

**Project Special Provisions**  
*(Version 06.4)*  
**Signals and Intelligent Transportation Systems**

*Prepared By: Voso  
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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 second paragraph, add “Use 200 amp meter base for underground electrical service”.

### 1.2. Conduit (1098-4)

Page 10-271, Subarticle 1098-4(B)

After the last paragraph, add the following:

**Dependent upon the number of conduits required, furnish conduits in black, orange, blue and white colors. Provide conduits that are factory extruded with the appropriate colors. Black conduits shall be used for signal cables only. White conduits shall be used for loop lead-in cables. Blue conduits shall be used for electrical service and/or reserved as a spare conduit. Orange conduit shall be used for fiber optic cable and/or coaxial cable for radio system. In instances where both fiber optic cable and coaxial cable are located at the same intersection, use separate orange conduits for each.**

### 1.3. Signals and Intelligent Transportation Systems – Construction Methods (1700-3)

Page 17-1, Subarticle 1700-3(A), Add the following:

**The Contractor will be limited to the installation of only one (1) controller cabinet per day. The traffic signal installation must be fully operational and the Contractor shall demonstrate said operation to the Engineer before installation of another controller cabinet can commence.**

### 1.4. Signals and Intelligent Transportation Systems – Construction Methods (1700-3)

Page 17-3, Subarticle 1700-3(F), Revise last sentence to read:

**Return all other equipment and material except traffic signal heads between 8:00 am and 12:00 pm, Monday through Thursday, to the Traffic Services Office within the Division responsible for administration of the project. The traffic signal heads will become property of the City of Hendersonville. Contact Mr. Chris Carter, Town Manager, at (828) 697-3000 to arrange for delivery of the removed signal heads.**

### 1.5. Wood Poles (1098-6)

Page 10-272, Delete article. Refer to Subarticles 1082 –3(F) and 1082-4(G).

### 1.6. Cabinet Base Adapter/Extender (1098-16)

Page 10-279, Subarticle 1098 –16, Revise 1<sup>st</sup> paragraph to include:

**Provide cabinet base extenders that are a minimum height of 18 inches at all master cabinet locations.**

### 1.7. Signal Heads-Construction Methods (1705-3)

Page 17-6, Subarticle 1715-3(C), Revise 2<sup>nd</sup> paragraph, 2<sup>nd</sup> sentence to include:

**In the event where metal poles are relocated in the field to avoid utility or other conflicts and this relocation will render the pedestrian push buttons in-assessable, push buttons and signs can be mounted on 2” metallic conduit at a location deemed accessible to handicap users. Obtain prior approval from the Engineer before mounting on conduit. No**

measurement will be made for 2” metallic conduit and related mounting as this is considered incidental to furnishing and installing pedestrian signal heads.

#### 1.8. Underground Conduit-Description (1715-1)

Page 17-9, Revise 1<sup>st</sup> paragraph to include:

**Provide one (1) spare conduit of equal size and type at every location requiring underground conduit as indicated in the plans. Install spare conduit in the same trench using manufacturer’s spacers.**

#### 1.9. Underground Conduit-Construction Methods (1715-3)

Page 17-9, Subarticle 1715-3(A) General, Add before 1<sup>st</sup> paragraph the following:

**Contractor is responsible for locating existing underground utilities prior to beginning conduit installation method in order to avoid any underground utility conflicts. Conduit runs as shown on plans may need to be modified to avoid conflicts. Modify conduit runs as necessary to avoid conflicts. Obtain Engineer’s approval before modifying any runs.**

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

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

#### 1.10. Fiber-Optic Cable-Measurement and Payment (1730-4)

Page 17-23, Subarticle 1730-4, Revise 1<sup>st</sup> paragraph to include:

**The quantity of fiber-optic cable, measured as provided above, will be paid for at the contract unit price per linear foot for “Communications Cable (\_\_\_-Fiber)” in accord with the following conditions: 75% of the payment will be made upon acceptance of the installed cable; 25% of the payment for the cable will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

#### 1.11. Fiber-Optic Splice Centers - Measurement and Payment (1731-4)

Page 17-25, Subarticle 1731-4, Revise 1<sup>st</sup> paragraph to include:

**The quantity of fiber-optic interconnect centers, measured as provided above, will be paid for at the contract unit price per linear foot for “Interconnect Center” in accord with the following conditions: 75% of the payment will be made upon acceptance of the installed unit; 25% of the payment for the unit will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

Page 17-25, Subarticle 1731-4, Revise 2<sup>nd</sup> paragraph to include:

**The quantity of splice enclosures, measured as provided above, will be paid for at the contract unit price per linear foot for “Splice Enclosure ” in accord with the following conditions: 75% of the payment will be made upon acceptance of the installed unit; 25% of the payment for the unit will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

#### 1.12. Fiber-Optic Transceivers - Measurement and Payment (1732-4)

Page 17-26, Subarticle 1732-4, Revise 2<sup>nd</sup> paragraph to include:

**The quantity of fiber-optic self-healing ring transceivers, measured as provided above, will be paid for at the contract unit price per linear foot for “Fiber-Optic Transceiver – Self-Healing Ring” in accord with the following conditions: 75% of the payment will be made upon acceptance of the installed unit; 25% of the payment for the unit will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

### 1.13. Signal Pedestals - Description (1743-1)

Page 17-28, Subarticle 1743-1, Replace 1<sup>st</sup> paragraph with:

**Furnish and install signal pedestals with decorative fluted bases matching in design to the traffic signal pole base or an Engineer-approved equivalent. The specific base style shall be approved by the Engineer prior to installation. Furnish and install signal pedestal assemblies with decorative bases, foundations, grounding systems and all necessary hardware.**

### 1.14. Signal Pedestals – Measurement and Payment (1743-4)

Page 17-29, Subarticle 1743-4, Replace 1<sup>st</sup> paragraph with:

**Signal pedestal with decorative base and foundation will be measured and paid as the actual number of signal pedestals with decorative bases and foundations furnished, installed, and accepted.**

### 1.15. Controllers with Cabinets – Measurement and Payment (1751-4)

Page 17-33, Subarticle 1751-4, Revise 1<sup>st</sup> paragraph to include:

**The quantity of controllers with cabinets, measured as provided above, will be paid for at the contract unit price per each for “Controller with Cabinet (\_\_\_)” in accord with the following conditions: 90% of the payment will be made upon acceptance of the installed unit; 10% of the payment for the unit will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

### 1.16. Cabinet Base Adapter/Extender-Construction Methods (1753-3)

Page 17-33, Subarticle 1753-3, Revise 3rd paragraph, 1st sentence to include:

**Provide a cabinet base extender at every location requiring a new Model 336 pole mounted cabinet.**

## 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 and end caps from die-cast aluminum. Fabricate 12-inch and 16-inch pedestrian signal head housings and end caps from die-cast aluminum. Fabricate 9-inch pedestrian signal head housings, end caps, and visors from virgin polycarbonate material. 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.

Fabricate tunnel and traditional visors from sheet aluminum.

Paint all surfaces inside and outside of signal housings and doors. Paint outside surfaces of tunnel and traditional visors, messenger cable mounting assemblies, pole and pedestal mounting assemblies, and pedestrian pushbutton housings. Have electrostatically-applied, fused-polyester



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paint **hunter green in color** a minimum of 2.5 to 3.5 mils thick. Do not apply paint to the latching hardware or rigid vehicle signal head mounting brackets.

Have the interior surfaces of tunnel and traditional visors painted an alkyd urea black synthetic baking enamel with a minimum gloss reflectance and meeting the requirements of MIL-E-10169, "Enamel Heat Resisting, Instrument Black."

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.

**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 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 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.

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Fabricate the mounting assemblies from malleable iron or aluminum, and provide serrated rings made of aluminum.

Provide light emitting diode (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.

**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 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 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  $\pm 1\%$  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.

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

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must provide replacement modules within 45 days of receipt of modules that have failed at no cost to the State. Provide manufacturer's warranty documentation to the Department during evaluation of product for inclusion on Qualified Products List (QPL).

Inclusion of the LED traffic signal modules on the Department's Qualified Products List for traffic signal equipment requires:

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 the VTCSH Circular Supplement. (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 will 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.

## **2. LED Arrow Signal Modules**

Ensure arrow modules meet or exceed the electrical and environmental operating requirements of sections 3 and 5 of the Interim Purchase Specification of the ITE VTCSH part 2 Light Emitting Diode (LED) Vehicular Traffic Signal Modules (hereafter referred to as VTCSH-2), the chromaticity requirements of Section 4.2, and the requirements of Sections 6.3 (except 6.3.2) and 6.4 (except 6.4.2).

Provide modules that meet the requirements of Table 1098-1. Ensure that fluctuations of line voltage have no visible effect on the luminous intensity of the indications. Design the module to have a normal operating voltage of 120 VAC rms, and measure all parameters at this voltage.

**Table 1098-1**

**Maximum Power Consumption (in Watts) at 77°F**

	Red	Yellow	Green
12-inch arrow	9	10	11

Certify that the module meets the requirements of VTCSH-2, Section 5.7. Ensure all wiring meets the requirements of Section 5.1 of the VTCSH-2. In addition, spade terminals appropriate to the lead wires and sized for a #10 screw connection to the existing terminal block in a standard signal head.

Ensure that the module is compatible with signal load switches and conflict monitors. Design the module to provide sufficient current draw to ensure proper load switch operation while the voltage is varied from a regulated 80 Vrms to 135 Vrms. Design off-state for green and yellow modules to be 30Vrms or less, and on-state to be 40 Vrms or greater. Design the voltage to decay to 10 Vrms or less in 100 milliseconds. Ensure that the control circuitry prevents current flow through the LEDs in the off state to avoid a false indication.

Design all modules to meet existing NCDOT monitor specifications for each of the following types of signal monitors: NEMA TS-1 conflict monitors (including so-called NEMA plus features such as dual indication detection and short yellow time detection); NEMA TS-2 Malfunction Management Units (MMU); and 170 cabinet Type 210ECL and 2010ECL conflict monitors

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(including red monitoring and so-called plus features such as dual indication detection and short yellow time detection).

Ensure that the modules and associated onboard circuitry meet Class A emission limits referred to in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.

Provide modules that meet the requirements of Table 1098-2. Design and certify the modules to meet or exceed the maintained minimum luminous intensity values throughout the warranty period based on normal use in a traffic signal operation over the operating temperature range. Test the Red and Green arrow modules for maintained luminous intensity at 165°F (ITE 6.4.2.2). Use LEDs that conform to the chromaticity requirements of VTCSH-2, Section 2 throughout the warranty period over the operating temperature range. Make chromaticity coordinate compliance measurements at 77°F.

**Table 1098-2**  
**Minimum Initial and Maintained Luminance for Arrow Indications (in cd/ft<sup>2</sup>)**

	Red	Yellow	Green
Arrow Indication	511	1022	1022

Design the modules as retrofit replacements for installation into standard incandescent traffic sections that do not contain the incandescent lens, reflector assembly, lamp socket and lens gasket. Ensure that installation does not require special tools or physical modification for the existing fixture other than the removal of the incandescent lens, reflector assembly, lamp socket, and lens gasket.

Provide modules that are rated for use in the operating temperature range of -40°F to +165°F. Ensure that the modules (except yellow) meet all specifications throughout this range. Fabricate the module to protect the onboard circuitry against dust and moisture intrusion per the requirements of NEMA Standard 250-1991 for Type 4 enclosures to protect all internal components.

Design the module to be a single, self-contained device with the circuit board and power supply for the module inside and integral to the unit.

Design the assembly and manufacturing process for the module to ensure all internal components are adequately supported to withstand mechanical shock and vibration from high winds and other sources. Group the individual LEDs such that a catastrophic loss or the failure of one LED will result in the loss of not more than 20 percent of the signal module light output. Solder the LEDs to the circuit board.

Fabricate the lens and signal module from material that conforms to ASTM specifications. Ensure enclosures containing either the power supply or electronic components of the module are made of UL94VO flame retardant materials. The lens of the signal module is excluded from this requirement.

Permanently mark the manufacturer's name, trademark, model number, serial number, date of manufacture (month & year), and lot number as identification on the back of the module.

Permanently mark the following operating characteristics on the back of the module: rated voltage and rated power in watts and volt-amperes.

If a specific mounting orientation is required, provide permanent markings consisting of an up arrow, or the word "UP" or "TOP" for correct indexing and orientation within the signal housing.

Provide a lens that is integral to the unit with a smooth outer surface and UV stabilized to withstand ultraviolet exposure for a minimum period of 60 months without exhibiting evidence of

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deterioration. Coat the front of a polycarbonate lens to make it more abrasion resistant. Seal the lens to the module to prevent moisture and dust from entering the module.

Tint the red, yellow, and green lens to match the wavelength (chromaticity) of the LED.

Ensure that the module meets specifications stated in Chapter 2, Section 9.01 of the ITE Equipment and Materials Standards for arrow indications. Design arrow displays to be solid LEDs (spread evenly across the illuminated portion of the arrow or other designs), not outlines. **Determine the luminous intensity using the CALTRANS 606 method or similar procedure.**

**Burn In** - Energize the sample module(s) for a minimum of 24 hours, at 100 percent on-time duty cycle, at a temperature of +165°F before performing any qualification testing. Any failure of the module, which renders the unit non-compliant with the specification after burn-in, is cause for rejection. All specifications will be measured including, but not limited to:

- (a) **Photometric (Rated Initial Luminous Intensity)** - Measure at +77°F. Measure luminous intensity for red and green modules upon the completion of a 30 minute 100 percent on-time duty cycle at the rated voltage. **Measure luminous intensity for yellow modules immediately upon energizing at the rated voltage.**
- (b) **Chromaticity (Color)** - Measure at +77°F. Measure chromaticity for red and green modules upon the completion of a 30 minute 100 percent on-time duty cycle at the rated voltage. **Measure chromaticity for yellow modules immediately upon energizing at the rated voltage.**
- (c) **Electrical** - Measure all specified parameters for quality comparison of production quality assurance on production modules. (rated power, etc)

NCDOT evaluates and approves all LED Traffic Signal modules for the QPL by a standard visual inspection and blind operational survey, a compatibility test, current flow, and other random tests, in addition to reviewing the lab reports and documentation from the manufacturer. The tests are conducted at the Traffic Electronics Center in Raleigh. Ensure each 12-inch arrow module is visible at 300 feet during sway conditions (extended view) until obscured by the visor. Sufficient luminance during the extended views will be determined during this blind survey evaluation.

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 replacement modules within 45 days of receipt of modules that have failed at no cost to the State. Provide manufacturer's warranty documentation to the Department during evaluation of product for inclusion on Qualified Products List (QPL).

**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"

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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 for installation into standard pedestrian traffic signal sections that do not contain the incandescent signal section reflector, lens, eggcrate visor, gasket, or socket. Provide a clear 0.25-inch, non-glare, mat finish lens with a smooth outer surface and UV stabilized to withstand ultraviolet exposure for a minimum period of 60 months without exhibiting evidence of deterioration. Coat the front surface of a polycarbonate lens to make it more abrasion resistant. Ensure that the lens has light transmission properties equal to or greater than 80%.

Ensure installation of all modules requires no physical modification of the existing fixture other than the removal of the incandescent signal section reflector, lens, eggcrate visor and socket where applicable.

Design the man and hand to be a solid display, which meets the minimum requirements of “The Equipment and Materials Standards” of the Institute of Transportation Engineers (ITE) Chapter 3, Table 1 *Symbol Message*. Group the LEDs such that a catastrophic loss or failure of one or more LEDs will result in the loss of not more than five percent of the signal module light output. Solder the LEDs to the circuit board.

Ensure that the power consumption for the modules is equal to or less than the following in watts, and that the modules have EPA Energy Star compliance ratings, if applicable to that shape, size and color:

Temperature	77°F	165°F
Hand	10	12
Man	9	12
Countdown	9	12

Provide 16-inch displays, where required by the plans, which have the hand/man overlay on the left and the countdown on the right. Ensure the hand/man symbols meet the dimension requirements cited in Chapter 3, Table 1 *Symbol Message* for Class 3 or Class 4 displays. Ensure that the countdown number display is at least 9 inches high by 6 inches wide. Configure the signal head with a sufficient number of LEDs to provide an average luminance of at least 342 candela per square foot of lighting surface for the “RAISED HAND” and “COUNTDOWN”, and 483 candela per square foot of lighting surface for the “WALKING PERSON”. Ensure modules meet this average luminous intensity throughout the warranty period over the operating temperature range. Design the countdown display as a double row of LEDs, and 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 until the beginning of the next don’t walk indication, and design the controlling circuitry to prevent the timer from being triggered during the solid hand indication.

Provide 12 inch displays, where required by the plans, that meet the dimension requirements cited in Chapter 3, Table 1 *Symbol Message* for Class 2 displays. Furnish the solid hand/man module as an overlay, the solid hand module, and the solid man module as required by the plans. Configure the signal head with a sufficient number of LEDs to provide an average luminance of at least 342

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candela per square foot of lighting surface for the “RAISED HAND” and “COUNTDOWN”, and 483 candela per square foot of lighting surface for the “WALKING PERSON”. Ensure modules meet this average luminance throughout the warranty period over the operating temperature range.

Design all modules to operate using a standard 3 - wire field installation. Provide lead wires that are eighteen gauge (18AWG) minimum copper conductors with 221 degree F insulation. Ensure that lead wires are a minimum of 30 inches long with NEMA “spade” terminals that are appropriate to the lead wires and sized for a #10 screw connection to the existing terminal block in the signal head.

Ensure that modules are compatible with signal load switches and conflict monitors. Design the module to provide sufficient current draw to ensure proper load switch operation while the voltage is varied from a regulated 80Vrms to 135Vrms. Provide control circuitry to prevent current flow through the LEDs in the off state to avoid a false indication. Design all modules to meet existing NCDOT monitor specifications for each of the following types of signal monitors: NEMA TS-1 conflict monitors (including so-called NEMA plus features such as dual indication detection and short yellow time detection); NEMA TS-2 Malfunction Management Units; and 170 cabinet 210ECL and 2010ECL conflict monitors (including red monitoring and so-called plus features such as dual indication detection and short yellow time detection).

Comply with the following sections: 3.3, 3.5, 3.6.1, 3.6.2, 5.2, 5.3, 5.7, 6.1, 6.3.1, 6.3.3, 6.3.4, 6.3.5, 6.4.4, 6.4.5, and 6.4.6 of VTCSH-2.

Furnish Portland Orange LEDs for the hand and countdown displays that are the latest AlInGaP technology or higher, and Lunar White LEDs for the man display that are the latest InGaN technology or higher.

Provide manufacturer’s certification of compliance with the sections of the ITE specification identified above and this specification when product is submitted for evaluation. Provide test results showing that the signal modules meet or exceed the luminous intensity requirements.

Provide modules that include, but are not limited to the following items: lens, LED display mounted on a circuit board, wire leads with strain relief, rigid housing, electronics including a power supply integral to the LED module which is protected by the housing, and a neoprene one piece gasket. Ensure that the module is compatible with standard, existing, pedestrian head mounting hardware.

Warrant performance for a period of 60 months from the date of installation and include repair or replacement of an LED signal module that exhibits light output degradation, which in the judgment of the Department, cannot be easily seen at 150 feet in bright sunlight with a visor on the housing or which drops below the luminous intensity output requirements. 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 replacement modules within 45 days of receipt of modules that have failed at no cost to the State. Provide manufacturer’s warranty documentation to the Department during evaluation of product for inclusion on Qualified Products List (QPL).

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.

#### **E. Optically-Programmed Vehicle Signal Sections:**

Material, equipment, and hardware furnished under this section must be pre-approved on the Department's QPL by the date of installation.

Design the programmable signal sections to tilt in two-degree increments for a maximum of ten degrees above and ten degrees below horizontal, while still maintaining a common vertical axis.

Design the programmable signal sections to mount to standard signal sections to form a signal head. Ensure that the programmable signal sections have a mounting system compatible with the standard 1 ½-inch traffic signal fittings.

Provide an optical system consisting of a lamp, a diffuser, an optical limiter, and an objective lens. Ensure that all programming is accomplished optically with no hoods or louvers necessary to accomplish the programming. Provide optical masking tape with each section.

Provide a 150-Watt, 115 VAC lamp with integral reflector and rated output of 1750 lumens. Ensure that the average rated life is at least 6000 hours.

Provide a high resolution, annular, incremental lens. Ensure that the lens and door are sealed to provide a moisture and dust proof seal. Provide a red, yellow, or green ball or arrow indication as specified by the bid list, plans, or purchase order.

### **3.2. CONSTRUCTION METHODS**

#### **A. Optically-Programmed Vehicle Signal Sections:**

Install vehicle signal heads with optically programmed vehicle signal sections so that movement of the vehicle signals head is restricted. Tightly tether vehicle signal heads at the top and bottom when installed on messenger cable. Attach vehicle signal heads using a mounting-bracket assembly that locks the vehicle signal head into position from the back and restricts movement when installed on mast arms.

### **3.3. MEASUREMENT AND PAYMENT**

Actual number of vehicle signal heads with multiple optically programmed sections furnished, installed, and accepted.



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Payment will be made under:

**Vehicle Signal Head with Multiple Optically-Programmed Section.....Each**

#### 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 Fiber-optic Restoration Kit:

Furnish a fully functional fiber-optic restoration kit consisting of the following items (minimum):

- Plier-type strippers
- Non-niks fiber stripper tool with procedures
- Buffer tube stripper tool with procedures
- Fiber-optic Cleaver (average cut less than 0.5 degrees from perpendicular) Diamond Blade
- Screw driver set
- 48 Alcohol wipes
- Tape, 3/4-inch, electrician
- Kim wipes
- Metal ruler
- Tweezers
- Crimping pliers
- CamSplice assembly manual
- CamSplice assembly fixture
- 12, Non-adhesive, mechanical, CamSplice, splices
- 2 Mechanical Splice Trays, 12 CamSplices Capacity, Compatible with the Interconnect Centers being installed in the Traffic Signal Controller Cabinets
- Scissors
- Hard-sided, padded, storage case

###### B.2 Fiber-optic Power Meter:

Furnish fiber-optic power meters for measuring absolute power and link losses, as well as monitoring power levels and testing threshold levels. Provide the following features:

- Spectral range .....750 nm to 1700 nm
- Calibrated wavelengths .....850, 1310, and 1550 nm
- Accuracy .....± 3 percent (± 0.1 dB) at -20 dBm at 70 degrees F  
at calibrated wavelengths

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- Readout resolution .....4 digits, 0.01 dBm
- Display .....Backlit LCD
- Fiber-optic connector .....ST type
- Power-up stabilization .....Less than five seconds at ambient temperature
- Tone threshold settings .....User selectable from 1 to 35 dB, plus OFF
- Analog output port
  - Voltage .....0 to + 1 V FSD of linear power range
  - Output impedance .....5 kilohms, nominal
- Temperature
  - Operating .....32 to 122 degrees F
  - Storage .....0 to 150 degrees F
- Relative humidity .....5 to 95 percent, non-condensing
- Battery power .....Alkaline: 28 hours; NiCad: 8 hours (recharger and NiCad batteries provided)
- Carrying case

**B.3 Optical Light Generator:**

Furnish optical light generators for measuring absolute power and link losses, as well as monitoring power levels and testing threshold levels. Provide the following features:

- Calibrated wavelengths .....1310 nm, and 1550 nm
- Accuracy .....3 percent at 70 degrees F at calibrated wavelengths
- Fiber-optic connector .....ST type
- Power-up stabilization .....Less than five seconds at ambient temperature
- Temperature
  - Operating .....32 to 122 degrees F
  - Storage .....-10 to 150 degrees F
- Relative humidity .....5 to 95 percent, non-condensing
- Battery power .....Alkaline: 28 hours; NiCad: 8 hours (recharger and NiCad batteries provided)
- Carrying case

**B.4 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 restoration kits furnished and accepted.

Actual number of fiber-optic power meters furnished and accepted.

Actual number of optical light generators furnished and accepted.

Actual number of fiber-optic transceivers furnished and accepted.

Payment will be made under:

<b>Furnish Fiber-optic Restoration Kit .....</b>	<b>Each</b>
<b>Furnish Fiber-optic Power Meter.....</b>	<b>Each</b>
<b>Furnish Optical Light Generator .....</b>	<b>Each</b>
<b>Furnish Fiber-optic Transceiver .....</b>	<b>Each</b>

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**5. FIBER-OPTIC TRAINING****5.1. DESCRIPTION**

Provide training for the installation, operation and maintenance of the fiber-optic communications cable, fiber-optic transceivers, interconnect centers, splice trays and other related fiber-optic equipment in accordance with the plans and specifications.

**5.2. MATERIALS**

Provide training to properly install, operate, maintain, diagnose and repair each piece of equipment associated with the fiber-optic system. Provide approved manufacturer's representatives or other qualified personnel to conduct training courses. Provide training for a minimum of fifteen Department personnel.

Before beginning the training course, submit detailed course curricula, draft manuals, and handouts, and resumes of the instructors for review and approval. The Engineer may request modification of the material and request courses desired by the Department.

Conduct all training courses at a location provided by the Department within the Division and at a time mutually agreed upon, but not later than the start of fiber-optic cable testing. Provide training material, manuals, and other handouts to serve not only as subject guidance, but also as quick reference for use by the students. Deliver course material in reproducible form immediately following the course.

Using VHS cassettes, videotape each training course and deliver cassettes at the conclusion of training.

Provide instruction on basic fiber-optic theories and principals as well as the installation, operation, maintenance, identification, detection, and correction of malfunctions in fiber-optic communications cable and related hardware. Include field level troubleshooting as an integral part of the training.

Provide training for the fiber-optic system for the following categories and for the minimum number of hours shown:

**COURSE OUTLINES (L = Lecture; D = Demonstration; H = Hands-on by Student)**

**TRANSCEIVER****DAY 1 (4 Hours)**

Safety - (L)

Introduction to transceivers - (L)

Review of Maintenance Manual - (L)

Review of Operations Manual - (L)

Question and answer session

**FIBER-OPTIC CABLE SYSTEM**

**DAY 2 (8 Hours)**

Safety - (L)

Introduction to fiber optics, theory, and principals - (L)

Fiber and cable types -(L, H)

National Electrical Code considerations - (L, H)

plenum and riser type cable  
out door cable, etc.

Introduction to terminating hardware, end equipment, and applications - (L, D, H)

connectors (ST, SC, etc.)  
splice enclosure, splice trays, and connector panels  
cable placement techniques

Question and answer session

**DAY 3 (8 Hours)**

Cable handling and preparation (sheath removal, grip installation, etc.) - (L, D, H)

Splicing and terminating methods - (L, D, H)

mechanical splicing using various techniques  
fusion splicing  
field termination of connectors types

Introduction to cable plant testing procedures - (L, D, H)

proper usage of optical light generator and power meter  
optical time domain reflectometer usage

Class project (build working system using cables/connectors made by attendees) - (L, D, H)

Question and answer session

**DAY 4 (4 Hours)**

Class project -- Testing and troubleshooting -- (L, D, H)

Cable system maintenance and restoration -- (L)

Question and answer session

**5.3. MEASUREMENT AND PAYMENT**

Lump sum for fiber-optic training with training packages completed and accepted.

Payment will be made under:

**Fiber-optic Training.....Lump Sum**

**6. VIDEO EQUIPMENT**

**6.1. DESCRIPTION**

Furnish and install video equipment described in this Section. Furnish equipment that is compatible, interoperable, and completely interchangeable with the existing CCTV system.

Furnish and install video field equipment necessary to control and monitor the CCTV assemblies installed at locations shown in the Plans. Each CCTV camera installation will be connected to a communications HUB/cabinet as shown on the plans over a fiber optic communications network. The communications HUB/cabinets shall include (but not be limited to) local CCTV camera control module for a local CCTV camera, video multiplexer, video encoder, communications protocol

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converter (if necessary), fiber optic interconnect centers, transceivers (data and video), and Ethernet equipment. Specifications for the HUB cabinet are located in Section 9 of these Project Special Provisions.

Furnish and install the central video equipment and software necessary to allow users at the Division 14, Traffic Building to control and view the video from the CCTV cameras located in the field. Provide equipment that is compatible with the existing CCTV system located in the Division 14 Traffic Building that allows control and viewing of the cameras and video multiplexer over the Internet.

The current system allows viewing of the existing CCTV cameras from the Triangle Regional Traffic Management Center (TRTMC), and the Emergency Information Center (EIC). The revised system upon completion shall allow for the same functionality.

**6.2. MATERIAL****A. CCTV Camera Assembly (Field Equipment):****1. General**

Furnish and install, at the locations shown on the Plans, new CCTV camera assemblies. Ensure that Underwriters Laboratory or an accredited 3rd party-listing agency certifies all equipment submitted. Each CCTV assembly consists of the following:

- One Pelco Spectra Series III Dome CCTV or approved equivalent that contains in a single enclosed unit the following functionality and accessories:
- CCTV color digital signal processing camera unit with zoom lens, filter, control circuit, and accessories
- Motorized pan, tilt, and zoom
- Pole-mount camera attachment assembly
- All necessary cables, connectors and incidental hardware to make a complete and operable system
- A lightning arrestor shall be furnished and installed in-line between the CCTV camera and the equipment cabinet components.
- Camera Unit housing shall be a NEMA Type 4, IP 66 enclosure constructed of aluminum with a clear acrylic dome or approved equivalent.

**2. Cameras**

Furnish new charged coupled device (CCD) color cameras. Ensure the cameras provide automatic gain control (AGC) for clear images in varying light levels. Furnish cameras meeting the following minimum requirements:

- Video signal format: NTSC composite color video output, 1 volt peak to peak
- Automatic Gain Control (AGC): 0-20 dB, peak-average adjustable
- Automatic focus: Automatic with manual override
- White balance: Automatic through the lens and manual adjustable from remote controller.

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- Electronic-Shutter: dip-switch selectable electronic shutter with speed range from 1/60 of a second (off) to 1/30,000th of a second
- Overexposure protection: The camera shall have built-in circuitry or a protection device to prevent any damage to the camera when pointed at strong light sources, including the sun
- Sensitivity: 1.5 lux at 90% scene reflectance
- Signal to noise ratio: Greater than 48-dB
- Video output Connection: 1-volt peak to peak, 75 ohms terminated, BNC connector
- Power: 24 VAC or less

**3. Zoom lens**

Furnish each camera with a motorized zoom lens that is a Pelco Spectra III high performance integrated dome system or approved equivalent with automatic iris control with manual override and neutral density spot filter. Furnish lenses that meet the following optical specifications:

- Focal length: 0.16" – 3.45", 22X optical zoom, 12X electronic zoom
- Preset positioning: 64 Presets

Ensure the lens is capable of both automatic and remote manual control iris and focus override operation. Ensure the lens is equipped for remote control of zoom and focus, including automatic movement to any of the preset zoom and focus positions. Mechanical or electrical means shall be provided to protect the motors from overrunning in extreme positions. Ensure the operating voltages of the lens is compatible with the outputs of the camera control.

**4. Camera Housing**

Furnish new dome style enclosures for the CCTV assemblies that are Pelco Spectra III high performance integrated dome systems or approved equivalents. Equip each housing with mounting assembly for attachment to the CCTV camera pole. Furnish an enclosure that is equipped with a sunshield that is fabricated from corrosion resistant aluminum and finished in a neutral color of weather resistant enamel. Furnish the housing with a heater/blower assembly controlled by a thermostat. Ensure the enclosures meet or exceed NEMA 4X ratings. Furnish a clear acrylic dome over the viewing area of the CCTV Camera.

**5. Pan and Tilt Unit**

Furnish each new dome style assembly with a pan and tilt unit. Ensure the pan and tilt unit is integral to the Pelco Spectra III high performance integrated dome system or approved equivalent. Ensure the pan and tilt unit is rated for outdoor operation and provides dynamic braking for instantaneous stopping, prevent drift, and have minimum backlash. Ensure the pan and tilt units meet or exceed the following specifications:

- Pan: continuous 360 Degrees
- Tilt: up/down 180 degrees minimum
- Input voltage: 24 VAC 50/60Hz
- Motors: Two phase induction type, continuous duty, instantaneous reversing
- Preset Positioning: 64 PTZ presets per camera

**U-4427****Signals & Intelligent Transportation Systems****6. Internal Video/PTZ Receiver/Driver**

Furnish new camera units with a Video/PTZ receiver/driver that is integral to the CCTV dome assembly. Ensure the receiver/driver receives serial asynchronous data initiated from a camera control unit, decodes the command data, performs error checking, and drives the pan/tilt unit, camera controls, and motorized lens. As a minimum, ensure the control receiver/drivers provides the following functions:

- Zoom in/out
- Automatic focus with manual override
- Tilt up/down
- Automatic iris with manual override
- Pan right/left
- Minimum 64 preset positions for pan, tilt, and zoom

In addition, ensure each receiver/driver accepts status information from the pan/tilt unit and motorized lens for preset positioning of those components. Ensure the camera receiver/driver accepts and relays pan, tilt, zoom, and focus positions. The preset commands from the camera control unit will consist of unique values for the desired pan, tilt, zoom, and focus positions.

**7. Local CCTV Camera Control Module**

Furnish a local CCTV camera control module with provision for local control of all camera functions, and with a BNC connector for attachment of test equipment to the video signal coming from the camera. Control of the camera functions shall be by an EIA-232 connection to a notebook computer (furnished by others) or a Personal Digital Assistant "PDA" with software. The BNC connector for the video shall be one output of a 1 x 2 distribution amplifier, with the other output feeding the video signal to the video/data transceiver.

**8. CCTV Camera Attachment to Pole**

At locations shown in the Plans where CCTV cameras are to be installed at signalized intersections on new metal poles furnish an attachment assembly for the CCTV camera unit. Submit shop drawings for review and approval by the Engineer prior to installation.

At locations shown in the Plans where CCTV cameras are to be installed at signalized intersections on wood signal poles, furnish an attachment assembly for the CCTV camera unit.

Furnish CCTV Camera Attachment Assembly that is able to withstand wind loading at the maximum wind speed and gust factor called for in these Project Special Provisions and can support a minimum camera unit dead load of 25 pounds (11.3 kg).

**9. Surge Suppression**

Ensure that all equipment at the top of the pole is protected by grounded metal oxide varistors connecting each power conductor to ground.

Furnish a surge protector equal to Vicon V15LP on each end of the coaxial cable.

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**B. CCTV Camera Poles:**

Furnish hot-dipped galvanized steel poles to mount CCTV units and equipment cabinets that meet or exceed the requirements of Section 16 of these Project Special Provisions unless otherwise noted in the Plans.

Mount cameras on traffic signal mast arm poles located at the intersections listed below.

*SIG INV # 14-0606 (Church Street at 6<sup>th</sup> Avenue) – Pole #5*

*SIG INV # 14-0597 (US 25 at US 176) – Pole #31*

Cameras located at the intersections listed below shall be mounted to a wood pole.

*SIG INV. # 14-0627 (King Street at 7<sup>th</sup> Avenue) – Joint Use Existing Wood Pole*

*SIG INV. # 14-0044 (4 Seasons Blvd. At Linda Vista Drive) – Joint Use Existing Wood Pole*

*SIG INV. # 14-1131 (US 64 at Highlands Sq. Shop. Center) – Proposed 50' Class-II Wood Pole*

Cameras located at the intersection listed below shall be mounted on a standalone CCTV metal pole designated as *Pole # 38*.

*SIG INV. # 14-0736 (4 Seasons Blvd. At I-26 Ramps)*

Cameras located at the intersections listed below shall be mounted to a metal strain pole, which is used to support traffic signal cable.

*SIG INV. # 14-0611 (US 25 at Fleming Street) – Pole #8*

Furnish and install a concrete foundation for each metal pole that is in accordance with the Plans and Specifications. Comply with Section 16 of these Project Special Provisions.

Furnish poles and foundations at Sig. Inv. # 14-0736 and Sig. Inv. # 14-0611 that meet or exceed the following functional requirements with all CCTV units, power meter, service disconnect, and all equipment cabinets attached and all risers, condulets, and weatherhead accessories in place:

- Maximum deflection at top of pole [in 48 km/hr (30 mph), non-gusting wind]: 25 mm (1 inch)
- Ultimate load: 129 km/hr (80 mph) wind with a 30% gust factor

Furnish poles and foundations that sustain the dead load of all equipment attached to the pole with a safety factor of 1.5.

Conduit elbows in foundation shall have a minimum radius of 15 inches (380 mm).

Prepare a design for the pole foundation and submit to the Engineer for review. The top of the drilled shaft foundation shall be flush with finished grade. Unstable soil may require a deeper foundation. Concrete for the foundation shall be 3000 psi (210 kg/square cm) minimum. Foundation design shall meet all NCDOT requirements and be prepared and sealed by a professional engineer licensed to do design work in North Carolina.

**Furnish on all poles an air terminal as shown on the Typical Details for CCTV camera installations.**

Furnish for CCTV camera installations at SIG. INV #14-0736 and 14-0611 metal poles that when erected in foundation and completely installed are at a minimum height of 50 feet (15 meters) above the grade of their base.



**U-4427****Signals & Intelligent Transportation Systems****C. Video Multiplexer (HUB Cabinet):**

For compatibility with the existing equipment in the Region, furnish a Protronix Pro-CC16B video multiplexer or an approved equivalent. Furnish and install a video multiplexer with the following features:

- Minimum of 16 NTSC inputs
- Minimum of 1 NTSC output
- Minimum output formats:
  - full screen for each input individually
  - Picture in a Picture
  - Multiple viewing options: 2 by 2; 3 by 3; 4 by 4, etc
- RS422 remote control
- Title generator providing up to 8 characters for each channel
- Built in Real Time Clock
- Dimensions:
  - Height:  $\leq 1.75''$  (1U)
  - Width: Fits in normal 19'' rack
  - Depth:  $< 11''$
- Power Requirements:  $\leq 10$  W at 12 VDC ( $\pm 10\%$ )

**D. Video Encoder (HUB Cabinet):**

Furnish and install Video Encoders as shown on the Plans. For compatibility with the existing equipment in the Region, furnish a Protronix Pro-VXII video encoder or an approved equivalent.

Provide a Video Encoder with a bandwidth capable of transmitting up to 30+ frames/second low resolution over 10Base-T Ethernet LAN. Provide a Video Encoder capable of varying the frame rate such that the slower the frames/second the higher the image resolution.

Provide a video encoder having the following minimum features:

- One (1) NTSC video input
- One (1) 10/100 Base-T Ethernet LAN (TCP/IP)
- Two (2) RS232 ports

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- Operate from 120 VAC (use of a transformer providing a lower voltage is permissible)

Furnish a video encoder that is easy to install and configure. Ensure the unit has password protection and is capable of upgrading the software via downloads. Ensure the unit is equipped with high performance image capture and compression software.

Ensure the unit is capable of full multiplexer control and is capable of providing control to multiple Pan/Tilt/Zoom cameras.

### **E. Fiber Optic Video/Data Transceivers:**

Furnish Fiber Optic Video Transmitter/Data Transceiver at the CCTV Camera Cabinet and a matching Fiber Optic Video Receiver/Data Transceiver at the HUB Cabinet.

Provide optical video equipment with the following features:

- 10-bit Digitally Encoded Video Transmission
- Meets or exceeds RS-250C Short Haul Transmission
- NTSC, PAL compatible
- Supports RS-232, RS-422, and two wire RS-485 Data Interfaces
- Full Color Compatibility
- LED Status Indicators
- Distances up to 43 miles (69 km) without repeaters
- Bandwidth: 5 Hz – 10 MHz
- Signal-to-Noise Ratio (SNR): > 67dB @ Maximum Loss Budget.
- Operating Mode: Simplex or Full Duplex
- Wavelength: 1310/1550 nm, Singlemode
- Number of Fibers: 1
- Optical Connectors: ST
- Coaxial Connection: BNC (Gold Plated Center Pin)
- Data Format: NRZ, NRZI, Manchester, Bi-phase
- Power: 24 VAC C.T. @ 300 mA
- Shelf Mount

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**F. Video Decoder (Central):**

Furnish and install Video Decoders as shown on the Plans. For compatibility with existing equipment in the Region, furnish a Protronix Pro-VXII-R video decoder or an approved equivalent.

Provide a Video Decoder with a bandwidth capable of receiving up to 30+ frames/second low resolution over 10Base-T Ethernet LAN. Provide a Video Decoder capable of varying the frame rate such that the slower the frames/second the higher the image resolution.

Provide a video decoder having the following minimum features:

- One (1) 10/100 Base-T Ethernet LAN (TCP/IP)
- One (1) NTSC video output
- Two (2) RS232 ports
- Operate from 120 VAC (use of a transformer providing a lower voltage is permissible)

Furnish a video encoder that is easy to install and configure. Ensure the unit has password protection for dial-in access and is capable of upgrading the software via downloads. Ensure the unit is equipped with high performance image decompression software.

**G. Equipment Rack Cabinet (Central):**

Furnish and install one (1) 19-inch Equipment Rack Cabinet in the Division 14 Traffic Building to house the Ethernet Switch, Video Decoders, and un-interruptible Power Supply (UPS).

Furnish rack cabinets with minimum external dimensions of 72" (H) X 24"(W) X 32"(D). Cabinets should be composed of extruded aluminum frame with dye cast corners and be charcoal metallic in color.

Furnish cabinets with a vented top, quick-release locking sides, four (4) shelf rails, a locking glass door and a locking steel door. The cabinets should have a cable access base and a raised top panel. The cabinets will be equipped with a power panel with surge protection (12 outlets, 15A-120V). The cabinets should be comprised of a sufficient number of slide shelving's to neatly house the equipment specified such that the equipment can removed and replaced with ease. The cabinets will be equipped with a Rack Unit cable management panels. The cabinets will be equipped with a set of four (4) casters with breaks.

**H. Uninterruptible Power Supply (Central):**

Furnish a rack mountable Uninterruptible Power Supply (UPS) for the equipment in the Division 14 Traffic Building. Provide a UPS unit capable of detecting a power failure and providing back-up power to the equipment in the Division 14 Traffic Building. The transition to the UPS source from primary power should occur without loss of data or damage to the equipment being provided with back-up power.

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The UPS should be sized appropriately to provide back-up power for the total load of all equipment connected to the UPS for a total of 3 hours of operation.

**I. Monitor (Central):**

Furnish and install four (4) 32-inch LCD color monitors with all necessary cable and hardware necessary to integrate the monitors with the related video equipment in the Division 14 Traffic Building.

Furnish all color video monitors from the same manufacturer.

Furnish and install video monitors at the Division 14 Traffic Building with the following features:

- Diagonal Viewable Size: 32 inch
- Contract Ratio: 500:1
- Aspect: 16:9
- Glass Surface: Anti-glare
- Viewing Angle: 170 degrees both Horizontal and Vertical
- Response Time: 5 to 8 ms
- Brightness: 450 cd/m<sup>2</sup>
- Input Signals: Analog RGB, DVI Digital Link, CVBS, S-Video, Component Video
- Input connector/cable: 15pin D-Sub, DVI-D, S-Video, BNC (video), BNC (component 2)
- Maximum resolution: 1280 x 768
- Power: 150 Watts
- Colors: 16.7 million
- Tuner: 181 channels, cable ready
- Audio: 2 internal speakers w/ Hi-Fi stereo, 40 watt output
- Remote Functions: Wireless, multi-function remote w/ on-screen programming
- Display: Liquid Crystal Display (LCD)

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Provide monitors that operate on 120 VAC ( $\pm 10\%$ ) at 60 Hz. Provide monitors that operate in a +32 degree to +132 degree Fahrenheit environment at 95 percent humidity.

**J. Monitor Rack (Central):**

Furnish and install video monitor rack(s) at the Division 14 Traffic Building to house a minimum of four (4) monitors as specified above.

The video monitor rack(s) shall be of minimum dimensions so as to completely enclose and house a minimum of four (4) 32-inch LCD monitors as provided on this project. Furnish monitor rack(s) with a maximum vertical dimension of 96 inches.

Rack(s) should be constructed of extruded aluminum or other acceptable materials and shall be pre-approved by the engineer. The rack(s) should be charcoal metallic in color. Furnish rack(s) with a sufficient number of shelves to house a minimum of four (4) monitors. Equip rack(s) with a power panel with surge protection (12 outlets, 15A – 120V). Equip rack(s) with a set of four (4) lockable casters.

**6.3. CONSTRUCTION METHODS****A. Electrical and Mechanical Requirements**

Ground all equipment as called for in the NCDOT Standard Specifications, these project special provisions, and the Plans.

Install surge protectors on all ungrounded conductors entering the CCTV cabinet and/or enclosure. House the protectors in a small, ventilated weatherproof cabinet attached near the CCTV attachment point in a manner approved by the Engineer. Ensure the air terminal ground wire does not pass through this cabinet.

Install coaxial cable as required to interconnect the CCTV camera assembly with the local CCTV camera control module. Insure that all connections are tight and fully secure.

**B. CCTV Camera**

Install CCTV assemblies at the locations shown on the Plans. Mount CCTV camera on side of pole nearest intended field of view and avoid occluding the view with the pole. Mount CCTV camera units at a height sufficient to adequately see traffic in all direction and as approved by the Engineer. For those CCTV cameras that are to be installed on metal traffic signal supports, the minimum mounting height shall be between 33 feet (10 meters) and 40 feet (15 meters) above ground level unless approved otherwise. Electrically bond each camera and pan/tilt/zoom mechanism and its housing to the CCTV camera attachment assembly using a number 6 AWG braided copper conductor. Integrate CCTV camera unit with, CCTV Controller, equipment cabinet, and equipment cabinet power supply.

**C. Camera Pole (Metal Mast Arm/Strain Pole/Standalone Metal CCTV Camera Pole)**

Obtain approval from the Engineer for final field locations of the CCTV metal poles before developing shop drawings and installing the poles. Obtain shop drawings, signed and sealed by a

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North Carolina registered engineer, for each pole location (each combination of pole height and equipment mix) and submit to Engineer for approval. When approved, submit to pole manufacturer. Determine and provide to pole manufacturer the effective projected area of all items to be attached to each pole at each pole location. Refer to Section 16 of these special provisions for design and fabrication requirements for metal poles.

Install steel pole in accordance with Section 16 of these Project Special Provisions and the plans.

**D. Video Multiplexer (HUB Cabinet)**

Install and integrate the Video Multiplexer with the Video Encoder and the CCTV Controller (local Camera) and the fiber optic video transceivers as shown in the Plans. Provide all necessary hardware and cables.

**E. Video Equipment (CCTV Cabinet)**

Install and integrate the local CCTV camera control module with the fiber optic video transmitter/data transceiver and fiber optic interconnect center as shown in the Plans. Provide all necessary hardware and cables.

**F. Fiber Optic Video (Transmitter or Receiver)/Data Transceiver**

Install and integrate the fiber optic video transmitter/data transceiver with the local CCTV camera control module and fiber optic interconnect center as shown in the Plans.

Install and integrate the fiber optic video receiver/data transceiver in the HUB Cabinet with the fiber optic interconnect center, multiplexer and video encoder as shown in the Plans.

Provide all necessary hardware and cables.

**G. Video Encoder (HUB Cabinet)**

Install and integrate the Video Encoders with the High Speed Internet Service as described in these Project Special Provisions. Integrate the Video Encoder with the Video Multiplexer as shown in the Plans. Provide all necessary hardware and cables.

**H. Equipment Rack & UPS (Central)**

The Engineer will determine the location where the Equipment Rack will be placed in the Division 14 Traffic Building. Install the equipment rack to house the Video Decoders, Ethernet Switch(s), Uninterruptible Power Supply and all cables and other hardware necessary to provide a complete and operational system.

**I. Video Decoder (Central)**

Install the Video Decoders and integrate them to the Ethernet Switch and the Monitors. Provide all necessary hardware and cables.

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**J. Monitor (Proposed)**

The Engineer will determine the location where the monitors are to be located in the Division 14 Traffic Building. The Engineer will determine the equipment layout in the appropriate room/office. Integrate the Monitors with the Video Decoders as shown in the Plans.

**K. Monitor Rack**

The Engineer will determine the location for the monitor rack(s). The proposed monitors shall be securely housed within the provided monitor rack(s) and positioned such that easy viewing of all screens is obtainable. The monitor racks shall be portable with lockable casters to secure the racks in place.

**6.4. METHOD OF MEASUREMENT**

Actual number of CCTV Camera Assemblies furnished, installed, integrated, and accepted. No separate measurement will be made for cabling, connectors, CCTV camera attachment assemblies, conduit, condulets, grounding equipment, CCTV camera enclosures, surge protectors, or any other equipment or labor required to install the CCTV assembly and integrate it with the communications media equipment. No separate measurement will be made for integration of CCTV unit with Video Software.

No separate payment will be made for coaxial cable. Coaxial cable, furnished and installed in the quantities required, will be incidental to the "CCTV Camera Assembly" pay item.

Actual number of Metal CCTV Poles furnished and installed will be paid for in Section 16, Metal Traffic Signal Supports. Payment for this item shall include field location of the pole placement position, and delivery and storage of poles. Items of work associated with performing soil tests, installing a drilled pier foundation, and design of the CCTV metal pole will be paid for as specified under Section 16 of these Project Special Provisions. However, design criteria for the CCTV metal pole and foundation as stated in this section shall apply.

**No separate payment will be made for design of metal pole or foundation at locations where CCTV cameras will be attached to Metal Strain Poles for signals or Metal Mast Arm Poles for signals. These poles will be paid for under "Metal Strain Poles" or "Signal Support Mast Arms with Metal Poles".**

Actual number of Video Multiplexers (HUB Cabinet) furnished, installed, integrated, and accepted. No separate measurement will be made for cabling, connectors, surge protectors, protocol converters, or any other equipment or labor required to install the video multiplexer and integrate it with the other video equipment. No separate measurement will be made for integration of the video multiplexer with the Video Software.

Actual number of Video Encoders (HUB Cabinet) furnished, installed, integrated, and accepted. No separate measurement will be made for cabling, connectors, surge protectors, or any other equipment or labor required to install the video encoder and integrate it with the high speed internet service or other video equipment. No separate measurement will be made for integration of the video encoder with the Video Software.

Actual number of Fiber Optic Video Transmitter/Data Transceivers furnished, installed, integrated, and accepted. No separate measurement will be made for cabling, connectors, surge

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protectors, or any other equipment or labor required to install the fiber optic video/data transceivers and integrate it with the other video equipment.

Actual number of Fiber Optic Video Receiver/Data Transceivers furnished, installed, integrated, and accepted. No separate measurement will be made for cabling, connectors, surge protectors, or any other equipment or labor required to install the fiber optic video/data transceivers and integrate it with the other video equipment.

Actual number of Video Decoders (Central) furnished, installed, integrated, and accepted. No separate measurement will be made for cabling, connectors, surge protectors, or any other equipment or labor required to install the video decoder and integrate it with the other video equipment. No separate measurement will be made for integration of the video decoder with the Video Software.

Actual number of Equipment Rack Cabinets furnished, installed and accepted. No separate payment will be made for the power panel and surge protection outlets, shelves, or rack unit cable management panels.

Actual number of Uninterruptible Power Supplies furnished, installed and accepted. No separate payment will be made for supplying power to the unit or cabling and connectors.

Actual number of Color Video Monitors furnished, installed and accepted. No separate payment will be made for mounting hardware, cables, brackets, hardware, integration or other accessories required for a complete installation of the CCTV monitors as they are considered incidental to the "Monitor" pay item.

Actual number of Monitor Racks furnished, installed and accepted. No separate payment will be made for mounting hardware, cables, brackets, hardware or other accessories necessary to integrate the proposed monitors into the monitor rack(s) as they are considered incidental to the "Monitor Rack" pay item.

No separate payment will be made for relocating and connecting any existing equipment into the system. No separate payment will be made for cables, mounting, mounting brackets and hardware, integration, or other accessories required for a complete installation of the monitor.

## **6.5. BASIS OF PAYMENT**

The quantity of CCTV Camera Assemblies as provided above will be paid for at the contract unit price each for "CCTV Camera Assembly" **in accord with the following conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

The quantity of CCTV Metal Poles as provided above will be paid for at the contract unit price each for "CCTV Metal Pole" as defined in Section 16.8.

The quantity of Video Multiplexers (HUB Cabinet) as provided above will be paid for at the contract unit price each for "Video Multiplexer (HUB Cabinet)" **in accord with the following conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

The quantity of Video Encoders (HUB Cabinet) as provided above will be paid for at the contract unit price each for "Video Encoder (HUB Cabinet)" **in accord with the following**



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**conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

The quantity of Fiber Optic Video Transmitter/Data Transceivers as provided above will be paid for at the contract unit price each for “Fiber Optic Video Transmitter/Data Transceivers” **in accord with the following conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

The quantity of Fiber Optic Video Receiver/Data Transceivers as provided above will be paid for at the contract unit price each for “Fiber Optic Video Receiver/Data Transceivers” **in accord with the following conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

The quantity of Video Decoders (Central) as provided above will be paid for at the contract unit price each for “Video Decoder (Central)” **in accord with the following conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

The quantity of Equipment Rack Cabinets as provided above will be paid for at the contract unit price each for “Equipment Rack Cabinet”.

The quantity of Uninterruptible Power Supplies as provided above will be paid for at the contract unit price each for “Uninterruptible Power Supplies”.

The quantity of LCD Video Monitors as provided above will be paid for at the contract unit price each for “Monitor” **in accord with the following conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

The quantity of Monitor Racks as provided above will be paid for at the contract unit price each for “Monitor Rack”.

Payment will be made under:

<b>CCTV Camera Assembly .....</b>	<b>Each</b>
<b>Video Multiplexer (HUB Cabinet) .....</b>	<b>Each</b>
<b>Video Encoder (HUB Cabinet) .....</b>	<b>Each</b>
<b>Fiber Optic Video Transmitter/Data Transceivers .....</b>	<b>Each</b>
<b>Fiber Optic Video Receiver/Data Transceivers .....</b>	<b>Each</b>
<b>Video Decoder (Central).....</b>	<b>Each</b>
<b>Equipment Rack Cabinet.....</b>	<b>Each</b>
<b>Uninterruptible Power Supply.....</b>	<b>Each</b>
<b>Monitor .....</b>	<b>Each</b>
<b>Monitor Rack .....</b>	<b>Each</b>

## **7. HIGH SPEED INTERNET SERVICE**

### **7.1. DESCRIPTION**

Install High Speed Internet service with a Static IP address at each of the HUB cabinet locations shown in the Plans. The internet service shall be provided by BellSouth at each HUB Cabinet site and shall be a minimum of 1.5 Mbits/sec with a minimum upload speed of 256 kbits/sec. The carrier shall provide equipment to convert their Internet technology to an Ethernet 10/100BaseT interface.

The current system allows viewing of the existing CCTV cameras from the Triangle Regional Traffic Management Center (TRTMC), and the Emergency Information Center (EIC). The revised system upon completion shall allow for the same functionality by connecting to the state's T1 line already present at the facility. Contact the NCDOT Division 14 Division Traffic Engineer at (828) 631-1185 prior to commencing any work at the Division 14 offices.

### **7.2. MATERIAL**

#### **A. HUB CABINET ETHERNET SWITCH**

Furnish and install Ethernet Switchs in the HUB cabinets as shown in the Plans. The Ethernet Switch shall have four (4) auto negotiating 10/100 Base-T ports. In addition, the switch shall have a RS232 port.

Minimum performance of the switch shall be as follows:

- 8.8 Gbps switching capacity.
- 6.6 million packets per second.
- Wirespeed performance.
- 8,000 MAC addresses supported.
- User Definable/Configurable Firewall protection

The internet switches installed in the field cabinets must be field hardened (-30 to 170 degrees F). Power inputs shall accept input voltages between 90 and 130 VAC, with a maximum current of 2.3 A. Maximum heat dissipation shall be 40 W or less.

#### **B. DIVISION OFFICE ETHERNET SWITCH**

Furnish and install an Ethernet Switch in the Division 14 Traffic Building. The Ethernet Switch shall have twenty-four (24) auto negotiating 10/100 Base-T ports. In addition, the switch shall have two (2) auto negotiating 10/100/1000 Base-T ports. The switch shall have a RS232 port as a console port.

Minimum performance of the switch shall be as follows:

- 8.8 Gbps switching capacity.
- 6.6 million packets per second.
- Wirespeed performance.

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- 8,000 MAC addresses supported.

The unit's height shall be 1U (1.75") or less. The width of the unit shall permit it to be placed in a standard 19" rack. Depth shall be 10.8" or less. The weight of the unit shall be 5.3 pounds or less. Power inputs shall accept input voltages between 90 and 240 VAC, with a maximum current of 2.3 A. Maximum heat dissipation shall be 40 W or less.

**7.3. CONSTRUCTION METHODS**

The Ethernet output from the carrier's Internet access equipment shall be integrated as shown on the Plans at each HUB cabinet and in the Division 14 Traffic Building. LAN CAT5, high speed Internet, and other cables necessary for integration shall be routed in either the HUB cabinets, or floors, ceilings, existing cable raceways, and new cable raceways in the Division 14 Traffic Building as approved by the Engineer. A static Internet Protocol (IP) address shall be provided at each of the locations.

Install, configure, and integrate the new Ethernet Switch in the Division 14 Traffic Building with both the new and existing equipment.

Provide Surge protection and power strips as necessary to protect the Internet Service, Workstation, Video Decoders, Ethernet Switch, and Monitors.

All cables shall be permanently labeled at all access points. Label identification shall be stamped or engraved on metal tags, or neatly and legibly lettered with permanent ink on nylon tags. Each cable shall have a unique identifier. Cables shall be labeled immediately upon installation. Use component name and labeling scheme approved by the Engineer.

**7.4. METHOD OF MEASUREMENT**

No separate payment will be made for installation of High Speed Internet Service to the HUB cabinets. Installation on High Speed Internet Service will be incidental to the "Video Encoder (HUB Cabinet) pay items.

No separate payment will be made for installation of High Speed Internet Service at the Division 14 Traffic Building. Installation on High Speed Internet Service will be incidental to the Systems Integration pay item.

Actual number of Ethernet Switches furnished, installed, integrated, and accepted. This price and payment will be full compensation for installation of the Ethernet Switch. All power cords, connectors, cables and installation materials necessary to complete this work shall be incidental to the cost. Final payment will be made when work is accepted by the Engineer.

**7.5. BASIS OF PAYMENT**

The quantity of Ethernet Switches as provided above will be paid for at the contract unit price each for "Ethernet Switch".

Payment will be made under:

**Ethernet Switch..... Each**

## 8. CCTV EQUIPMENT CABINETS

### 8.1.DESCRPTION

Furnish and install equipment cabinets and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the 2006 Standard Specifications for Roads and Structures.

### 8.2.MATERIAL

#### A. General

Furnish 336 stretch cabinets to house CCTV control and all communications equipment (Video transceivers, interconnect centers, path panels, etc.). The 336 stretch CCTV cabinet shall consist of a cabinet housing, 19-inch EIA mounting cage, and power distribution assembly (PDA #3 as described in the CALTRANS TSCES).

**Any CCTV camera located at the site of the HUB Cabinet will be controlled from the Hub Cabinet and a CCTV cabinet will not be necessary. Refer to Section 9 of these Special Provisions for Hub cabinet requirements. No direct payment will be included at these installations for the CCTV Equipment Cabinet. It will be considered incidental to the Hub Cabinet.**

The cabinet housing shall conform to sections 6.2.2 (Housing Construction), 6.2.3 (Door Latches and Locks), 6.2.4 (Housing Ventilation), and 6.2.5 (Hinges and Door Catches) of the CALTRANS TSCES. CCTV cabinet housings shall not be equipped with a police panel.

The cabinet cage shall conform to section 6.3 of the CALTRANS TSCES.

Terminal blocks on the PDA #3 Assembly have internal wiring for the Model 200 switch pack sockets. Do not use terminal blocks on PDA #3 as power terminals for cabinet devices. Do not furnish cabinet with "Input Panels" described in section 6.4.7.1 of the TSCES. Do furnish cabinet with "Service Panels" as described in section 6.4.7.1 of the TSCES and as depicted on drawing TSCES-9 in the TSCES. Use service panel #2.

Furnish terminal blocks for power for cabinet CCTV and communications devices as needed to accommodate the number of devices in the cabinet.

Do not furnish cabinets with C1, C5, or C6 harness, input file, output file, monitor units, model 208 unit, model 430 unit, or switch packs.

Furnish all conduit, shelving, mounting adapters, and other equipment as necessary to route cabling, mount equipment, and terminate conduit in equipment cabinet.

The Engineer shall approve all CCTV cabinets.

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A pull out, hinged-top drawer, having sliding tracks, with lockout and quick disconnect feature, such as a Vent-Rak Retractable Writing Shelf, #D-4090-13 or equivalent, shall be provided in the cabinet. The pullout drawer shall extend a minimum of 14 inches (36 cm). It shall be possible to lift this hinged platform in order to gain access to the interior of the drawer. Minimum interior dimensions of the drawer shall be 1 inch (2.5 cm) high, 13 inches (33 cm) deep, and 16 inches (40.6 cm) wide. The drawer shall be capable of supporting a 40 pound (18 kg) device or component when fully extended.

**C. Cabinet Light**

Each cabinet shall include two (2) fluorescent lighting fixtures (one front, one back) mounted horizontally inside the top portion of the cabinet. The fixtures shall include a cool white lamp, and shall be operated by a normal power factor UL-listed ballast. A door-actuated switch shall be installed to turn on the applicable cabinet light when the front door or back door is opened. The lights shall be mounted not to interfere with the upper door stay.

**D. Surge Protection for System Equipment**

Each cabinet shall be provided with devices to protect the enclosed equipment from electrical surges and over voltages as described below.

**E. Main AC Power Input**

Each CCTV cabinet shall be provided with a UL approved hybrid type power line surge protection device mounted inside the power distribution assembly. The protector shall be installed between the applied line voltage and earth ground. The surge protector shall be capable of reducing the effect of lightning transient voltages applied to the AC line. The protector shall be mounted inside the Power Distribution Assembly housing facing the rear of the cabinet. The protector shall include the following features and functions:

- Maximum AC line voltage: 140 VAC.
- Twenty pulses of peak current, each of which shall rise in 8 microseconds and fall in 20 microseconds to ½ the peak: 20000 Amperes.

The protector shall be provided with the following terminals:

- Main Line (AC Line first stage terminal).
- Main Neutral (AC Neutral input terminal).
- Equipment Line Out (AC line second state output terminal, 19 amps).
  - Equipment Neutral Out (Neutral terminal to protected equipment).
  - GND (Earth connection).

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

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

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

The protector for the first and second stage clamp shall have a Metal Oxide Varistor (MOV) or similar solid state device rated at 20 KA and shall be of a completely solid state design (i.e., no gas discharge tubes allowed).

The Main Neutral and Equipment Neutral Out shall be connected together internally and shall have a MOV, similar solid-state device, or gas discharge tube rated at 20 KA between Main Neutral and Ground terminals.

Peak Clamp Voltage: 350 volts at 20 KA. (Voltage measured between Equipment Line Out and Equipment Neutral Out terminals. Current applied between Main Line and Ground Terminals with Ground and Main Neutral terminals externally tied together).

Voltage shall never exceed 350 volts.

The Protector shall be epoxy-encapsulated in a flame retardant material.

Continuous service current: 10 Amps at 120 VAC RMS.

The Equipment Line Out shall provide power to cabinet's enclosed equipment.

**F. Ground Bus**

Provide a neutral that is not connected to the earth ground or the logic ground anywhere within the cabinet. Ensure that the earth ground bus and the neutral ground bus each have ten compression type terminals, each of which can accommodate wires ranging from number 14 through number 4.

**8.3.CONSTRUCTION METHODS**

Install pole-mounted cabinets. Install cabinets approximately five feet from the ground line to the top of the cabinet. For each cabinet use banding or other method approved by the Engineer to fasten cabinet to pole.

Install all conduit, condulets, and attachments to equipment cabinets in a manner that preserves the minimum bending radius of the cables and creates water proof connections and seals.

**8.4.METHOD OF MEASUREMENT**

Actual number of 336 stretch CCTV cabinets (pole mounted) furnished, installed, and accepted.

**8.5.BASIS OF PAYMENT**

The quantity of 336 stretch CCTV cabinets, measured as provided above, will be paid for at the contract unit price each for "CCTV Equipment Cabinet (Pole Mounted)" **in accord with the following conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

Payment will be made under:

**CCTV Equipment Cabinet (Pole Mounted).....Each**

## 9. HUB CABINET

### 9.1.DESCRPTION

Furnish and install hub cabinets and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the 2006 Standard Specifications for Roads and Structures.

HUB cabinets are to be located as shown on the plans and shall house, as a minimum; equipment specified in Section 6, Section 7, and Section 13 of these Project Special Provisions. These items include:

- Video Multiplexer
- Video Encoder
- Communications Protocol Converter (if necessary)
- Fiber Optic Video Transceivers
- Fiber Optic Data Transceivers
- Fiber Optic Interconnect Center
- High Speed Internet Service Connection for CCTV Camera
- Phone Drop for Intersection Control
- Local CCTV Camera Control Module (1 unit for the CCTV camera located at the HUB cabinet)
- Wireless Radio Transceiver (HUB Cabinet #1)

### 9.2.MATERIAL

#### A. General

Furnish 332 base mounted cabinets to house the equipment listed above. The 332 Hub cabinet shall consist of a cabinet housing, 19-inch EIA mounting cage, and power distribution assembly (PDA #3 as described in the CALTRANS TSCES).

The cabinet housing shall conform to sections 6.2.2 (Housing Construction), 6.2.3 (Door Latches and Locks), 6.2.4 (Housing Ventilation), and 6.2.5 (Hinges and Door Catches) of the CALTRANS TSCES. Hub cabinet housings shall not be equipped with a police panel.

The cabinet cage shall conform to section 6.3 of the CALTRANS TSCES.

Terminal blocks on the PDA #3 Assembly have internal wiring for the Model 200 switch pack sockets. Do not use terminal blocks on PDA #3 as power terminals for cabinet devices. Do not furnish cabinet with "Input Panels" described in section 6.4.7.1 of the TSCES. Do furnish cabinet with "Service Panels" as described in section 6.4.7.1 of the TSCES and as depicted on drawing TSCES-9 in the TSCES. Use service panel #2.

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Furnish terminal blocks for power for cabinet CCTV and communications devices as needed to accommodate the number of devices in the cabinet.

Do not furnish cabinets with C1, C5, or C6 harness, input file, output file, monitor units, model 208 unit, model 430 unit, or switch packs.

Furnish all conduits, shelving, mounting adapters, and other equipment as necessary to route cabling, mount equipment, and terminate conduit in equipment cabinet.

The Engineer shall approve all Hub cabinets.

**B. Shelf Drawer**

A pull out, hinged-top drawer, having sliding tracks, with lockout and quick disconnect feature, such as a Vent-Rak Retractable Writing Shelf, #D-4090-13 or equivalent, shall be provided in the cabinet. The pullout drawer shall extend a minimum of 14 inches (36 cm). It shall be possible to lift this hinged platform in order to gain access to the interior of the drawer. Minimum interior dimensions of the drawer shall be 1 inch (2.5 cm) high, 13 inches (33 cm) deep, and 16 inches (40.6 cm) wide. The drawer shall be capable of supporting a 40 pound (18 kg) device or component when fully extended.

**C. Cabinet Lighting**

Each cabinet shall include two (2) fluorescent lighting fixtures (one front, one back) mounted horizontally inside the top portion of the cabinet. The fixtures shall include a cool white lamp, and shall be operated by a normal power factor UL-listed ballast. A door-actuated switch shall be installed to turn on the applicable cabinet light when the front door or back door is opened. The lights shall be mounted not to interfere with the upper door stay.

**D. Surge Protection for Equipment**

Each cabinet shall be provided with devices to protect the enclosed equipment from electrical surges and over voltages as described below.

**E. Main AC Power Input**

Each hub cabinet shall be provided with a UL approved hybrid type power line surge protection device mounted inside the power distribution assembly. The protector shall be installed between the applied line voltage and earth ground. The surge protector shall be capable of reducing the effect of lightning transient voltages applied to the AC line. The protector shall be mounted inside the Power Distribution Assembly housing facing the rear of the cabinet. The protector shall include the following features and functions:

- Maximum AC line voltage: 140 VAC.
- Twenty pulses of peak current, each of which shall rise in 8 microseconds and fall in 20 microseconds to ½ the peak: 20000 Amperes.

The protector shall be provided with the following terminals:



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- Main Line (AC Line first stage terminal).
- Main Neutral (AC Neutral input terminal).
- Equipment Line Out (AC line second state output terminal, 19 amps).
  - Equipment Neutral Out (Neutral terminal to protected equipment).
  - GND (Earth connection).

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

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

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

The protector for the first and second stage clamp shall have a Metal Oxide Varistor (MOV) or similar solid state device rated at 20 KA and shall be of a completely solid state design (i.e., no gas discharge tubes allowed).

The Main Neutral and Equipment Neutral Out shall be connected together internally and shall have a MOV, similar solid-state device, or gas discharge tube rated at 20 KA between Main Neutral and Ground terminals.

Peak Clamp Voltage: 350 volts at 20 KA. (Voltage measured between Equipment Line Out and Equipment Neutral Out terminals. Current applied between Main Line and Ground Terminals with Ground and Main Neutral terminals externally tied together).

Voltage shall never exceed 350 volts.

The Protector shall be epoxy-encapsulated in a flame retardant material.

Continuous service current: 10 Amps at 120 VAC RMS.

The Equipment Line Out shall provide power to cabinet's enclosed equipment.

**F. Ground Bus**

Provide a neutral that is not connected to the earth ground or the logic ground anywhere within the cabinet. Ensure that the earth ground bus and the neutral ground bus each have ten compression type terminals, each of which can accommodate wires ranging from number 14 through number 4.

**G. Cabinet Base Extender**

Install the HUB cabinet on a Cabinet Base Extender as specified elsewhere in these Project Special Provisions.

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**H. Cabinet Foundation**

Install hub cabinets on signal cabinet foundations as specified in Section 1750 of the “Standard Specifications for Roads and Structures” dated July 2006.

**9.3.CONSTRUCTION METHOD**

Locate HUB Cabinets so as not to obstruct sight distance of vehicles turning right on red or in such a manner that it would become an obstruction to pedestrians.

Provide an external electrical service disconnect as required elsewhere in these plans.

Install all equipment as necessary to furnish an operational HUB Cabinet.

**9.4.METHOD OF MEASUREMENT**

Actual number of HUB Cabinets furnished, installed and accepted.

No separate payment will be made for the electrical service at the HUB Cabinets as it will be considered incidental to the electrical service installation at the Master Controller Cabinet. Inclusive in this item is integration of the High Speed Internet Service as described elsewhere in this document.

**9.5.BASIS OF PAYMENT**

The quantity of HUB Cabinets, measured as provided above, will be paid for at the Contract Unit price for each “HUB Cabinet” **in accordance with the following conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

**HUB Cabinet.....Each**

**10. ELECTRICAL SERVICE**

**10.1. DESCRIPTION**

Comply with the 2006 Standard Specifications and these Project Special Provisions. At locations called out in the Plans, install new electrical service. All work involving electrical service shall be coordinated with the appropriate electrical utility company.

**10.2. MATERIAL**

Construct electrical service installations in accordance with the Standard Specifications. For locations shown on the Plans requiring new electrical service, provide a service that includes a new external service disconnect (breaker box) and a meter base. Service cables shall run separately to each of the cabinets in 1” rigid metallic conduit (RMC). **At locations where both a master cabinet and hub cabinet are called for, install service cables to each cabinet from the electrical service disconnect in separate 1” rigid metallic conduit. Install a second breaker at the service**

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**disconnect to supply power to the cabinets (50 amp single pole breaker for service feed to the signal controller cabinet and 50 amp single pole breaker for service feed to the HUB cabinet).**

Provide an external electrical service disconnect at all new and existing cabinet locations shown on the Plans. Provide a service disconnect with a single pole 50 ampere circuit breaker with a minimum of 10,000 RMS symmetrical amperes short circuit rating in a lockable NEMA 3R enclosure. Provide a ground bus and neutral bus with a minimum of four terminals with a minimum wire capacity of number 14 through number 4.

For base mounted cabinets, mount the service on an existing nearby pole as indicated in the Plans, and extend the service cables into the cabinet through a new 1" RMC.

Coordinate with utility company to ascertain the practicality of installing electrical service at each location before performing any work.

### 10.3. CONSTRUCTION METHODS

#### A. Electrical Service

At locations where new electrical service is to be installed on wood or metal poles, furnish and install electrical service as called for in the Plans. **Unless otherwise shown on the plans, electrical service at mast arm installations will be via underground conduit.** After installation of the meter base, the utility company will transfer the existing meter or install a new meter if required and make any necessary connections to the power lines. Ground the new electrical service in accordance with the Standard Specifications and Standard Drawings.

#### B. External Electrical Service Disconnect

Furnish and install new external electrical service disconnect (breaker box) of the type shown in the Plans. Route the electrical service through the meter base and service disconnect to the controller cabinet to form a complete electrical service assembly as shown in the Plans. Ensure that existing grounding system for the existing electrical service with new service disconnect added complies with the grounding requirements of these Project Special Provisions, the Standard Specifications and the Plans.

### 10.4. METHOD OF MEASUREMENT

New electrical service will be measured by the number of complete functional electrical service locations furnished, installed and tested. Riser assemblies (1-inch, meter bases, service disconnects, underground and exposed conduit runs to the cabinet, **restoration of disturbed areas, repair of sidewalk (joint-to-joint)**, acquisition of service fees, electrical service conductors, ground rod, ground wire and any remaining hardware and conduit to connect the electrical service to the cabinet will be considered incidental to new service.

New external electrical service disconnects shall be measured by the number of external electrical service disconnects furnished, installed, and integrated into an existing service to form a complete electrical service. Any electrical service conductors, remaining hardware and conduit to connect the electrical service to the cabinet will be considered incidental to the service disconnects. No separate payment will be made for extending or replacing electrical service cable and conduits

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between the disconnect and the cabinet at locations where an existing pole-mounted cabinet is being replaced with a new base-mounted cabinet, or where a base-mounted cabinet is being relocated.

10.5. BASIS OF PAYMENT

The quantity of electrical service installations and external electrical service disconnects, measured as provided above, will be paid for at the contract unit price each for "New Electrical Service."

New Electrical Service.....Each

11. SYSTEM COMPUTER EQUIPMENT AND SYSTEM INTEGRATION REQUIREMENTS

11.1. DEPARTMENT FURNISHED EQUIPMENT

The NCDOT Division 14 offices are located at 79 Division of Highways Drive, Sylva, NC 28779.

The Department will furnish one (1) central computer (workstation) and one (1) notebook computer with Windows 2000™ installed for use on this project. The Contractor must send a written request to the Engineer 120 working days prior to the required computer deployment.

The central computer will meet or exceed the following minimum specifications:

- Type: Business Class Desktop
- Processor: Intel Pentium 4, 3.40GHz, 1M, 800 MHz FSB
- Memory: 1 GB of RAM with two (2) free slots for additional memory
- Keyboard: Performance USB keyboard with 8 hot keys
- Microsoft Windows 2000 operating system pre-loaded and on CD-ROM.
- Floppy Drive: One (1) 3.5 inch Floppy Drive
- Video Card: 128 MB, Dual Monitor DVI or VGA capable Video
- Hard Drive: 80 GB SATA, 7200 RPM
- Operating System Software: Microsoft Windows XP Pro, SP2 with Media and NTFS
- Integrated NIC: Integrated Ethernet Gigabit (10/100/1000) Card
- Mouse: USB 2-button optical mouse with Scroll
- Optical Drive (One): 24X CD-RW/DVD-ROM Combination Drive
- Speakers: Internal/No External
- Resource CD: Resource CD or Hard Drive space that contains diagnostics and drivers
- Mouse Pad: Included
- External Bays: Two (2) Total, One (1) Available

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- USB Ports: Six (6) Total, Two (2) in Front, Four (4) in Back
- Ports: One (1) Serial Port and One (1) Parallel Port
- Smallest Form Factor: Yes
- Hardware Support Service: 4 Year Limited Warranty / 4 Year Next Business Day On-Site
- 19 inch LCD Monitor

The notebook computer will meet or exceed the following minimum specifications:

- Type: Business Class Laptop
- Processor: Intel Pentium M, 2.00 GHz, 400 MHz FSB
- Memory: 1 GB of RAM, with one (1) free slot of additional memory
- Video Screen: 15 inches, Wide SXGA
- Hard Drive: 80 GB
- Operating System Software: Microsoft Windows XP Pro, SP2 with Media and NTFS
- Integrated NIC: Integrated Ethernet Gigabit (10/100/1000) Card
- Integrated Modem: Integrated V.92 56K Modem
- Optical Drive: 24X CD-RW/DVD-ROM Combination Drive
- AC Adapter: Included
- Nylon Carrying Case: Included
- Resource CD: Resource CD or Hard Drive space that contains Diagnostics and Drivers
- Hardware Support Service: 4 Year Limited Warranty / 4 Year Next Business Day On-Site
- Hardware Support Service: 4 Year Accidental Drop/Spills/Damage Replacement Warranty

The Contractor upon receiving the workstation and laptop computers may make changes to the devices by adding additional hardware and software necessary to provide a fully functional and operating systems as specified by these Project Special Provisions. **The Contractor must provide software license documentation and CD copies for all software that is loaded by the Contractor onto the Department furnished equipment. If the Contractor supplied software is not a commercially available off the shelf software, obtain and provide the source code to the Department.**

In addition to the items listed above the Contractor is instructed to use the existing PTZ Control Panel (PELCO Model #KBD-4000) and printer currently in operation in the Division 14 office and integrate these items into the completed system.

## 11.2. SOFTWARE

### A. General

Develop, install and integrate software onto the workstation and laptop computers to allow an operator to launch Video Software by clicking on icons present on a geographic information system (GIS) based map of this project. In addition, the Video Software shall provide a drop down list labeling each of CCTV cameras available for viewing from this project as well as those video feeds from existing CCTV Camera installations.

**Install the State-supplied Closed Loop System Software on the Workstation and Laptop computer and integrate these components into a functioning system along with the CCTV software. Develop a Closed Loop System Map showing intersection status displays and overlay the CCTV Icons on the system map.**

Furnish Contractor provided software that allows for the installation of the software via an automated, self-extracting, and self-installing program that steps the user through the installation of the software.

### B. GIS Map for CCTV System

Furnish a GIS map of the project that is scalable from the entire project down to an individual CCTV device. Add icons for all CCTV units under this project to the project GIS map in their geographically correct locations. Add icons for all existing CCTV units that are currently in operation in the Division. Clicking on the CCTV icons on the GIS map shall launch the Video Software as defined in these Project Special Provisions.

The software shall be Windows 2000 compatible.

The map display shall utilize ESRI shapefile (the native ArcView digital format) files from a regional GIS map that will be provided to the Contractor by the Engineer.

### C. Video Software

To ensure compatibility with existing equipment installed in the Division, provide Protronix VideoPro computer based video management system software or approved equivalent.

The software shall provide for either software control of Pan/Tilt/Zoom (PTZ) functions or allow usage of a hardware PTZ controller panel.

Furnish Video Software on the Workstation and the Laptop Computers. The software will allow the user the ability to select various views of the CCTV cameras as they are related to their designated viewing monitors. Video quality shall be selectable for each remote site to meet variations in network performance. (The system as designed only allows for the video feeds being received from a remote site to be displayed only on one of the four (4) dedicated LCD monitors). The system shall allow the user to view either single views or multiple views of all cameras associated with a particular remote site. The system software and hardware shall be integrated with the existing CCTV camera video feeds already being displayed in the Division 14 Office.

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The software shall provide the following system capabilities:

- Pan/Tilt/Zoom Controller
- Video Multiplexer Controller, as necessary
- Monitor Selection and Display

The software shall be Windows 2000 compatible and shall provide the following features:

- RS232 and RS485 formats
- Uniquely addressable video distribution
- Broad Band Networks
- Networkable over existing LAN
- Host and Multiple Secondary Locations
- Allows up to 99 presets per camera location.
- Allows up to 32 users to be networked to simultaneously use the system.

The system shall have the capability of being password protected and shall allow the system administrator to easily configure and make changes to the operations as required. The system shall be menu driven and user friendly. The software shall be flexible and allow for new and enhanced protocols to be added, as equipment becomes available. The software shall support multiple video multiplexers, and Pan/Tilt/Zoom cameras.

### **11.3. MATERIALS**

#### **A. Surge Suppression Strips:**

Provide surge suppression power strips with an illuminating on/off switch, isolating filter banks, a minimum of six 120 VAC, 60 HZ outlets, and a minimum of 808 Joules.

### **11.4. CONSTRUCTION METHODS**

Upon receipt of the State-furnished computers, the Contractor will be required to install the necessary software to operate the ITS systems and any special computer hardware not supplied by the Department. The Contractor must provide written documentation of all software installed on the computers. All Contractor installed software licenses must be transferred to the Department prior to the end of the Observation Period. Two (2) copies of the system software must be provided on the compact disks with install and setup instructions.

Install State-furnished central computer. Install all connecting cables, hardware and software as necessary to develop a complete and operational system.

Install State-furnished notebook computer. Install all connecting cables, hardware and software as necessary to develop a complete and operational system. Integrate and make fully operational workbook computer's internal modem with existing phone lines and Internet services network.

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Integrate new CCTV cameras installed under this project into the Video Software system. Update software databases, link new CCTV cameras with proper software drivers, revise system graphic displays, and align new CCTV cameras with appropriate logical and physical server ports.

Integrate the existing PTZ Control panel (PELCO Model #KBD-4000) into the system. Connect the control panel to the workstation. Furnish any additional hardware (serial boards, cables, etc.) necessary to connect the control panel to the workstations.

Integrate the existing printer with the workstation and network. Load all software drivers as necessary to make the Printer operational with the system.

Install surge suppression strips as necessary for all components and equipment.

**11.5. METHOD OF MEASUREMENT**

Actual number of Contractor Modified Central Computers with operating software installed, and accepted.

Actual number of Contractor Modified Notebook Computers with operating software installed, and accepted.

Lump sum for System Integration. This shall include the development, furnishing, installation, testing, and all materials, equipment, labor, tools, storage, shipping, and incidentals necessary to successfully provide the GIS map, Video Software, and Closed Loop Software and Mapping of the system intersections into an operational ITS system. Inclusive in this item is integration of the High Speed Internet Service as described elsewhere in this document.

No separate payment will be made for integrating the existing PTZ Control Panel (PELCO MODEL # KBD-4000), existing printer or the Contractor provided surge suppression strips as this will be considered incidental to the Systems Integration Pay Item.

**11.6. BASIS OF PAYMENT**

The quantity of Contractor Modified Central Computers, measured as provided above, will be paid for at the contract unit price each for "Modified Central Computer".

The quantity of Contractor Modified Notebook Computers, measured as provided above, will be paid for at the contract unit price each for "Modified Notebook Computer".

The integration of the Video Software into a system shall be paid for at the lump sum price for "System Integration" **in accord with the following conditions: 50% of the lump sum price upon delivery and installation of the software and 50% of the lump sum price upon successful completion of the Observation Period. No payment will be made for providing software license and source code as required in these Project Special Provisions.**



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Payment will be made under:

<b>Modified Central Computer.....</b>	<b>Each</b>
<b>Modified Notebook Computer.....</b>	<b>Each</b>
<b>System Integration.....</b>	<b>Lump Sum</b>

**12. TESTING – CCTV AND CLOSED LOOP SYSTEM**

**12.1. DESCRIPTION**

This section covers the testing requirements for the Closed Loop System and CCTV Video System, including workstations, monitors, Internet and phone line connections and software. Testing requirements described in this section do not supersede any of the testing requirements described in any other section of these Project Special Provisions. Perform testing on all major hardware and software components supplied for use on this project. These include:

- CCTV Field Equipment
- CCTV Central Equipment and Software
- GIS Map Software
- Closed Loop Software
- Division 14 Office Hardware

Test results from this section will demonstrate the integrity of the system’s sub-components and the overall operational integrity of the final integrated system.

**12.2. MATERIAL**

**A. General**

Perform tests on each of the major hardware and software components.

Unless otherwise specified, create testing procedures and reporting forms to demonstrate each device being tested meets or exceeds manufacturer performance criteria as well as any criteria called for in these Project Special Provisions.

If, during any testing, two (2) items of the same type fail to satisfy one or more of the tests, the Engineer may require the Contractor to replace the entire complement of equipment with a different make or model of equipment at the Engineer’s option at no additional cost to the project.

**B. CCTV Equipment Testing**

**1. General**

All CCTV camera equipment and materials furnished by the Contractor will be subject to monitoring and testing to determine conformance with all applicable requirements and to ensure proper operation of the CCTV camera assemblies

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Provide forms to be used for documenting test results.

Submit to the Engineer for review a test plan for the CCTV system test. The test plan will be reviewed by the Engineer, who will either approve or indicate changes that are required for approval within forty (40) calendar days of receipt. Submit a revised test plan to the Engineer for review within forty (40) calendar days following receipt of the review of the initial plan. The review and re-submittal process described above will continue until the Engineer approves a final test plan. Multiple submittals of the test plan, if required, will be supplied at no additional cost. Testing will commence at a time mutually agreed by the Contractor and the Engineer.

**2. Field Camera Assembly Tests**

Each camera assembly furnished and installed by the Contractor will be subject to the following tests:

- Verification of installation of specified cables and connections between the camera unit (with combined pan, tilt, and zoom unit and control receiver driver) and the local cabinet.
- Local operation of all CCTV equipment, exercising the pan, tilt, zoom, focus, iris opening, and power on/off functions while observing the video picture on a portable monitor. These operations should be observed on both sides of the Video Encoders. (The Ethernet side of the Video Encoder will require a Video Decoder for correct observation of video picture.)
- Preset test to ensure camera consistently goes to the proper preset position.

Whenever any unit of equipment fails to pass the assembly tests, the Contractor shall correct the deficiencies, either by repair or replacement, at his expense (including freight costs), as required to comply with the testing requirements. Upon notification by the Contractor that the deficiencies have been corrected, the equipment shall be re-tested. All camera assembly testing and re-testing will be performed in the presence of the Engineer or his designated representative.

**3. GIS Map**

Upon completion of software installation and integration, the Contractor shall perform a software Operational Test. This test shall be designed to insure that all field device icons are able to launch their native software application from the workstation in the Division 14 office.

Develop a testing protocol that is approved by the Engineer and performs tests on the GIS Map Software that determines if all the requirements listed in Sections 14.1.B and 14.2.A of these Project Special Provisions are satisfied.

**4. Video Software Test (Central)**

Upon installation and integration of video equipment and video software, perform a operations test from the Division 14 office. This test shall be designed to insure communications between the Video software and each CCTV assembly via the Internet is functioning properly as designed. In addition to being able to view the various CCTV images on the monitors, the Operational Test should also test the Video Multiplexer, and the Pan/Tilt/Zoom functions of each CCTV.

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Develop testing protocol that is approved by the Engineer. Perform tests on the Video software to determine that all requirements listed in Sections 14.1.C and 14.2.B of these Project Special Provisions are satisfied.

**5. Closed Loop System Test**

This test shall verify that communications to each field master is functioning and working as designed. The test should demonstrate proper operation of the interconnection between the Central Office and the master controller and the master controller and the local controllers using commands from central or the field. The test should also verify that connection from a local controller to the Central Office can be establish pending an alarm condition occurring in a master or local controller. Program telemetry command sequences and enable devices necessary for testing of the Closed Loop System.

Provide forms to be used for documenting test results.

**C. 30-Day Observation Period**

Upon completion of all project work, the successful completion of the Video Software Test (Central) and the Closed Loop System Test, and the correction of all deficiencies, including minor construction items, a 30-day Observation Period shall commence. This observation shall consist of a 30-day period of normal operations of the new field equipment in operation with the existing central equipment without any failure. The 30-day Observation Period shall be warranted by the payment and performance bond. The purpose of this period is to ensure that all components of the system function in accordance with the Plans and these Special Project Provisions over an extended length of time.

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

**12.3. CONSTRUCTION METHODS**

Provide test procedures for approval by the Engineer.

After delivery and installation of the hardware and software, perform detailed tests on each system component. Execution of these test procedures will demonstrate that all equipment is fully integrated, operational, and properly operating.

**12.4. METHOD OF MEASUREMENT**

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

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

## 12.5. BASIS OF PAYMENT

None specified.

## 13. SPREAD SPECTRUM WIRELESS RADIO

### 13.1. DESCRIPTION

Furnish and install a spread spectrum wireless radio system with all necessary hardware and signage in accordance with the plans and specifications to provide a data link between field devices (i.e. Traffic Signal Controllers, Dynamic Message Signs, etc.). Provide a radio system with a bi-directional, full duplex communications channel between two "line-of-sight" antennas using license free, spread spectrum technology operating in the 902-928 MHz frequency band.

Furnish material and workmanship conforming to the *National Electrical Code* (NEC), the *National Electrical Safety Code* (NESC), Underwriter's Laboratories (UL) or a third-party listing agency accredited by the North Carolina Department of Insurance, and all local safety codes in effect on the date of advertisement. Comply with all regulations and codes imposed by the owner of affected utility poles.

### 13.2. MATERIALS

#### A. 900MHz Wireless Radio Systems:

Furnish license free 902 – 928 MHz radio modems with antennas, coaxial cable and mounting hardware, and configuration software. Design radio modems to work in "point-to-point", "point-to-multipoint", "multipoint-to-point", and "multipoint-to-multipoint" configurations. Ensure the spread spectrum wireless radio meets the following minimum requirements:

- License free (ISM) Spread Spectrum radio band (902 – 928 MHz)
- Frequency Hopping Technology (Direct Sequence Spread Spectrum Technology is not acceptable)
- Bi-Directional, Full Duplex
- Programmable Radio Frequency (RF) output levels of 1mW, 10mW, 100mW, or 1 Watt
- A minimum of 139 user-selectable radio frequency channels, with 62 available hopping sequences (2 non-overlapping)
- RS-232 interface capable of operating from 1200 bps to 115.2 Kbps, with 8 or 9 bit format or 1200 bps Bell 202.
- DB9-F connector for RS-232 port
- Maximum of 8 mSec. end-to-end latency
- 16 bit Cyclic Redundancy Check (CRC) error checking with auto re-transmit
- Built-in store-and-forward (single radio repeater – back to back radio set-ups are not allowed to accomplish this function)
- 32 Bit encryption
- Receiver Sensitivity of -110dBm @ 10<sup>-6</sup> BER
- Antenna port: Reverse Polarity - Threaded Normalized Connector-Female (RP TNC-F) antenna connector
- Front panel LED indicators:

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- Power
- Transmit Data
- Receive Data
- Data Port Indicator
- Operating temperature of -40 to +176 degrees F at 0 to 95% Humidity
- Power supply requirements:
  - Wall Adapter: 120 VAC UL/CSA wall cube plug-in module with 12 VDC, 1 Amp, nominal output.
  - Typical current draw of no greater than 355 mA when powered with 12 VDC input, and transmitting 1 Watt of RF output power.
  - Radio Sleep mode with a maximum current draw of <1 $\mu$ A.
- Shelf mounted design not to exceed 9" long x 2" wide x 5" high

Furnish a Radio Frequency Signal Jumper constructed of an RG-58 Coaxial Cable with Reverse Polarity - Threaded Normalized Connector-Male (RP TNC-M) on one end for connection to a radio unit and a Standard N-Type Male Connector on the other end for connection to the lightning arrestor. Provide the jumper in 6 foot lengths.

Furnish an RS-232 data interface cable to be installed between the radio modem and the field device's RS-232 interface. Ensure cable is a minimum of 6 feet long.

Ensure that installing the wireless radio system with a fully functional field device (i.e. controller) does not require any field device modifications with regards to hardware or software.

Furnish an ENCOM Model # EP-5200 Spread Spectrum Wireless Radio or an approved equivalent.

**B. Software:**

Furnish units with a Window Based™ software program that uses a GUI (Graphical User Interface) to provide "remote programming, radio configuration, remote maintenance, diagnostics and spectrum analyzer" features. For compatibility with the ENCOM wireless radio or an approved equivalent wireless radio, provide ENCOM ControlPAK software or an approved equivalent software that is designed to function with the approved wireless radio. Provide configuration software that can be upgraded in the future at no additional charge.

Ensure the radio modem is configurable from a single location (i.e. master radio location) via supplied software (no extra cost). Furnish software supplied with drivers to allow easy set-up with all industry standard traffic signal controllers, including 2070 controllers containing custom software written specifically for the North Carolina Department of Transportation. Ensure the supplied software contains pre-written drivers for industry standard radar and video detection packages and Dynamic Message Sign controllers.

**C. Directional Antenna (Yagi):**

Furnish a directional antenna that will allow the system to function as designed. Furnish Cushcraft Model # PC906N (8.5 dB Gain) or Cushcraft Model # PC9013N (13 dB Gain) antenna or an approved equivalent antenna that meets the following minimum specifications:

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## Cushcraft Model # PC906N (8.5 dB Gain)

Frequency Range	896 – 940 MHz
Nominal Gain	8.5 dB
Front to Back Ratio	18 dB
Horizontal Beamwidth (at half power points)	65 degree
Vertical Beamwidth (at half power points)	55 degree
Power Rating, UHF Frequency	200 Watts
Lightning Protection	DC Ground
Termination	Coaxial pigtail with a Standard N-Type Female Connector
Impedance	50 ohms
Length	24”
Rated Wind Velocity	125 mph
Rated Wind Velocity (with 0.5 inch radial ice)	100 mph
Projected Wind Surface Area (flat plane equivalent)	0.26 ftsq.
Number Elements	6
Allows for Vertical or Horizontal polarization	
Minimum separation distance from persons installing and using an active device	9”
Minimum separation distance from other RF sources including radios and antennas	6.5’
Welded construction	

## Cushcraft Model # PC9013N (13 dB Gain)

Frequency Range	902 – 928 MHz
Nominal Gain	13 dB
Front to Back Ratio	20 dB
Horizontal Beamwidth (at half power points)	40 degree
Vertical Beamwidth (at half power points)	35 degree
Power Rating, UHF Frequency	200 Watts
Lightning Protection	DC Ground
Termination	Coaxial pigtail with a Standard N-Type Female Connector
Impedance	50 ohms
Length	53”
Rated Wind Velocity	125 mph
Rated Wind Velocity (with 0.5 inch radial ice)	100 mph
Projected Wind Surface Area (flat plane equivalent)	0.46 ftsq.
Number Elements	13
Allows for Vertical or Horizontal polarization	
Minimum separation distance from persons installing and using an active device	9”
Minimum separation distance from other RF sources including radios and antennas	6.5’
Welded construction	

Furnish mounting hardware to secure the antenna to the metal pole or wood pole, as recommended by the manufacturer of the antenna and as approved by the Engineer.

**U-4427****Signals & Intelligent Transportation Systems****D. Omni Directional Antenna:**

Furnish an omni directional antenna that will allow the system to function as designed. Furnish 3dB Antenex Model # FG9023 or 6dB Antenex Model # FG9026 antenna or approved equivalent antennas that meet the following minimum specifications:

Frequency Range	902 – 928 MHz
Nominal Gain	Typical gains of 3 or 6 dB (dependent upon gain needed for application)
Termination	Standard N-Type Female Connector
Impedance	50 ohms
VSWR	1.5:1
Vertical Beam Width	3 dB – 33 degrees; 6 dB – 17 degrees
Lightening Protection	DC Ground
Power Rating, UHF Frequency	100 Watts
Length	3dB – 25" 6dB – 65"
Rated Wind Velocity	125 mph
Solid, single piece construction	
Minimum separation distance from persons installing and using an active device	9"
Minimum separation distance from other RF sources including radios and antennas	6.5'
Mount in a vertical direction and limit to vertically polarized RF systems	

Furnish mounting hardware to secure the antenna to the metal pole or wood pole, as recommended by the manufacturer of the antenna and as approved by the Engineer.

**E. Coaxial Cable:**

Furnish a Times Microwave Systems™ LMR 400 Cable or ANDREW CNT-400 Cinta™ Braided Cable, or equivalent antenna coaxial cable to provide a link between the antenna and the lightning arrester that meets the following minimum specifications:

Attenuation (dB per 100 feet) @ 900 MHz	3.9 dB
Power Rating @ 900 Mhz	0.58 kW
Center Conductor	0.108" Copper Clad Aluminum
Dielectric: Cellular PE	0.285"
Shield	Aluminum Tape – 0.291" Tinned Copper Braid – 0.320"
Jacket	Black UV protected polyethylene
Bend Radius	1" with less than 1 ohm impedance change at bend
Impedance	50 ohms
Capacitance per foot	23.9 pf/ft
End Connectors	Standard N-Type Male Connectors on both ends

**F. Standard N-Type Male Connector:**

Furnish Standard N-Type Male Connector(s) of proper sizing to mate with the 400 series coaxial cable and utilize a crimping method to secure the connector to the coaxial cable. Furnish a connector that meets the following minimum specifications:

- Center Contact: Gold Plated Beryllium Copper-(spring loaded – Non-solder)

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- Outer Contact: Silver Plated Brass
- Body: Silver Plated Brass
- Crimp Sleeve: Silver Plated Copper
- Dielectric: Teflon PTFE
- Water Proofing Sleeve: Adhesive Lined Polyolefin – Heat Shrink
- Attachment Size: Crimp Size 0.429” (minimum) hex

**Electrical Properties:**

- Impedance: 50 ohms
- Working Voltage: 1000 vrms (max)
- Insertion loss:  $0.1 \times \sqrt{F}$ ghz
- VSWR: 1.25:1 (max) up to 3GHz

Provide instructions on properly installing the connector.

**G. Coaxial Cable Shield Grounding and Weatherproofing Kits:**

Furnish a Coaxial Cable Shield Grounding Kit containing components that will adequately bond and ground the cable shield to the pole ground. Ensure the grounding kit complies with MIL-STD-188-124A Specifications “Military Standard for Grounding, Bonding and Shielding” for coaxial cable and protects the cable from lightning currents in excess of 200kA. Ensure each kit is supplied, as a minimum, with the following:

- Preformed Strap: 24 Gauge copper strap that is a minimum of 1 5/8 inch long and is sized to mate with the 400 series coaxial cable
- Tensioning Hardware: Copper nuts and lock washers
- Grounding Lead Cable: #6 AWG, stranded, insulated copper wire
- Instructions on properly installing the shield grounding system

Furnish a Weatherproofing Kit containing components that will protect the coaxial cable shield grounding system against the ingress of moisture and prevent vibrations from loosening the connections. Ensure the weatherproofing kit is supplied, as a minimum, with the following:

- Butyl Mastic Tape: 3 3/4 inches wide by 24 inches long (approximately)
- Electrical Tape: 2 inch wide by 20 inches long (approximately)
- Instructions on properly installing the weatherproofing system

**H. Lightning Arrestor:**

Furnish a lightning arrestor installed in line between each antenna and its designated radio modem inside the equipment cabinet. Furnish a Polyphaser Model # DSXL lightning arrestor or an approved equivalent that meets the following minimum specifications:

- Surge: 20kA, 800MHz to 2.0GHz  $\leq 1.1 : 1$  VSWR  
18kA, 800MHz to 2.3GHz  $\leq 1.1 : 1$  VSWR  
700MHz to 2.7GHz  $\leq 1.2 : 1$  VSWR
- Insertion Loss:  $\leq 0.1$  dB over frequency range
- Max Power: 500 w @ 920MHz (750 W @ at 122° F)
- RF Power: 300 Watts
- Let Through Voltage:  $\leq \pm 3$  Volts for 3kA @ 8/20  $\mu$ s Waveform
- Throughput energy:  $\leq 0.5$   $\mu$ J for 3kA @ 8/20  $\mu$ s Waveform
- Temperature: -40 to 185° F Storage/Operating 122° F
- Vibration: 1G at 5 Hz up to 100Hz



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- Unit Impedance: 50Ω
- VSWR: 1.1:1
- Frequency Range: 800 MHz to 2200 MHz
- Multistrike capability
- Low strike throughput energy
- Flange mount and bulkhead mount options
- Standard N-Type Female Connector on both the surge side and protected side connectors

**I. Disconnect Switch:**

Furnish a double pole, single throw snap switch in a weatherproof outlet box with cover, suitable for use in wet locations. Ensure outlet box and cover supports a lockout tag device. Ensure outlet box includes one ½-inch hole in back of box. Furnish mounting hardware, sealing gaskets and lockout tag.

**J. Warning Signs(s) and Decal(s):**

Furnish Warning Sign and Decal at locations called for in the plans. Furnish mounting hardware to secure the Sign to either metal or wood poles. Secure to the pole using 'Band-It' brackets or a method approved by the engineer.

**13.3. CONSTRUCTION METHODS****A. General:**

**Perform a radio path Site Survey test before installing any equipment.** Ensure the test evaluates the Signal Strength (dBm), Fade Margin (dB), Signal-to-Noise Ratio, Data Integrity (poll test), and a complete frequency spectrum scan. Ensure the radio path site survey test is performed using the supplied brand of radio equipment to be deployed. During the initial radio path signal strength test it may be determined that a repeater station may be necessary to complete the intended link. Provide the test results to the Engineer for review and approval. Submit copies of the test results and colored copies of the frequency spectrum scan along with an electronic copy of this information. The Engineer will approve final locations of antennas and any necessary repeater stations. Install an antenna splitter cable at locations where it is determined that a dual antenna configuration is necessary to accommodate communications in multiple directions.

Install the antenna in such a manner that avoids conflicts with other utilities (separation distances in accordance with the guidelines of the NESC) and as specified in the antenna manufacturer's recommendations. Secure the antenna mounting hardware to the pole and route the coaxial cable such that no strain is placed on the N-Type Male coaxial connectors. On wood pole installations, bond the antenna mounting hardware to the pole ground using # 6 AWG bare copper wire using split bolt or compression type fitting.

Install the coaxial cable shield grounding system by carefully removing the outer jacket of the coaxial cable without damaging the cable shield. Install the shield grounding system following the cable manufacturer's recommendations. Install and weatherproof the connection using the appropriate weatherproofing materials and following the manufacturer's recommendations. On wood poles, secure the #6 AWG grounding lead cable to the pole ground using split bolt or compression type fitting or an Engineer approved method. On metal poles, secure the #6 AWG grounding lead cable to the pole using an Engineer approved method.

Do not exceed the 1-inch bend radius of the coaxial cable as it traverses from the cabinet to the antenna assembly. Connect the lightning arrestor to the coaxial cable in the equipment cabinet. Properly ground and secure the arrestor in the cabinet. Permanently label all cables entering the

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cabinet. Ensure the power supply for the radio system is **NOT** connected to the GFCI receptacle circuit located in the cabinet. Place a copy of all manufacturer equipment specifications and instruction and maintenance manuals in the equipment cabinet.

At certain locations it may be necessary to integrate the radio system with a fiber optic system. Follow the details shown in the fiber optic splice plans.

**B. Disconnect Switch:**

At all locations install a double pole, snap switch to remove power from the spread spectrum wireless radio system. Do not mount weatherproof box on the traffic signal cabinet door. Drill a hole in the side of the traffic signal cabinet. Mount the outlet box over the hole using a ½-inch chase nipple and bushings. Ensure sealing gaskets are in place and no water can enter the cabinet. Securely mount the weatherproof outlet box with additional mounting screws. Bond the outlet box to the equipment ground bus. See plans for approximate mounting height. Run the power supply cord of the spread spectrum radio unit into the outlet box and connect to switch. Securely attach power supply cord to equipment rack. Install disconnect switch with lockout tag cover.

Do not install power supply for the radio in a GFCI protected outlet.

**C. Warning Sign(s) and Decal(s):**

Secure Warning Sign to pole. Mount Warning Sign(s) at locations called for on the plans. Ensure there are no conflicts between the warning sign and surrounding utilities. Mount Warning Sign to be easily viewed. Do not mount Warning Sign under pole grounds or conduit.

Clean and remove any dirt or oil on traffic cabinet before placing Decal. Place decal adjacent to the disconnect switch located on the outside of traffic cabinet.

**13.4. WARRANTY**

Provide a minimum two-year warranty with each radio and antenna assembly to ensure the products are free of manufacturing defects in material and workmanship. The warranty commences on the date the radio system is accepted by the Engineer.

**13.5. MEASUREMENT AND PAYMENT**

Actual number of 900MHz wireless radio systems and antenna(s) furnished, installed and accepted. This item includes the appropriate antenna, coaxial cable, splitter cable, coaxial cable shield grounding system with weatherproofing, lightning arrestor, labeling and any integration between the wireless radio system and a fiber optic network if necessary.

All power supplies, power cords, adapters, antenna mounting hardware, connectors, serial cables, signs, decals, disconnect switches, installation materials and configuration software necessary to complete this work, including the radio path Site Survey test and warranties, will be incidental. Final payment will be made when work is accepted by the Engineer.

Payment will be made under "900 MHz Wireless Radio System" **in accord with the following conditions: 75% of the payment will be made upon acceptance of each unit; 25% of the payment will be made following final acceptance of the integrated system (including completion of the 30 day observation period).**

**900MHz Wireless Radio System.....Each**

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**14. SYSTEM SUPPORT EQUIPMENT – CCTV AND WIRELESS RADIO****14.1. DESCRIPTION**

Furnish system support equipment with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the 2006 Standard Specifications for Roads and Structures.

**14.2. MATERIAL****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.

Prior to starting any system testing or training, furnish all system support equipment.

**B. System Support Equipment:**

Furnish new, unused system support equipment to the Engineer in the quantities shown below:

- One (1) CCTV Camera Assembly as specified in Section 6
- One (1) Video Multiplexer as specified in Section 6
- One (1) Video Encoder as specified in Section 6
- One (1) Fiber Optic Video Transmitter/Data Transceiver as specified in Section 6
- One (1) Fiber Optic Video Receiver/Data Transceiver as specified in Section 6
- One (1) Video Decoder as specified in Section 6
- One (1) Ethernet Switch as specified in Section 7
- Two (2) Wireless Radio Modems as specified in Section 13
- Two (2) Lightning Arrestors as specified in Section 13
- One (1) CCTV Test Monitors

**C. CCTV Test Monitor:**

Furnish a portable color CCTV test monitor to allow for the field testing of CCTV assembly installations in the field and in the shop.

Furnish one (1) portable color monitor meeting the following specifications:

Display	4" Liquid Crystal Display, active matrix
Input Signal	2 NTSC inputs
Color	Full Color or Black and White
Picture Elements	480 (H) x 234 (V)
Dot Pitch	0.171 (W) x 0.264 (H)
Back Light	Built In
Controls	Color, brightness, on/off, tint, red & blue drive
Supply voltage	12 VDC, 500mA
Connectors	Switchable video – BNC; Power – DC jack
Operating Temperature	32 degrees F to 104 degrees F
Dimensions (maximum)	5.5 inches (W) x 3.6 inches (H) x 1.8 inches (D)

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Weight (maximum) 1 lbs.

Include 12 feet of power and video cables with the monitor and case. Furnish monitor with all equipment necessary to operate from 120 VAC power source.

**14.3. METHOD OF MEASUREMENT**

Actual number of CCTV Camera Assemblies furnished and accepted.

Actual number of Video Multiplexers furnished and accepted.

Actual number of Video Encoders furnished and accepted.

Actual number of Fiber Optic Video Transmitter/Data Transceiver furnished and accepted.

Actual number of Fiber Optic Video Receiver/Data Transceiver furnished and accepted.

Actual number of Video Decoders furnished and accepted.

Actual number of Ethernet Switches furnished and accepted.

Actual number of Wireless Radio Modems furnished and accepted.

Actual number of Lightning Arrestors furnished and accepted.

Actual number of CCTV Test Monitors furnished and accepted.

**14.4. BASIS OF PAYMENT**

The quantity of CCTV Camera Assemblies, measured as provided above, will be paid for at the contract unit price each for "Furnish CCTV Camera Assembly".

The quantity of Video Multiplexers, measured as provided above, will be paid for at the contract unit price each for "Furnish Video Multiplexer".

The quantity of Video Encoders, measured as provided above, will be paid for at the contract unit price each for "Furnish Video Encoder".

The quantity of Fiber Optic Video Transmitter/Data Transceiver, measured as provided above, will be paid for at contract unit price each for "Furnish Fiber Optic Video Transmitter/Data Transceiver".

The quantity of Fiber Optic Video Receiver/Data Transceiver, measured as provided above, will be paid for at contract unit price each for "Furnish Fiber Optic Video Receiver/Data Transceiver".

The quantity of Video Decoders, measured as provided above, will be paid for at the contract unit price each for "Furnish Video Decoder".

The quantity of Ethernet switches, measured as provided above, will be paid for at the contract unit price each for "Furnish Ethernet Switch".

The quantity of Wireless Radio Modems, measured as provided above, will be paid for at the contract unit price each for "Furnish Wireless Radio Modem".

The quantity of lightning Arrestors, measured as provided above, will be paid for at the contract unit price each for "Furnish Lightning Arrestor".

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The quantity of CCTV Test Monitors, measured as provided above, will be paid for at the contract unit price each for “Furnish CCTV Test Monitor”.

Payment will be made under:

<b>Furnish CCTV Camera Assembly .....</b>	<b>Each</b>
<b>Furnish Video Multiplexer .....</b>	<b>Each</b>
<b>Furnish Video Encoder .....</b>	<b>Each</b>
<b>Furnish Fiber Optic Video Transmitter/Data Transceiver.....</b>	<b>Each</b>
<b>Furnish Fiber Optic Video Receiver/Data Transceiver.....</b>	<b>Each</b>
<b>Furnish Video Decoder .....</b>	<b>Each</b>
<b>Furnish Ethernet Switch .....</b>	<b>Each</b>
<b>Furnish Wireless Radio Modem .....</b>	<b>Each</b>
<b>Furnish Lightning Arrestor.....</b>	<b>Each</b>
<b>Furnish CCTV Test Monitor .....</b>	<b>Each</b>

**40.15. TRAINING – CCTV AND RADIO MODEMS**

**40.1.15.1. Description**

Provide training for the installation, operation and maintenance of the CCTV and Radio system.

**40.2.15.2. Materials**

**A. General**

**Provide training to properly install, operate, maintain, diagnose and repair each piece of equipment and the software associated with the CCTV and Radio system.** Provide approved manufacturer’s representatives or other qualified personnel to conduct training courses. Provide training for a total of fifteen Department personnel.

Prior to commencement of the training course, submit detailed course curricula, draft manuals, and handouts, and resumes of the instructors for review and approval. The Engineer may request modification of the material and request courses desired by the Department.

For all training programs, a staff of engineers, technicians, and maintenance personnel familiar with the system will be the training participants. A “day” of training shall consist of training conducted between the hours of 8:30am and 4:30 pm. For each session, provide training materials (manuals, notebooks, hand-outs, etc.) as specified in the Documentation Section of these Project Special Provisions.

Qualified instructors shall present all training courses, lectures, and demonstrations in person. The Engineer shall approve all instructors.

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Conduct all training courses at a location provided by the Contractor within the Division at a time mutually agreed upon, but not later than the start of system acceptance testing. Provide training material, manuals, and other handouts to serve not only as subject guidance, but also as quick reference for use by the students. Deliver course material in reproducible form immediately following the course.

**A.B. Subject Areas**

Provide the training sessions at the required durations as listed in the Table below. A more detailed description of the required content of each training session is provided in the following sections. As part of the Project Implementation Schedule, propose the time of occurrence of each such training schedule.

<b>Subject</b>	<b>Minimum Duration</b>
Fiber Optic Communications System (Reference Section 8)	
CCTV System – Session 1	1 Day
CCTV System – Session 2	1 Day
Radio Modems – Session 1	1 Day
Radio Modems – Session 2	1 Day

**15.3. Required Content and Format****B.5.A. Fiber Optic Communications System**

Provide training as outline in Section 8 of these Project Special Provisions.

**B.7.1. CCTV Central and Field Equipment**

Provide two sessions for the CCTV central and field equipment training. The first session shall address the maintenance of the CCTV equipment. The training shall address the preventative maintenance and trouble shooting procedures for all the field and central equipment including the video transceivers.

This session shall consist of a mixture of lecture and hands-on workshops and shall have a minimum duration of one (1) day.

The second session shall address the operational theory and procedures of the CCTV system. This training shall be oriented towards users of the system. The training shall address the use of, but not limited to, the following devices:

- Camera control software and GIS software

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- Camera control panel
- Video multiplexer
- Video Encoder
- Video Decoder
- Ethernet Switch for internet service

Include "hands-on" training workshop with a minimum duration of one (1) day as part of this session. The CCTV training sessions shall be presented by field service specialist(s) employed by the suppliers of the CCTV system components.

**B.7.2. \_\_\_\_\_ Radio Modems**

Provide two sessions for the Radio System field equipment training. The first session shall address the theory and operation of the radio system and various coaxial cable and antenna configurations. The training shall address procedures and practices associated with performing a site survey analyses and deployment of the radio modems with regards to selecting antenna polarization, coaxial cable length vs. antenna dB losses. This training shall also address setting radio operating parameters for hop patterns and repeater designations and establishing additional radio modems to an existing system.

This session shall consist of a mixture of lecture and hands-on workshops and shall have a minimum duration of one (1) day.

The second session shall reinforce the first session and be conducted in the field under real life circumstances. This session shall demonstrate and review the class-room portion of this training (Session 1) and be developed for maintenance and designers such that they can evaluate and determine the successful deployment of future radio sites. This session shall have a minimum duration of one (1) day.

**40.3.15.4. \_\_\_\_\_ Method of Measurement**

Training will not be measured, and will be paid on a lump sum basis.

Fiber optic training will be covered under Section 8 of the Project Special Provisions.

**40.4.15.5. \_\_\_\_\_ Basis of Payment**

Payment will be made under:

**Training – CCTV and Radio Modems..... Lump Sum**

## 16. METAL TRAFFIC SIGNAL SUPPORTS

### 16.1. METAL TRAFFIC SIGNAL SUPPORTS – ALL POLES

#### A. General:

Furnish and install metal strain poles, metal poles with mast arms, and metal CCTV camera pole, grounding systems, **fluted decorative bases** and all necessary hardware. **The style of decorative base shall be approved by the Engineer prior to installation.** The work covered by this special provision includes requirements for the design, fabrication, and installation of both standard and custom/site specifically designed metal traffic signal supports and associated foundations.

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, Luminaries and Traffic Signals* 4th Edition, 2001 (hereafter called 4th Edition AASHTO), including the latest interim specifications. Provide assemblies with a round or near-round cross-sectional design consisting of no less than six sides. The sides may be straight, convex, or concave.

Comply with Subarticle 1098-1B “General Requirements” of the *Standard Specifications* for submittal requirements. Furnish shop drawings for approval. Provide triplicate copies of detailed shop drawings for each type of structure. Ensure that shop drawings show materials specifications for each component and identifies welds by type and size. Do not release structures for fabrication until structural drawings have been approved. Provide an itemized bill of materials for all structural components and associated connecting hardware on the drawings.

If plans call for Standard Metal Signal Supports, comply with Subarticle 1098-1A “General Requirements” for QPL submittals. In addition to these requirements, provide a sealed copy of the pre-approved shop drawings that includes a signal inventory number and project number or work order number on the drawings. Provide design calculations with these submittals.

Summary of information needed for metal pole review submittals:

- Shop drawings & supporting calculations
- Foundation design (custom designed poles only)
- Standard Metal Pole Foundation Selection Form (standard poles only)
- Soil boring logs
- Soil boring location map or other means to correlate borings and the corresponding poles
- Geotechnical report

#### B. Materials:

Fabricate monotube shafts with a uniform linear taper of 0.14 in/ft with steel that conforms to ASTM A-595 minimum Grade A or an approved equivalent. Galvanize in accordance with AASHTO M111.

Use the submerged arc process to continuously weld shafts for the entire length. Ground or roll smooth exposed welds until flush with the base metal. Ensure shafts have no circumferential welds except at the lower end joining the shaft to the 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.

Refer to Standard Drawings for Metal Poles M2 for fabrication details. Fabricate anchor bases from plate steel meeting 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.



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Conform to the applicable bolt pattern and orientation specified by the design as shown on drawing M2.

Ensure hardware is galvanized steel or stainless steel.

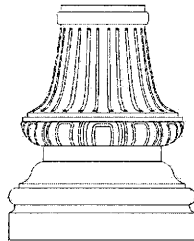
Ensure material used in steel anchor bolts conforms to AASHTO M 314, and yield strength does not exceed 55,000 psi. Unless otherwise required by the design, ensure each anchor bolt is 2" in diameter and 60" in length. Provide 10" minimum thread projection at the top of the bolt, and 8" minimum at the bottom of the bolt. Galvanize each anchor bolt in accordance with AASHTO M232 or M298 from the top of the bolt to a minimum of 2" below the threads.

Provide a circular anchor bolt lock plate that will be secured to the anchor bolts at the embedded end with 2 washers and 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.

**Furnish a "Washington" style decorative base as provided by Valmont Industries or an Engineer-approved equivalent.**



**"Washington" Style Decorative Base**

#### **C. Construction Methods:**

**The majority of locations being upgraded to metal poles with mast arms will utilize a single pole with diagonal mast arm to minimize utility and right-of-way conflicts. The Contractor is responsible for ensuring the diagonal mast arm is placed at the proper angle in relation to the intersection to achieve the minimum necessary clearance from stopbars to signal heads. Additional stopbar adjustments other than what is specified in the plans may be necessary depending on the exact angle the mast arm is placed. The Contractor shall be responsible for field measuring distances from the signal heads to the stopbars after placement of the mast arms. Any measurements not meeting MUTCD standards shall be noted and adjusted accordingly to achieve the proper clearance. Obtain prior approval from the Engineer before making any adjustments not specified in the plans.**

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 Strain Poles, or Metal Pole with Mast Arm.

Connect poles to grounding electrodes and the intersection grounding systems.

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For holes in the poles used to accommodate cables, install grommets before wiring pole or arm. Do not cut or split grommets.

Attach the terminal compartment cover to the pole by a sturdy chain or cable. Ensure 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 the chain or cable will not interfere with service to the cables in the pole base.

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

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

**Anchor Nut Tightening Procedure**

Compute the required projection of the anchor bolt above the foundation top. Compute the total projection based on the following:

- Provide between 3 and 5 threads of anchor bolt projection above the top nut after tightening is complete. Avoid any additional projection, or a normal depth socket torque wrench can not be used on top nuts.
- Include the sum of the thickness of top nut, top nut flat washer or top nut beveled washer, base plate, leveling nut flat washer or leveling nut beveled washer, and leveling nut.
- Set the maximum distance between the bottom of the leveling nut and the foundation top to one nut height to avoid excessive bending stresses in the anchor bolt under service conditions.
- Do not use lock washers.

**Installation Procedure:**

1. Place a leveling nut and washer on each anchor bolt and install a template on top of the leveling nuts to verify that the nuts are level and uniformly contact the template. Use beveled washers if the leveling nuts cannot be brought into firm contact with the template. Verify that the distance between the bottom of the leveling nuts and the top of the concrete is no more than one nut height. Consider how attachments and applied loads may affect the vertical nature of the metal pole after erected and fully loaded. If necessary, induce a rake to the upright in the opposite direction of the anticipated loads during the initial erection by adjusting the leveling nuts accordingly. Failure to consider this could result in the upright being out of the allowable vertical tolerance as specified in the Metal Strain Pole Construction Methods of this special provision.
2. Install the vertical upright on the anchor bolts, and tighten nuts in compliance with steps 3, 4, and 5 below. Do not attach cantilever arms or messenger cable to the vertical post until all of the top nuts and leveling nuts have been properly tightened on the anchor bolts.
3. Install top nuts and washers. Install flat washers under the top and leveling nuts. Use beveled washers if the nuts cannot be brought into firm contact with the base plate. Lubricate threads of the anchor bolts, nuts, and bearing surface of the nuts and tighten to a snug-tight condition with a spud wrench following a star pattern (using at least two increments). Snug-tight condition is defined as 20% to 30% of the verification torque (600 ft-lbs.). Ensure lubricant is beeswax, stick paraffin, or other approved lubricant.
4. After the top nuts have been snug tightened, snug tighten the bottom nuts up to the base plate using the same procedure as described above. The base-plate must be in firm contact with both the top and bottom nuts to achieve the proper pretension in the anchor bolts.

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5. Before further turning of the nuts, mark the reference position of the top nut in the snug-tight condition by match marking each nut, bolt shank, and base plate. Use ink or paint that is not water-soluble.
6. Turn the top nuts in increments using the star pattern (using at least two full tightening cycles) to 1/6 of a turn. Use a torque wrench to verify that at least 600 ft-lbs. is required to further tighten the top nuts. At least 48 hours after the entire structure and any attachments are erected, use a torque wrench again to verify that at least 600 ft-lbs. is still required to tighten the top nuts. Verify that the leveling nuts remain in firm contact with the base plate.
7. Do not place non-shrink grout between the base plate and foundation. This will allow for future inspection of leveling nuts and for adequate drainage of moisture.

**16.2. METAL STRAIN POLE****A. Materials:**

Provide ground lug at 0° on the pole's radial index for grounding spanwire. Ensure #4 or #6 AWG wire will pass through opening.

**B. 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.

**16.3. METAL POLE WITH MAST ARM****A. Materials:**

Fabricate arms from standard weight black steel pipe conforming to ASTM A 53-90a, Type E or Type S, Grade B or an approved equivalent.

After all fabricating, cutting, punching, and welding is completed, hot-dip galvanize the structure in accordance with the 4th Edition AASHTO M111.

**B. Construction Methods:**

Install horizontal-type arms within 2 degrees of horizontal when loaded with signal heads and signs.

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.

**16.4. METAL CCTV CAMERA POLE**

Furnish CCTV poles and foundations at Sig. Inv. # 14-0736 and Sig. Inv. # 14-0611 that meet or exceed the following functional requirements with all CCTV units, power meter, service disconnect, and all equipment cabinets attached and all risers, condulets, and weatherhead accessories in place:

- Maximum deflection at top of pole [in 48 km/hr (30 mph), non-gusting wind]: 25 mm (1 inch)
- Ultimate load: 129 km/hr (80 mph) wind with a 30% gust factor

Furnish poles and foundations that sustain the dead load of all equipment attached to the pole with a safety factor of 1.5.

Cameras located at the intersection listed below shall be mounted on a standalone CCTV metal pole designated as *Pole # 38*.

*SIG INV. # 14-0736 (4 Seasons Blvd. At I-26 Ramps)*

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Cameras located at the intersections listed below shall be mounted to a metal strain pole, which is used to support traffic signal cable.

*SIG INV. # 14-0611 (US 25 at Fleming Street) – Pole #8*

Conduit elbows in foundation shall have a minimum radius of 15 inches (380 mm).

**16.5. DRILLED PIER FOUNDATIONS FOR METAL TRAFFIC SIGNAL POLES****A. Description:**

Perform a soil test at each proposed metal pole location. Furnish and install foundations for NCDOT metal poles with all necessary hardware in accordance with the plans and specifications.

Metal Pole Standards have been developed and implemented by NCDOT for use at signalized intersections in North Carolina. If the plans call for a standard pole, then a standard foundation may be selected from the plans. However, the Contractor is not required to use a standard foundation. If the Contractor chooses to design a non-standard site-specific foundation for a standard pole or if the plans call for a non-standard site-specific pole, design the foundation to conform to the applicable provisions in the NCDOT Metal Pole Standards and Section B4 (Non-Standard Foundation Design) below. If non-standard site specific foundations are designed for standard QPL approved strain poles, the foundation designer must use the design moment specified by load case on drawing M8 of the Standard Drawings for Metal Poles. Failure to conform to this requirement will be grounds for rejection of the design.

If the Contractor chooses to design a non-standard foundation for a standard pole and the soil test results indicate a standard foundation is feasible for the site, the Contractor will be paid the cost of the standard foundation (drilled pier and wing wall, if applicable). Any additional costs associated with a non-standard site-specific foundation including additional materials, labor and equipment will be considered incidental to the cost of the standard foundation. All costs for the non-standard foundation design will also be considered incidental to the cost of the standard foundation. **All foundations shall be a maximum of 36 inches in diameter. Vary the depth of the foundations to account for instances where a diameter greater than 36 inches is needed.**

**B. Soil Test and Foundation Determination:****1. General:**

Drilled piers are reinforced concrete sections, cast-in-place against in situ, undisturbed material. Drilled piers are of straight shaft type and vertical.

Some standard drilled piers for supporting poles with mast arms may require wing walls to resist torsional rotation. Based upon this provision and the results of the required soil test, a drilled pier length and wing wall requirement may be determined and constructed in accordance with the plans.

For non-standard site-specific poles, the contractor-selected pole fabricator will determine if the addition of wing walls is necessary for the supporting foundations.

**2. Soil Test:**

Perform a soil test at each signal location. Complete all required fill placement and excavation at each signal pole location to finished grade before drilling each boring. Drill one boring to a depth of 26 feet.

Perform standard penetration tests (SPT) in accordance with ASTM D 1586 at depths of 1, 2.5, 5, 7.5, 10, 15, 20 and 26 feet. Discontinue the boring if one of the following occurs:

- A total of 100 blows have been applied in any 2 consecutive 6-in. intervals.
- A total of 50 blows have been applied with < 3-in. penetration.

Describe each intersection as the “Intersection of (Route or SR #), (Street Name) and (Route or SR #), (Street Name), \_\_\_\_\_ County, Signal Inventory No. \_\_\_\_\_”. Label borings with “B- N, S, E, W, NE, NW, SE or SW” corresponding to the quadrant location within the intersection. Pole numbers should be made available to the drill contractor. Include pole numbers in the boring label if they are available. If they are not available, ensure the boring labels can be cross-referenced to corresponding pole numbers. For each boring, submit a legible (hand written or typed) boring log signed and sealed by a licensed geologist or professional engineer registered in North Carolina. Include on each boring the SPT blow counts and N-values at each depth, depth of the boring, and a general description of the soil types encountered.

### 3. Standard Foundation Determination:

Use the following method for determining the Design N-value:

$$N_{AVG} = \frac{(N@1' + N@2.5' + \dots + N@Deepest\ Boring\ Depth)}{\text{Total Number of N-values}}$$

$$Y = (N@1')^2 + (N@2.5')^2 + \dots + (N@Deepest\ Boring\ Depth)^2$$

$$Z = (N@1' + N@2.5' + \dots + N@Deepest\ Boring\ Depth)$$

$$N_{STD\ DEV} = \left[ \frac{(\text{Total Number of N-values} \times Y) - Z^2}{(\text{Total Number of N-values}) \times (\text{Total Number of N-values} - 1)} \right]^{0.5}$$

**Design N-value** equals lesser of the following two conditions:

$$N_{AVG} - (N_{STD\ DEV} \times 0.45)$$

Or

$$\text{Average of First Four N-Values} = \frac{(N@1' + N@2.5' + N@5' + N@7.5')}{4}$$

*Note: If less than 4 N-values are obtained because of criteria listed in Section 2 above, use average of N-values collected for second condition. Do not include the N-value at the deepest boring depth for above calculations if the boring is discontinued at or before the required boring depth because of criteria listed in Section 2 above. Use N-value of zero for weight of hammer or weight of rod. If N-value is greater than 50, reduce N-value to 50 for calculations.*

If standard NCDOT strain poles are shown on the plans and the Contractor chooses to use standard foundations, determine a drilled pier length, “L,” for each signal pole from the Standard Foundations Chart (sheet M 8) based on the Design N-value and the predominant soil type. For each standard pole location, submit a completed “Metal Pole Standard Foundation Selection Form” signed by the contractor’s representative. Include the Design N-value calculation and resulting drilled pier length, “L,” on each form.

If non-standard site-specific poles are shown on the plans, submit completed boring logs collected in accordance with Section 2 (Soil Test) above along with pole loading diagrams from the plans to the contractor-selected pole fabricator to assist in the pole and foundation design.

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If one of the following occurs, the Standard Foundations Chart shown on the plans may not be used and a non-standard foundation may be required. In such case, contact the Engineer.

- The Design N-value is less than 4.
- The drilled pier length, “L”, determined from the Standard Foundations Chart, is greater than the depth of the corresponding boring.

In the case where a standard foundation cannot be used, the Department will be responsible for the additional cost of the non-standard foundation.

The Standard Foundations Chart is based on level ground around the traffic signal pole. If the distance between the edge of the drilled pier and the top of a slope steeper than 2:1 (H:V) is less than 10 feet or the grade within 10 feet is steeper than 2:1 (H:V), contact the Engineer.

The “Metal Pole Standard Foundation Selection Form” may be found at:

<http://www.ncdot.org/doh/preconstruct/highway/geotech/formdet/mpsf.pdf>

If assistance is needed with the required calculations, contact the Signals and Geometrics Structural Engineer at (919) 733-3915. However, in no case will the failure or inability to contact the Signals and Geometrics Structural Engineer be cause for any claims or requests for additional compensation.

#### **4. Non-Standard Foundation Design:**

Design non-standard foundations based upon site-specific soil test information collected in accordance with Section 2 (Soil Test) above. Provide a drilled pier foundation for each pole with a length and **diameter no greater than 36 inches** that results in a horizontal lateral movement of less than 1 inch at the top of the pier and a horizontal rotational movement of less than 1 inch at the edge of the pier. Contact the Engineer for pole loading diagrams for standard poles to be used for non-standard foundation designs. Submit any non-standard foundation designs including plans, calculations, and soil boring logs to the Engineer for review and approval before construction. A professional engineer registered in the state of North Carolina must seal all plans and calculations.

#### **C. Drilled Pier Construction:**

##### **1. Excavation:**

Perform excavations for drilled piers to the required dimensions and lengths including all miscellaneous grading and excavation necessary to install the drilled pier. Depending on the subsurface conditions encountered, excavation in weathered rock or removal of boulders may be required.

Dispose of drilling spoils as directed and in accordance with Section 802 of the *Standard Specifications*. Drilling spoils consist of all material excavated including water or slurry removed from the excavation either by pumping or with augers.

Construct all drilled piers such that the piers are cast against undisturbed soil. If a larger casing and drilled pier are required as a result of unstable or caving material during drilling, backfill the excavation before removing the casing to be replaced. No additional payment will be made for substituting a larger diameter drilled pier in order to construct a drilled pier cast against undisturbed soil.

Construct drilled piers within the tolerances specified herein. If tolerances are exceeded, provide additional construction as approved by the Engineer to bring the piers within the tolerances specified. Construct drilled piers such that the axis at the top of the piers is no more than 3 inches in any direction from the specified position. Build drilled piers within 1% of the plumb deviation for the total length of the piers. Construct the finished top of pier elevation between 5 inches above and

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2 inches above the finished grade elevation. Form the top of the pier such that the concrete is smooth and level.

If unstable, caving, or sloughing soils are anticipated or encountered, stabilize drilled pier excavations with either steel casing or polymer slurry. Steel casing may be either the sectional type or one continuous corrugated or non-corrugated piece. Ensure all steel casings consist of clean watertight steel of ample strength to withstand handling and driving stresses and the pressures imposed by concrete, earth or backfill. Use steel casings with an outside diameter equal to the specified pier size and a minimum wall thickness of 1/4 inches. Extract all temporary casings during concrete placement in accordance with this special provision unless the Contractor chooses to leave the casing in place in accordance with the requirements below.

Any temporary steel casing that becomes bound or fouled during pier construction and cannot be practically removed may constitute a defect in the drilled pier. Improve such defective piers to the satisfaction of the Engineer by removing the concrete and enlarging the drilled pier, providing a replacement pier or other approved means. All corrective measures including redesign as a result of defective piers will not be cause for any claims or requests for additional compensation.

Any steel casing left in place will be considered permanent casing. Permanent steel casings are only allowed for strain poles. When installing permanent casing, do not drill or excavate below the tip of the permanent casing at any time such that the permanent casing is against undisturbed soil. The Contractor may excavate a hole smaller than the specified pier size to facilitate permanent casing installation. Ensure the sides of the excavation do not slough during drilling. Ensure the hole diameter does not become larger than the inside diameter of the casing. No additional compensation will be paid for permanent casing.

If polymer slurry is chosen to stabilize the excavation, use one of the following polymers listed in the table below:

PRODUCT	MANUFACTURER
SlurryPro CDP	KB Technologies Ltd 3648 FM 1960 West, Suite 107 Houston, TX 77068 (800) 525-5237
Super Mud	PDS Company 105 West Sharp Street El Dorado, AR 71730 (800) 243-7455
Shore Pac GCV	CETCO Drilling Products Group 1500 West Shure Drive Arlington Heights, IL 60004 (800) 527-9948
Novagel Polymer	Geo-Tech Drilling Fluids 220 North Zapata Hwy, Suite 11A Laredo, TX 78043 (210) 587-4758

Use slurry in accordance with the manufacturer's guidelines and recommendations unless approved otherwise by the Engineer. The Contractor should be aware that polymer slurry may not be appropriate for a given site. Polymer slurry should not be used for excavations in soft or loose soils as determined by the Engineer.

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

## 2. Reinforcing Steel:

Completely assemble a cage of reinforcing steel consisting of longitudinal and spiral bars and place cage in the drilled pier excavation as a unit immediately upon completion of drilling unless the excavation is entirely cased. If the drilled pier excavation is entirely cased down to the tip, immediate placement of the reinforcing steel is not required.

Lift the cage so racking and cage distortion does not occur. Keep the cage plumb during concrete operations and casing extraction. Check the position of the cage before and after placing the concrete.

Securely cross-tie the vertical and spiral reinforcement at each intersection with double wire. Support or hold down the cage so that the vertical displacement during concrete placement and casing extraction does not exceed 2 inches.

Do not set the cage on the bottom of the drilled pier excavation. Place plastic bolsters under each vertical reinforcing bar that are tall enough to raise the rebar cage off the bottom of the drilled pier excavation a minimum of 3 inches.

In order to ensure a minimum of 3 inches of concrete cover and achieve concentric spacing of the cage within the pier, 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 bars to the outermost surface of the drilled pier. Tie spacer wheels that snap together with wire and allow them to rotate. Use spacer wheels that span at least two adjacent vertical bars. Start placing spacer wheels at the bottom of the cage and continue up along its length at maximum 10-foot intervals. Supply additional peripheral spacer wheels at closer intervals as necessary or as directed by the Engineer.

## 3. Concrete:

Begin concrete placement immediately after inserting reinforcing steel into the drilled pier excavation. If the drilled pier excavation is entirely cased down to the tip, immediately placement of the concrete is not required.

### a) Concrete Mix

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

Designate the concrete as Drilled Pier Concrete 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/yd<sup>3</sup> and a maximum cement content of 800 lbs/yd<sup>3</sup>; 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/yd<sup>3</sup> Type IP blended cement and a maximum of 833 lbs/yd<sup>3</sup> Type IP blended cement in the mix.

Limit the water-cementitious material ratio to a maximum of 0.45. Do not air-entrain drilled pier concrete.



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 Drilled Pier 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.

#### b) Concrete Placement

Place concrete such that the drilled pier is a monolithic structure. Temporary casing may be completely removed and concrete placement may be temporarily stopped when the concrete level is within 42 to 48 inches of the ground elevation to allow for placement of anchor bolts and conduit. Do not pause concrete placement if unstable caving soils are present at the ground surface. Remove any water or slurry above the concrete and clean the concrete surface of all scum and sediment to expose clean, uncontaminated concrete before inserting the anchor bolts and conduit. Resume concrete pouring within 2 hours.

Do not dewater any drilled pier excavations unless the excavation is entirely cased down to tip. Do not begin to remove the temporary casing until the level of concrete within the casing is in excess of 10 feet above the bottom of the casing being removed. Maintain the concrete level at least 10 feet above the bottom of casing throughout the entire casing extraction operation except when concrete is near the top of the drilled pier elevation. Maintain a sufficient head of concrete above the bottom of casing to overcome outside soil and water pressure. As the temporary casing is withdrawn, exercise care in maintaining an adequate level of concrete within the casing so that fluid trapped behind the casing is displaced upward and discharged at the ground surface without contaminating or displacing the drilled pier concrete. Exerting downward pressure, hammering, or vibrating the temporary casing is permitted to facilitate extraction.

Keep a record of the volume of concrete placed in each drilled pier 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 drilled pier 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.
- **Wet Placement:** 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

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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.

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, in the top 10 feet of the drilled pier or as approved by the Engineer. Remove any contaminated concrete from the top of the drilled pier and wasted concrete from the area surrounding the drilled pier upon completion.

Permanently mark the top of each foundation with a stamp or embedded plate to identify the depth of the foundation. Restore all disturbed areas to a like-new condition. On concrete surfaces, replace the entire joint of concrete unless otherwise directed. **On brick paver surfaces, remove and replace pavers to accommodate foundations. Pavers may need to be cut to form a smooth transition from paver to foundation.**

#### 4. 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.

#### 5. Scheduling and Restrictions:

During the first 16 hours after a drilled pier 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 drilled pier.

The foundation will be considered acceptable for loading when the concrete reaches a minimum compressive strength of 3000 psi. This provision is intended to allow the structure to be installed on the foundation in a shorter time frame, and does not constitute full acceptance of the drilled pier. Full acceptance will be determined when the concrete meets its full strength at 28 days.

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 drilled piers. If the integrity of a drilled pier 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 drilled piers 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 drilled piers found defective or not in accordance with these special provision or the plans.

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**16.6. CUSTOM DESIGN OF TRAFFIC SIGNAL SUPPORTS****A. General:**

Design traffic signal supports and corresponding foundations consisting of metal strain poles, metal poles with mast arms and metal CCTV camera poles.

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

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 (Recommended Minimum Design Life) in the 2003 Interim to the 4<sup>th</sup> 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. Maximum allowable stress ratios for all signal support designs is 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.

Special loading criteria for the computed surface area for ice load on signal heads is:

- 3-section, 12-inch, Surface area: 26.0 ft<sup>2</sup>
- 4-section, 12-inch, Surface area: 32.0 ft<sup>2</sup>
- 5-section, 12-inch, Surface area: 42.0 ft<sup>2</sup>

**Special loading criteria is specified for 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.

Ensure that designs provide a removable pole cap with stainless steel attachment screws for each pole top and mast arm end.

**B. 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

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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 and review and acceptance of these designs by the Department does not relieve said Professional Engineer of this 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 cable passage hole in the pole to allow passage of the signal cables from the pole to the arm.

For strain poles, where ice is present, assume wind loads as shown in Figure 3-5 of the 4th Edition AASHTO Specification for Group III loading.

For each strain pole, provide designs with provisions for two span wire clamps and associated hardware to attach the span wire support cable. Ensure that the diameter of the clamp is appropriately designed to be adjustable from 18 inches below the top, down to 10 feet below the top of the pole.

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

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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 Standard Drawings for Metal Poles 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 only a 6 x 12-inch hand hole with a reinforcing frame for poles that will have decorative base covers installed..

Provide designs with a terminal compartment with cover and screws in each pole that encompasses the hand hole and contains provisions for a 12-terminal barrier type terminal block on poles that will not have decorative base covers installed.

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.

For CCTV pole (pole No. 38), design with provisions for a 1" threaded half coupling one foot below the top of the pole on the same radial index as the hand hole. Ensure that strain pole No. 8 has the appropriate number of threaded half couplings at the top of the pole as specified on the Standard Strain Pole drawings.

**C. Mast Arms:**

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

Design for grommeted 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.

Use a full penetration groove weld with a backing ring to connect the mast arm to the pole. Refer to Standard Drawings for Metal Poles M5.

**16.7. METAL SIGNAL POLE REMOVALS****A. Description:**

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

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**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. **On concrete surfaces, replace the entire joint of concrete unless otherwise directed. On asphalt surfaces, patch asphalt as appropriate to provide a smooth surface.**

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.

**16.8. MEASUREMENT AND PAYMENT**

Actual number of metal strain signal poles **including decorative bases** without regard to height or load capacity furnished, installed and accepted.

Actual number of metal poles with single mast arms **including decorative bases** furnished, installed, and accepted.

Actual number of metal poles with dual mast arms **including decorative bases** furnished, installed, and accepted.

Actual number of CCTV poles furnished, installed and accepted.

Actual number of soil tests with SPT borings drilled furnished and accepted.

Actual volume of concrete poured in cubic yards of drilled pier foundation furnished, installed and accepted. **No measurement will be made for restoration of disturbed areas as this is considered incidental to the placement of drilled pier foundations.**

Actual number of designs for metal strain poles furnished and accepted.

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

Actual number of designs for metal CCTV poles furnished and accepted.

No measurement will be made of foundation designs prepared with metal pole designs, as these will be considered incidental to designing signal support structures.

Actual number of metal signal pole foundations removed and disposed. **No measurement will be made for restoration of disturbed areas as this is considered incidental to removal of pole foundations.**

Actual number of metal signal poles removed and disposed.

Payment will be made under:

<b>Metal Strain Signal Pole.....</b>	<b>Each</b>
<b>Metal Pole with Single Mast Arm.....</b>	<b>Each</b>

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<b>Metal Pole with Dual Mast Arm.....</b>	<b>Each</b>
<b>Metal CCTV Pole.....</b>	<b>Each</b>
<b>Soil Test.....</b>	<b>Each</b>
<b>Drilled Pier Foundation.....</b>	<b>Cubic Yard</b>
<b>Metal Strain Pole Design.....</b>	<b>Each</b>
<b>Mast Arm with Metal Pole Design.....</b>	<b>Each</b>
<b>Metal CCTV Pole Design.....</b>	<b>Each</b>
<b>Metal Pole Foundation Removal.....</b>	<b>Each</b>
<b>Metal Pole Removal.....</b>	<b>Each</b>

**17. LUMINAIRE MAST ARMS**

**17.1. DESCRIPTION**

Furnish and install luminaire mast arms (excluding lighting assemblies) and all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700.

Design the luminaire support arm together with the signal support structure to achieve a light assembly mounting height of 30 feet above the roadway. Refer to the Radial Orientation Detail on loading diagrams for proper orientation of arm attachment to the signal pole. Design free end of support arm for a 2-inch slip fit socket connection for attaching light assembly.

Lighting assembly to be provided and installed by others.

Verify lighting assembly manufacturer and specifications prior to submittal of shop drawings.

**17.2. MATERIALS**

Comply with the provisions of Section 1741-2.

**17.3. CONSTRUCTION METHODS**

Comply with the provisions of Section 1741-3.

Perform work as required by the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 4<sup>th</sup> Edition, 2001, including all of the latest interim revisions, and the Standard Specifications for Roads and Structures.

**17.4. METHOD OF MEASUREMENT**

Actual number of luminaire mast arms furnished, installed, and accepted.

**17.5. BASIS OF PAYMENT**

The quantity of luminaire mast arm, measured as provided above, will be paid for at the contract unit price each for "Luminaire Mast Arm."

Payment will be made under:

<b>Luminaire Mast Arm.....</b>	<b>Each</b>
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## 18. POWDER COAT FOR METAL POLES, MAST ARMS AND PEDESTALS

### 18.1. DESCRIPTION

Powder coat all metal signal poles, metal CCTV camera poles, mast arms with metal signal poles, **luminaire mast arms** and pedestrian pedestals and all necessary hardware for the signalized intersections in accordance with the plans and specifications.

### 18.2. MATERIALS

Furnish signal support metal poles, metal CCTV poles, pedestrian pedestals and mast arms with metal poles, **luminaire mast arms**, grounding systems, and all necessary hardware. Furnish metal poles, pedestrian pedestals, **luminaire mast arms**, and metal poles and mast arms that have a high density, low gloss polyester, thermosetting resin powder coat finish that is **hunter green** in color applied over a hot-dipped galvanized surface.

Provide a removable pole cap with stainless steel attachment screws for the top of each pole. Furnish removable pole caps that have a high density, low gloss polyester, thermosetting resin powder coat finish that is **hunter green** in color applied over a hot-dipped galvanized surface.

Furnish housings for mounting of pedestrian pushbuttons. Provide housings that have a high density, low gloss polyester, thermosetting resin powder coat finish that is **hunter green** in color applied over a hot-dipped galvanized surface.

### 18.3. METHOD OF MEASUREMENT

Actual number of hunter green powder coating for metal strain pole assemblies furnished, installed and accepted.

Actual number of hunter green powder coating for metal CCTV pole assemblies furnished, installed and accepted.

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

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

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

**Actual number of hunter green powder coating for luminaire mast arms furnished, installed and accepted.**

### 18.4. BASIS OF PAYMENT

The quantity of hunter green powder coating for metal strain pole assemblies will be paid for at the contract price for "Powder Coat for Metal Strain Pole."

The quantity of hunter green powder coating for metal CCTV pole assemblies will be paid for at the contract price for "Powder Coat for Metal CCTV Pole."

The quantity of hunter green powder coating for single mast arm with metal pole assemblies will be paid for at the contract price for "Powder Coat for Single Mast Arm with Metal Pole."

The quantity of hunter green powder coating for double mast arms with metal pole assemblies will be paid for at the contract unit price each for "Powder Coat for Double Mast Arm with Metal Pole."

The quantity of hunter green powder coating for pedestrian pedestal assemblies will be paid for at the contract unit price each for "Powder Coat for Pedestrian Pedestal."



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The quantity of hunter green powder coating for luminaire mast arms will be paid for at the contract unit price each for "Powder Coat for Luminaire Mast Arm."

Payment will be made under:

<b>Powder Coat for Metal Strain Pole .....</b>	<b>Each</b>
<b>Powder Coat for Metal CCTV Pole .....</b>	<b>Each</b>
<b>Powder Coat for Single Mast Arm with Metal Pole.....</b>	<b>Each</b>
<b>Powder Coat for Double Mast Arm with Metal Pole .....</b>	<b>Each</b>
<b>Powder Coat for Pedestrian Pedestal .....</b>	<b>Each</b>
<b>Powder Coat for Luminaire Mast Arm.....</b>	<b>Each</b>

**19. RELOCATE EXISTING SIGN**

**19.1. DESCRIPTION**

Relocate existing signs.

**19.2. CONSTRUCTION METHODS**

As directed by the plans, relocate existing signs. Comply with Article 1745-3 Signs Installed for Signals.

**19.3. MEASUREMENT AND PAYMENT**

Actual number of existing signs, regardless of mounting method, relocated and accepted.

Payment will be made under:

<b>Relocate Existing Sign .....</b>	<b>Each</b>
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**20. CONTROLLERS WITH CABINETS**

**20.1. MATERIALS – TYPE 2070L CONTROLLERS**

Conform to CALTRANS *Transportation Electrical Equipment Specifications (TEES)* (11-19-99) 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.

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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.

## 20.2. 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.

### 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 maximum 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

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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  $\mu$ 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  $\Omega$ .

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  $\Omega$  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.

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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.

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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.

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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 with 16 channels. In addition to CALTRANS requirements, ensure the conflict monitor monitors for the absence of a valid voltage level on at least one channel output of each load switch. Ensure that the absence of the programming card will cause the conflict monitor to trigger, and remain in the triggered state until reset.

Provide a conflict monitor that recognizes the faults specified by CALTRANS and the following additional per channel faults that apply for monitor inputs to each channel:

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

Ensure monitor will trigger upon detection of a fault and will remain in the triggered (failure detected) state until unit is reset at the front panel or through the 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 the P20 Connector is installed and 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. **Yellow Indication Sequence Error:** Yellow indication following a green is missing or shorter than 2.7 seconds (with  $\pm 0.1$ -second accuracy). If a channel fails to detect an “on” signal at the Yellow input following the detection of an “on” signal at a Green input for that channel, ensure that the monitor triggers and generates a sequence error fault indication.
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

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displays the proper failure indication (Dual Ind fault). If this condition is detected for less than 250 ms, ensure that the monitor does not trigger.

Enable the monitor function for short/missing yellows and for dual indications on a per channel basis.

Provide Special Function 1 and Special Function 2 that comply with the Los Angeles City DOT *Traffic Signal Specification DOT 170 ATSAC Universal and Related Equipment #54-053-02* to eliminate red failure monitoring while allowing other additional enhanced fault monitoring functions to continue.

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

Ensure that when the Conflict Monitor is triggered due to a fault, it provides an LED indication identifying the type of failure detected by the monitor except for the P20 ribbon cable removal fault. Ensure that the monitor indicates which channels were active during a conflict condition and which channels experienced a failure for all other per channel fault conditions detected, and that these indications and the status of each channel are retained until the Conflict Monitor is reset.

Ensure that the conflict monitor will store at least nine of the most recent malfunctions detected by the monitor in EEPROM memory. For each malfunction, record at a minimum the time, date, type of malfunction, relevant field signal indications, and specific channels involved with the malfunction.

Provide communications from the monitor to the 170/2070L controller via an RS-232C/D port on the monitor in order to upload all event log information from the monitor to the controller or to a Department-furnished system computer via the controller. Ensure that the controller can receive the data through a controller Asynchronous Communications Interface Adapter (Type 170E) or Async Serial Comm Module (2070L) determined by the controller software. Provide software capable of communicating directly through the same monitor RS-232C/D to retrieve all event log information to a Department-furnished laptop computer.

In addition to the connectors required by the CALTRANS Specifications, provide the conflict monitor with a connector mounted on the front of the monitor (3M-3428-5302 with two polarizing keys or equal) which mates with a 20 pin ribbon cable connector that conducts the signals from the P20 connector on the cabinet assembly. Provide a P20 connector and terminal assembly that complies with the Los Angeles City DOT "Traffic Signal Specification DOT 170 ATSAC Universal and Related Equipment #54-053-02". Provide connector pins on the monitor with the following functions:

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

Provide a DB-9 female connector for the purpose of data communication with the controller. Electrically isolate the port interface electronics from all monitor electronics, excluding Chassis Ground. Furnish a communications connecting cable with pin connections as follows:

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<b>170</b>		<b>Conflict Monitor DB-9</b>
RX pin L	Connect to	TX pin 2
TX pin K	Connect to	RX pin 3
+5 pin D	Connect to	DTR pin 4
GND pin N	Connect to	GND pin 5

<b>2070L</b>		<b>Conflict Monitor DB-9</b>
DCD pin 1	Connect to	DCD pin 1
RX pin 2	Connect to	TX pin 2
TX pin 3	Connect to	RX pin 3
GND pin 5	Connect to	GND pin 5
RTS pin 7	Connect to	CTS pin 7
CTS pin 8	Connect to	RTS pin 8

**20.3. 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.