedestrian pushbuttons, R10-3 pedestrian information signs, and all necessary hardware as directed by the plans. Furnish R10-3 signs that include the appropriate pedestrian information for the crossing.

9.2. MATERIALS

Provide push button posts that are constructed out of rigid galvanized conduit and that are a nominal diameter of 1-2 inches. Subject to the Engineer's approval, a spun aluminum post with an aluminum cap may be provided for use with a pedestal base in lieu of a rigid galvanized post. Do not use timber posts, U-channel sign posts, square sign posts, or any other type of post not described here.

9.3. CONSTRUCTION METHODS

Comply with the requirements of Section 1705 of the *Standard Specifications* and Drawing No. 1705.02, sheet 4 of 4 of the Roadway Standard Drawings.

Install push button post immediately adjacent to the sidewalk or pedestrian path and conveniently near the end of the crosswalk that it serves. Where plans call for the push button post to be installed in a pedestrian refuge or median, locate the push button post adjacent to, but not within the pedestrian path.

Install each pushbutton so that it is pointed in the direction of travel and is aligned parallel to the direction of travel on the associated crosswalk.

Ensure pushbuttons are separated by a distance of at least 10 feet such that they clearly indicate which crosswalk has the WALK indication. Where there are constraints on a particular corner that

make it impractical to provide the 10 feet of separation between the two pushbuttons, the pushbuttons may be placed closer together or on the same post, with approval by the Engineer.

Construct the push button post such that it has a minimum height of 5 feet above ground when embedded in its foundation.

Embed the post in a 12" x 12" x 18" simple concrete foundation with a top that is finished flush with the adjacent surface. Stub a rigid galvanized conduit elbow out of the foundation for the conveyance of lead-in cables.

9.4. MEASUREMENT AND PAYMENT

Actual number of push button posts furnished, installed, and accepted.

No measurement will be made of concrete foundations, conduit stub-outs, pedestrian signs, or pushbuttons as these will be considered incidental to furnishing and installing push button posts.

Push button Posts..... Each