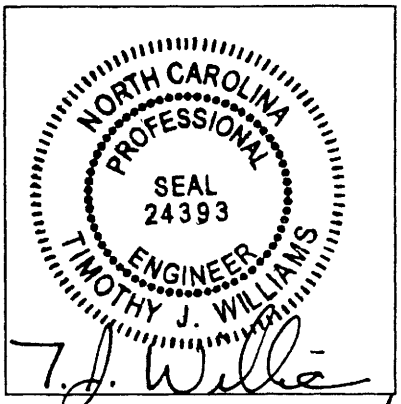


5/8/06.

Project Special Provisions

(Version 02.16b)

Signals and Intelligent Transportation Systems

Prepared By: IOU
8-May-06

Contents

1. 2002 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES – SECTION 1098 REVISIONS 3
1.1. GENERAL REQUIREMENTS (1098-1) 3
1.2. SIGNAL HEADS (1098-2) 3
1.3. WOOD POLES (1098-6) 11
1.4. GUY ASSEMBLIES (1098-7) 11
1.5. LOOP LEAD-IN CABLE (1098-9) 11
1.6. FIBER-OPTIC CABLE (1098-11) 11
1.7. TYPE 170E CABINETS (1098-19) 11
1.8. TYPE 2070L CONTROLLERS (1098-20) 15
1.9. NEMA TS-2 TYPE 1 CABINETS (1098-22) 15

2. 2002 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES – SECTION 1700 REVISIONS 16
2.1. GENERAL REQUIREMENTS (1700) 16
2.2. MESSENGER CABLE (1710) 17
2.3. UNDERGROUND CONDUIT (1715) 17
2.4. WOOD POLES (1720) 17
2.5. RISER ASSEMBLIES (1722) 18
2.6. INDUCTIVE DETECTION LOOPS (1725) 18
2.7. LOOP LEAD-IN CABLE (1726) 18
2.8. CONTROLLERS WITH CABINETS (1751) 18

3. GENERAL REQUIREMENTS 19

4. ELECTRICAL REQUIREMENTS 19

5. FIBER-OPTIC SELF-HEALING RING TRANSCEIVERS 19
5.1. DESCRIPTION 19
5.2. MATERIALS 19
5.3. CONSTRUCTION METHODS 20
5.4. MEASUREMENT AND PAYMENT 20

6. FIBER-OPTIC SYSTEM SUPPORT EQUIPMENT 20
6.1. DESCRIPTION 20
6.2. MATERIALS 20
A. General: *20*
B. SMFO Transceiver (For Emergency Restoration): *20*
6.3. MEASUREMENT AND PAYMENT 20

7. CABINET BASE EXTENDER 20
7.1. DESCRIPTION 20
7.2. MATERIALS 20

7.3. CONSTRUCTION METHODS 20
7.4. MEASUREMENT AND PAYMENT 21

1. 2002 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES – SECTION 1098 REVISIONS

The 2002 Standard Specifications are revised as follows:

1.1. General Requirements (1098-1)

Page 10-220, Subarticle 1098-1(A)

In the last paragraph, sentence 1, revise "by the date of advertisement of the project" to "by the date of materials installation."

Pages 10-222,3 Subarticle 1098-1(H)

Replace paragraphs 2, 3, and 4 with the following paragraphs:

Except for grounding conductors, provide signal cable conductors of size Number 16 AWG that are fabricated from stranded copper. **Number 16 AWG cable can only be used with an all LED traffic signal intersection.** Repairs to a non-LED traffic signal intersection must use Number 14 AWG cable.

Provide either 0.05 x 0.30 inch (1.3 x 7.6 mm) aluminum wrapping tape or 0.06 inch (1.5 mm) stainless steel lashing wire for the purpose of lashing cables, except fiber-optic communications cables, to a messenger cable. Use 0.045-inch (1.14-mm) stainless steel lashing wire for the aerial installation of fiber-optic communications cable to messenger cable.

1.2. Signal Heads (1098-2)

Page 10-223, Subarticle 1098-2(A)

In paragraph 5, sentence 4, revise "1 3/8 inch (32 mm) vertical conduit entrance hubs" to "1 1/4 inch (32 mm) vertical conduit entrance hubs" and revise "1 5/8 inch (40 mm) horizontal hubs" to "1 1/2 inch (40 mm) horizontal hubs."

In the last paragraph, sentence 3, revise "2/5 x 3/4 inch (9.5 mm x 19.1 mm) square head bolts" to "3/8 x 3/4 inch (9.5 mm x 19.1 mm) square head bolts."

Page 10-225, Subarticle 1098-2(C)

Replace paragraphs 2 and 3 with the following paragraphs:

Unless otherwise required by the plans, provide single-section countdown pedestrian heads with 6 inch (150 mm) minimum deep traditional visors that prevent the sun phantom illumination of the indication.

Where required by the plans, provide two-section pedestrian signal heads with traditional three-sided, rectangular visors 12 inches (300 mm) long.

Replace the last paragraph with the following:

Provide lead-in cable that complies with the loop lead-in cable section of these project special provisions.

Pages 10-225-227, Subarticle 1098-2(E) [**Light Emitting Diode (LED) Sections**]

Replace the entire subarticle with the following two subarticles:

(1) Vehicular

Provide light emitting diode (LED) 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°C to +74°C (-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.

Ensure, unless otherwise stated in these specifications, that each module meets or exceeds the requirements 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). Ensure arrow displays meet or exceed the electrical and environmental operating requirements of VTCSH-2 sections 3 and 5, 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. Design the modules to operate from a 60 ±3 HZ AC line voltage ranging from 80 volts to 135 volts. 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, and measure all parameters at this voltage.

Table 1098-1
Maximum Power Consumption (in Watts) at 25°C (77°F)

	Red	Yellow	Green
300 mm circular	17	34	24
200 mm circular	10	16	12
300 mm arrow	9	10	11

Certify that the module has a power factor of 0.90 or greater, and that total harmonic distortion (THD) (current and voltage) induced into an AC power line by the module does not exceed 20 percent for modules with power ratings above 15W, and 40 percent for modules with power ratings of 15W or less. Design the module's onboard circuitry to include voltage surge protection to withstand high repetition noise transients as stated in Section 2.1.6 of NEMA Standard TS-2, 1992. Ensure all wiring meets the requirements of Section 13.02 of the ITE Publication: Equipment and Material Standards, VTCSH-2. Provide 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 greater, and on-state to be 40 Vrms or greater. Design the voltage decay to 10 Vrms or less to be 100 milliseconds or less for green and yellow modules. 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 (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 Tables 1098-2, 3, and 4. Test all ball modules for luminous intensity at 25°C (77°F) to meet 115% of values in tables 1098-2 and 4. 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 modules for maintained luminous intensity (Tables 1098-2, 3, and 4) at 74°C (165°F) (ITE 6.4.2.2). Use LEDs that conform to the chromaticity requirements of VTCSH-2, Section 8.04 throughout the warranty period over the operating temperature range. Make chromaticity coordinate compliance measurements at 25°C (77°F).

Table 1098-2
Specification for 12 inch (300 mm) Extended View Signals

Minimum Luminous Intensity Values (In Candelas)				
Expanded View Vertical Angle	Horizontal Angle (Left/Right)	RED	YELLOW	GREEN
+/-2.5	2.5	339	678	678
	7.5	251	501	501
	12.5	141	283	283
	17.5	77	154	154
+/-7.5	2.5	226	452	452
	7.5	202	404	404
	12.5	145	291	291
	17.5	89	178	178
	22.5	38	77	77
	27.5	16	32	32
+/-12.5	2.5	50	101	101
	7.5	48	97	97
	12.5	44	89	89
	17.5	34	69	69
	22.5	22	44	44
	27.5	16	32	32
+/-17.5	2.5	22	44	44
	7.5	22	44	44
	12.5	22	44	44
	17.5	22	44	44
	(Not Extended View) 22.5	20	41	41
	(Not Extended View) 27.5	16	32	32
+/-22.5	2.5	20	40	40
	17.5	20	40	40

Notes

1. Design signal modules to meet these requirements as a minimum throughout the warranty period.
2. Design signal modules to have a minimum initial intensity equal to 115% of Table 2 at 25°C.
3. Independent laboratory test reports are required to validate the initial intensity.

Table 1098-3
Minimum Initial and maintained Intensities for Arrow Indications (in cd/m2)

	Red	Yellow	Green
Arrow Indication	5,500	11,000	11,000

Table 1098-4
Specification for 8 inch (200 mm) Extended View Signals

Minimum Luminous Intensity Values (In Candelas)for circular indications				
Expanded View Vertical Angle	Horizontal Angle (Left/Right)	RED	YELLOW	GREEN
+/-2.5	2.5	133	267	267
	7.5	97	194	194
	12.5	57	113	113
	17.5	25	48	48
+/-7.5	2.5	101	202	202
	7.5	89	178	178
	12.5	65	129	129
	17.5	41	81	81
	22.5	18	37	37
	27.5	10	20	20
+/-12.5	2.5	37	73	73
	7.5	32	65	65
	12.5	28	57	57
	17.5	20	41	41
	22.5	12	25	25
	27.5	9	16	16
+/-17.5	2.5	16	32	32
	7.5	14	28	28
	12.5	10	20	20
	17.5	9	16	16
	(Not Extended View) 22.5	6	12	12
	(Not Extended View) 27.5	4	9	9

Notes

4. Design signal modules to meet these requirements as a minimum throughout the warranty period.
5. Design signal modules to have a minimum initial intensity equal to 115% of Table 4 at 25°C.
6. Independent laboratory test reports are required to validate the initial intensity.

Table 1098-5
Chromaticity Standards (CIE Chart)

Red	Y: not greater than 0.308, or less than 0.998 - x
Yellow	Y: not less than 0.411, nor less than 0.995 - x, nor less than 0.452
Green	Y: Not less than 0.506 -.519x, nor less than 0.150 + 1.068x, nor more than 0.730 - x

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°C (-40°F) to +74°C (+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. Wire 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 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 and yellow lens to match the wavelength (chromaticity) of the LED. Provide a green lens that is either colorless or tinted to match the wavelength (chromaticity) of the LED.

For 12-inch (300-mm) arrow modules, ensure that the module meets specifications stated in Section 9.01 of the ITE VTCSH 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.

Provide test results for ball modules from an independent testing laboratory showing wattage and compliance with ITE VTCSH-2 specifications 6.4.2, 6.4.4.1, 6.4.4.2, 6.4.4.3, 6.4.5, and 6.4.6.1 as a minimum. Ensure the 6.4.2.1 test meets the requirements of Tables 1098-2 and 4 of this specification. The 6.4.2.2 test is for Red and Green only. Ensure that the LED signal modules tested are typical, average production units.

Burn In - Energize the sample module(s) (a sample of one module minimum) for a minimum of 24 hours, at 100 percent on-time duty cycle, at a temperature of +74°C (+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 +25°C (+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 +25°C (+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)

Equipment Compatibility - In addition to the 6.4.4.5 test of modules for compatibility with controllers, conflict monitors, and load switches, perform the following test, and certify the results. Connect each signal module to the output of a standard load switch connected to a variable AC voltage supply (95 to 135 VAC). With the load switch "off," vary the AC voltage from 95 Vrms to 135 Vrms, and measure the drop across the module. Readings greater than 15 Vrms are unacceptable.

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 (300-mm) ball module is visible at 450 feet (135 meters) during sway conditions (extended view) until obscured by the visor. Ensure each 8-inch ball (200-mm) and 12-inch (300-mm) arrow modules are visible at 300 feet (90 meters) 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 shipment acceptance of the modules. Provide replacement modules within 30 days of receipt of modules that have failed at no cost to the State. Provide warranty documentation to the Department before QPL acceptance. Provide luminous intensity testing at an independent lab, to determine degradation, for two modules of each color provided by NCDOT at the end of two and four years of operation.

Provide testing at an independent laboratory for a designated module to be tested for maintained luminous intensity at 25°C (77°F) once each year during the five year warranty period.

(2) Pedestrian

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 (6.4-mm), 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 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.

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*. Wire 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.

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 (25°C)	165°F (74°C)
Hand	10	12
Man	9	12
Countdown	9	12

Provide 16-inch (400-mm) displays, where required by plan or bid document, that have the hand/man overlay on the left and the countdown on the right. Ensure the hand/man meets the dimension requirements cited in Chapter 3, Table 1 *Symbol Message* for Class 3 displays. Ensure that the countdown number display is at least 7 inches high by 6 inches wide. Configure the signal head with a sufficient number of LEDs to provide an average luminous intensity of at least 342 candela per square feet (3750 candela per square meter) of lighting surface for the "RAISED HAND" and "COUNTDOWN", and 483 candela per square feet (5300 candela per square meter) of lighting surface for the "WALKING PERSON". Ensure they meet this average luminous intensity throughout the warranty period over the operating temperature range.

Provide 12 inch (300 mm) displays, where required by plan or bid document, that meet the dimension requirements cited in Chapter 3, Table 1 *Symbol Message* for Class 2 displays. Furnish three types of modules, the solid hand/man module as an overlay, the solid hand module, and the solid man module. Configure the signal head with a sufficient number of LEDs to provide an average luminous intensity of at least 342 candela per square feet (3750 candela per square meter) of lighting surface for the "RAISED HAND" and "COUNTDOWN", and 483 candela per square feet (5300 candela per square meter) of lighting surface for the "WALKING PERSON". Ensure they meet this average luminous intensity 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 (105 degree C) insulation. Ensure that lead wires are a minimum of 30 inches (760 mm) 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. Solder the LEDs to the circuit board.

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, 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 "The Equipment and Material Standards" of the Institute of Transportation Engineers "Vehicular Traffic Control Signal Heads" (VTCSH) Part 2, Chapter 2A.

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

Provide certification with the signal modules when offered for evaluation that your product complies with the sections of the ITE specification identified in paragraph 1.12 above and this specification. Provide test results showing that the signal modules meet or exceed the luminous intensity requirements of sections 1.8 and 1.9 of this specification.

Ship each module as a complete kit designed for retrofitting existing pedestrian signal sections with an LED display module. 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 (45 meters) in bright sunlight with a visor on the housing or which drops below the luminous intensity output requirements. Warrant failure due to workmanship, materials, and manufacturing defects during the first 60 months after the date of installation. Repair or replace any failed modules within 30 calendar days of notification at no cost to the Department.

Page 10-227, Subarticle 1098-2(F)

Replace the first sentence in the paragraph with the following:

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.

1.3. Wood Poles (1098-6)

Page 10-228, Article 1098-6

Replace the entire article with the following:

Provide poles of treated southern pine or treated Douglas fir that meet the requirements of ANSI 05.1. Provide Class 3 or better wood poles that are a minimum length of 40 feet (12.2 meters) unless otherwise shown on the plans and are of a sufficient length to maintain minimum required distances above the roadway, obstructions and affected railroad tracks. Mark each pole in accordance with ANSI 05.01. First roof and bore poles and then give them a full-length preservative treatment.

Provide poles with pentachlorophenol or chromated copper arsenate (CCA) preservative, in accordance with AWPA Standard C4-99. Ensure the retention of preservative is a minimum of 0.45 lb. per cubic foot (7.2 kg per cubic meter) for pentachlorophenol and 0.6 lb. per cubic foot (9.6 kg per cubic meter) for CCA.

1.4. Guy Assemblies (1098-7)

Page 10-228, Article 1098-7

Add the following to paragraph two:

Anchor assemblies with double-strand eyes may be used in lieu of those with the tripleye feature when only one guy cable is to be attached. Ensure anchor assemblies are 7 feet (2.13 meters) minimum in length.

1.5. Loop Lead-In Cable (1098-9)

Page 10-230, Article 1098-9

Replace the entire article with the following:

Furnish lead-in cable with conductors of size 18 AWG that are fabricated from stranded copper, and that complies with IMSA Specification 50-2 except as follows:

- Provide the following two pair (4 conductor) conductor insulation pair colors: clear-brown and blue-pink.
- Provide the following four pair (8 conductor) conductor insulation pair colors: clear-brown, blue-pink, clear with black stripe tracer-brown with black stripe tracer, and blue with black stripe tracer-pink with black stripe tracer. Apply continuous stripe tracer on conductor insulation with a longitudinal or spiral pattern.
- Ensure one spirally-wrapped Aluminum Mylar tape is applied with the aluminum side out to completely cover the conductor assembly.
- Provide cable jacket formed from black polyethylene. Ensure the finished jacket provides environmental stress resistance, outdoor weatherability, toughness, low temperature performance, and ultraviolet resistance.
- Provide a ripcord to allow the cable jacket to be opened without using a cutter.

1.6. Fiber-optic Cable (1098-11)

Page 10-233, Subarticle 1098-11(A)

In paragraph 3, sentence 5, delete "Construct buffer tubes with an inner layer made of polycarbonate and an outer layer made of polyester."

1.7. Type 170E Cabinets (1098-19)

Page 10-241, Subarticle 1098-19(B)

Add the following paragraphs:

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 call 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

Pages 10-245-247, Subarticle 1098-19 (D) **(Model 2010 Enhanced Conflict Monitor)**

Replace Subarticle (D) with the following:

Furnish Model 2010 Enhanced Conflict Monitors with 16 channels. In addition to CALTRANS requirements, ensure that 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 that the monitor will trigger upon detection of a fault and will remain in the triggered (failure detected) state until the 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 valid 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 that the monitor will trigger and put the

intersection into flash. If the absence of any indication condition lasts less that 750 ms when used with a 170 controller and 1200 ms when used with a 2070L controller, ensure that the conflict monitor will not trigger. Have red monitoring occur when the P20 Connector is installed and both of the following input conditions are in effect: a) the 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 Vrms and 70 Vrms), and b) and 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 ± 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 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" in effect on the date of advertisement. 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:

170		**Conflict Monitor DB-9**
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

2070L		**Conflict Monitor DB-9**
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

Pages 10-247, Subarticle 1098-19(E)

Replace Subarticle (E) with the following:

Furnish external electrical service disconnects with a single pole 50 ampere circuit breaker with a minimum of 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure. Ensure service disconnects are UL listed and marked as being suitable for use as service equipment. Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint finish, light gray in color, to yield a minimum thickness of 2.4 mils (60 μm). Provide ground bus and neutral bus with a minimum of four terminals with a minimum wire capacity range of number 14 through number 4.

Furnish a NEMA Type 3R outdoor enclosure, 100 Ampere rated meter base. Furnish a 4 terminal, 600 volt, single phase, 3 wire meter base that complies with the following:

- Line, Load, and Neutral Terminals accept #8 to 2/0 AWG Copper/Aluminum wire

- Ringless Type without bypass
- Made of galvanized steel
- Meet the UL-414 standard
- Overhead and underground service entrance

Provide meter bases in which the ampere rating of the meter sockets are based on the meter sockets being wired with a minimum of 167 degrees F (75 degrees C) insulated wire. Ensure that the meter bases have an electrostatically applied dry powder paint finish, light gray in color, with a minimum thickness of 2.4 mils (60 μm).

Furnish 1-inch (25-mm) watertight hub for threaded rigid conduit with meter base.

If meter base and electrical service disconnect are supplied in the same enclosure, ensure assembly is UL listed and marked as being suitable for use as service equipment.

1.8. Type 2070L Controllers (1098-20)

Page 10-247, Article 1098-20

Replace the entire article with the following:

Conform to CALTRANS Traffic Signal Control Equipment Specifications and all addenda in effect on the date of advertisement except as required herein. Where an item is no longer cited, the last applicable specification applies.

Furnish Model 2070L controllers. Ensure that removal of the program 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.

Furnish one removable data key with each 2070L controller unit.

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.

1.9. NEMA TS-2 Type 1 Cabinets (1098-22)

Page 10-251, Subarticle 1098-22(B)

In paragraph 1, sentence 3, revise "latching plate at least 1/8 inch (4.5 mm) thick" to "latching plate at least 3/16 inch (4.5 mm) thick."

Pages 10-257, Subarticle 1098-22(D)

Replace Subarticle (D) with the following:

Furnish external electrical service disconnects with a single pole 50 ampere circuit breaker with a minimum of 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure. Ensure service disconnects are UL listed and marked as being suitable for use as service equipment. Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint finish, light gray in color, to yield a minimum thickness of 2.4 mils (60 μm). Provide ground bus and neutral bus with a minimum of four terminals with a minimum wire capacity range of number 14 through number 4.

Furnish a NEMA Type 3R outdoor enclosure, 100 Ampere rated meter base. Furnish a 4 terminal, 600 volt, single phase, 3 wire meter base that complies with the following:

- Line, Load, and Neutral Terminals accept #8 to 2/0 AWG Copper/Aluminum wire
- Ringless Type without bypass
- Made of galvanized steel
- Meet the UL-414 standard
- Overhead and underground service entrance

Provide meter bases in which the ampere rating of the meter sockets are based on the meter sockets being wired with a minimum of 167 degrees F (75 degrees C) insulated wire. Ensure that the meter bases have an electrostatically applied dry powder paint finish, light gray in color, with a minimum thickness of 2.4 mils (60 μm).

Furnish 1-inch (25-mm) watertight hub for threaded rigid conduit with meter base.

If meter base and electrical service disconnect are supplied in the same enclosure, ensure assembly is UL listed and marked as being suitable for use as service equipment.

2. 2002 Standard Specifications for Roads & Structures – Section 1700 Revisions

The 2002 <u>Standard Specifications</u> are revised as follows:

2.1. General Requirements (1700)

Page 17-1, Subarticle 1700-3 (C), replace the 3rd paragraph with the following paragraph:

The Department will be responsible for direct payment of monthly utility company usage charges. The Contractor will be responsible for all expenses associated with utility installation costs, hookups, etc.

Page 17-2, Subarticle 1700-3 (D), add the following paragraph:

Except for damages and malfunctions caused by the contractor's work activities, the contractor will not be held responsible for pre-existing conditions that were reported to the Engineer before starting traffic signal work at the specific intersection. The contractor will assume responsibility for all maintenance and emergency services necessary once traffic signal work has begun at the specific intersection, and for all damages and malfunctions caused either directly or indirectly by the contractor's work activities.

In the event the contractor fails to perform in accordance with the plans and specifications within the time frame specified, the Department reserves the right to perform the maintenance and emergency service necessary to assure continuous traffic signal operation. Further, all expenses incurred by the Department in implementing this option will be deducted from the payment due the contractor, plus a $2,500 liquidated damage per occasion, per day, or any portion thereof, until corrected. The liquidated damages are due to increased public hazard resulting from the malfunction.

Page 17-2, Subarticle 1700-3 (F)

In paragraph 2, sentence 2, delete "type 1."

Page 17-3, Subarticle 1700-3 (J)

In paragraph 2, sentence 2, revise "detectable metallic burial tape" to "marker tape."

Page 17-3, Article 1700-3, add Subarticle (K) to read as follows:

(K) Electrical Bonding

Using an approved termination means, connect a Number 14 AWG min. 19-strand copper conductor (Type THW) with green insulation to serve as an equipment grounding conductor to metal poles with mast arm supports, vehicular and pedestrian signal pedestals, and other metallic components which are not otherwise bonded through means approved by the Engineer.

2.2. Messenger Cable (1710)

Page 17-6, Article 1710-3

In paragraph 5, revise "provide a minimum of 30 feet (9.1 m)" to "provide a minimum of 27 feet (8.2 m)".

2.3. Underground Conduit (1715)

Page 17-8, Subarticle 1715-3(A)

Add the following paragraph:

Install metallic conduit at all locations where conduits traverse railroad tracks or as shown on the plans. For all other locations, install nonmetallic conduit unless otherwise shown on the plans. Backfill with excavated material and compact to 95% of its original density. Remove any rock and debris from backfill material.

Page 17-8, Subarticle 1715-3(C)

Delete the first paragraph.

Page 17-8, Subarticle 1715-3(D)

Replace reference to Article 342-3 with reference to Article 1540-3 (A&B).

Page 17-8, Subarticle 1715-3(E)

Revise the last sentence to:

Label all tracer wires. Terminate tracer wire to equipment ground bus as specified in the plans.

2.4. Wood Poles (1720)

Page 17-10, Article 1720-3

Replace the fourth paragraph with the following paragraph:

On joint use poles and NCDOT owned poles, at signal and intelligent transportation systems equipment installations (i.e. controller cabinets, CCTV cabinets, DMS cabinets, etc.), bond the messenger cable to the existing pole ground using burndy clamps at each end and at 1300-foot intervals. On multiple messenger cable arrangements, connect all messenger cable ends with #6 solid bare copper wire and bond with split bolt connectors or burndy clamps (UCG25RS) or equivalent. On joint use and NCDOT owned poles, if an existing pole ground does not exist, install a grounding system consisting of a #6 AWG bare copper wire that is exothermically welded to a ground rod.

In the last paragraph, last sentence, revise "5/8 inch x 8 foot (16 mm x 2.4 m) ground rod" to "5/8 inch x 10 foot (16 mm x 3.0 m) ground rod."

2.5. Riser Assemblies (1722)

Page 17-12, Article 1722-3

In paragraph 4 add the following after the last sentence:

Install condulet on all risers for lead-in cable.

2.6. Inductive Detection Loops (1725)

Page 17-13, Article 1725-3

Add the following paragraph before paragraph 1:

All work performed in this section must be done in the presence of the Engineer.

Replace paragraph 6 with the following:

Before sealing loop conductors, test that impedance from the loop wire to ground is at least 100 megohms. For each location with inductive loops, submit a completed "Inductive Detection Loop & Grounding Test Results" form and place copy in controller cabinet. Ensure all loops are included on form. The form is located on the Department's website at:

http://www.ncdot.org/doh/preconstruct/traffic/tmssu/ws/default.htm

2.7. Loop Lead-In Cable (1726)

Page 17-14, Article 1726-3

Replace paragraph 1 with the following:

Install lead-in cable.

Delete paragraph 3.

In paragraph 4, delete "type 1."

In paragraph 6, revise "less than 0.0036 ohms per foot (0.012 ohms per meter)" to "less than 0.00885 ohms per foot (0.0295 ohms per meter)."

Page 17-15, Article 1726-4

Replace the last sentence with the following:

No measurement will be made between 2-pair and 4-pair lead-in cable as this will be considered incidental to furnishing and installing lead-in cable.

2.8. Controllers with Cabinets (1751)

Page 17-34, Subarticle 1751-3(A)

In paragraph 3, replace sentence 2 with the following:

For all other installations, do not program the controller for late night flashing operation unless otherwise directed.

Page 17-34, Subarticle 1751-3(B)

Add the following paragraph after the first paragraph:

Program telemetry command sequences and enable devices necessary for testing of communication between local controllers and field master controllers, and between field master controllers and the Department-furnished central computer.

Page 17-34, Article 1751-4

Replace paragraph 2 with the following:

Actual number of each type of detector cards (2-channels) furnished, installed, and accepted. If 4-channel detector cards are used in order to fulfill the requirements of the plans, payment will be allowed for two detector cards for each 4-channel detector card.

In paragraph 3, revise "No measurement will be made..." to include "modems and meter bases."

Page 17-35, Article 1751-5

Replace paragraph 2 with the following:

The quantity of detector cards, measured as provided above, will be paid for at the contract unit price each for "Detector Card (_____)."

In paragraph 3, revise "Detector Channel" to "Detector Card."

3. GENERAL REQUIREMENTS

Comply with the requirements of Division 17 of the 2002 Standard Specifications for Roads and Structures.

4. 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.

5. FIBER-OPTIC SELF-HEALING RING TRANSCEIVERS

5.1. DESCRIPTION

Furnish and install fiber-optic self-healing ring transceivers with all necessary hardware in accordance with the plans and specifications.

Furnish shelf mounted, modular designed, single mode, self-healing-ring fiber-optic transceivers and all necessary hardware that are compatible with the system equipment and designed for RS-232 drop-and-repeat communications. Do not provide transceivers that are internal to the system equipment. Provide identical transceivers at all locations that are capable of being interchanged throughout the system.

5.2. MATERIALS

Furnish shelf mounted, self-healing ring fiber-optic transceivers that are capable of supporting RS-232 C/D, RS-422, or RS 485 protocols and support communications in an asynchronous, simplex or full-duplex operating mode. Ensure transceivers are switch selectable for either local or master operation. Ensure that transceivers are capable of operating at distances up to 5 miles (8 kilometers) without the need to boost the signal and without distortion of the signal.

Provide LEDs on the front panel of transceivers for power, and transmitting and receiving indication. Comply with the following:

Input Power:	115 VAC
Minimum Loss Budget:	12dB with corresponding receiver
Operating Wavelength:	1310 or 1550nm
Optical Connector:	ST
Signal Connector:	Female Plug Type

Temperature Range: 0 to 150 degrees F (-17 to 65 degrees C)

5.3. CONSTRUCTION METHODS

Install fiber-optic self-healing ring transceivers in each equipment cabinet and comply with the manufacturer's installation instructions.

5.4. MEASUREMENT AND PAYMENT

Actual number of fiber-optic self-healing ring transceivers furnished, installed, and accepted.

Payment will be made under:

Fiber-Optic Transceiver – Self-Healing Ring.....Each

6. FIBER-OPTIC SYSTEM SUPPORT EQUIPMENT

6.1. DESCRIPTION

Furnish fiber-optic system support equipment with all necessary hardware in accordance with the plans and specifications.

6.2. 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 fiber-optic system support equipment.

B. 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.

6.3. MEASUREMENT AND PAYMENT

Actual number of fiber-optic transceivers furnished and accepted.

Payment will be made under:

Furnish Fiber-optic Transceiver.....Each

7. CABINET BASE EXTENDER

7.1. DESCRIPTION

Furnish and install cabinet base extenders in accordance with the plans and specifications.

7.2. MATERIALS

Fabricate base extenders out of the same materials and with the same finish as the cabinet housing. Fabricate the base extender in the same manner as the controller cabinets, meeting all applicable specifications called for in Section 6.2.2 of the CALTRANS Traffic Signal Control Equipment Specifications (TSCES). Provide base extenders that are a minimum height of 12 inches (300 mm).

7.3. CONSTRUCTION METHODS

Install a cabinet base **extender** at every location requiring a new Model 332A cabinet on a new foundation or an existing Model 332A cabinet that does not have a cabinet base extender.

Use a permanent, flexible waterproof sealing material to:

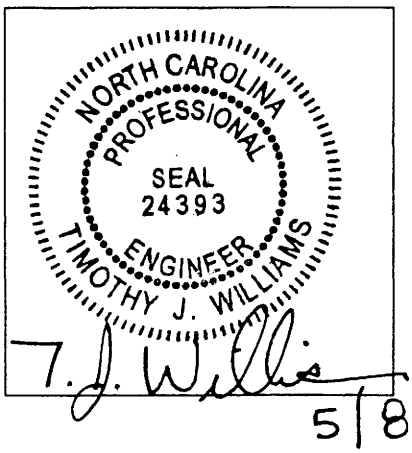
- Seal between the base of the cabinet and the cabinet base extender,
- Seal the seams of a two-piece cabinet base extender, and
- Seal the space between the cabinet base extender and the foundation.

7.4. MEASUREMENT AND PAYMENT

Actual number of cabinet base extenders furnished, installed, and accepted.

Payment will be made under:

Cabinet Base Extender.....Each



Project Special Provisions

(Version 02.16b)

Signals and Intelligent Transportation Systems

Prepared By: IOU
8-May-06

Contents

1. 2002 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES – SECTION 1098 REVISIONS 3
1.1. GENERAL REQUIREMENTS (1098-1) 3
1.2. SIGNAL HEADS (1098-2) 3
1.3. WOOD POLES (1098-6) 11
1.4. GUY ASSEMBLIES (1098-7) 11
1.5. LOOP LEAD-IN CABLE (1098-9) 11
1.6. FIBER-OPTIC CABLE (1098-11) 11
1.7. TYPE 170E CABINETS (1098-19) 11
1.8. TYPE 2070L CONTROLLERS (1098-20) 15
2. 2002 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES – SECTION 1700 REVISIONS 15
2.1. GENERAL REQUIREMENTS (1700) 15
2.2. MESSENGER CABLE (1710) 16
2.3. UNDERGROUND CONDUIT (1715) 16
2.4. WOOD POLES (1720) 17
2.5. RISER ASSEMBLIES (1722) 17
2.6. INDUCTIVE DETECTION LOOPS (1725) 17
2.7. LOOP LEAD-IN CABLE (1726) 17
2.8. CONTROLLERS WITH CABINETS (1751) 18
3. GENERAL REQUIREMENTS 18
4. ELECTRICAL REQUIREMENTS 18
5. DIRECTIONAL DRILLING 19
5.1. DESCRIPTION 19
5.2. MATERIALS 19
A. General: *19*
B. Polyethylene Conduit: *19*
5.3. CONSTRUCTION METHODS 19
A. Pre-Approvals and Minimum Depth Requirements: *19*
B. Directional Drill Operations: *20*
C. Drilling Fluids: *21*
D. Splicing of the Conduit: *21*
E. Duct Plugs and Mechanical Sealing Devices: *21*
F. Plan of Record Drawings: *21*
5.4. MEASUREMENT AND PAYMENT 22
6. FIBER-OPTIC SELF-HEALING RING TRANSCEIVERS 22
6.1. DESCRIPTION 22
6.2. MATERIALS 22

6.3. CONSTRUCTION METHODS 22
6.4. MEASUREMENT AND PAYMENT 22

7. FIBER-OPTIC SYSTEM SUPPORT EQUIPMENT 23
7.1. DESCRIPTION 23
7.2. MATERIALS 23
A. General: *23*
B. SMFO Transceiver (For Emergency Restoration): *23*
7.3. MEASUREMENT AND PAYMENT 23

8. METAL TRAFFIC SIGNAL SUPPORTS 23
8.1. METAL TRAFFIC SIGNAL SUPPORTS – ALL POLES 23
A. General: *23*
B. Materials: *24*
C. Construction Methods: *24*
8.2. METAL STRAIN POLE 25
A. Materials: *25*
B. Construction Methods: *25*
8.3. DRILLED PIER FOUNDATIONS FOR METAL TRAFFIC SIGNAL POLES 25
A. Description: *25*
B. Soil Test and Foundation Determination: *26*
C. Drilled Pier Construction: *28*
8.4. MEASUREMENT AND PAYMENT 32

9. CABINET BASE EXTENDER 32
9.1. DESCRIPTION 32
9.2. MATERIALS 32
9.3. CONSTRUCTION METHODS 32
9.4. MEASUREMENT AND PAYMENT 33

1. 2002 Standard Specifications for Roads & Structures – Section 1098 Revisions

The 2002 Standard Specifications are revised as follows:

1.1. General Requirements (1098-1)

Page 10-220, Subarticle 1098-1(A)

In the last paragraph, sentence 1, revise "by the date of advertisement of the project" to "by the date of materials installation."

Pages 10-222,3 Subarticle 1098-1(H)

Replace paragraphs 2, 3, and 4 with the following paragraphs:

Except for grounding conductors, provide signal cable conductors of size Number 16 AWG that are fabricated from stranded copper. **Number 16 AWG cable can only be used with an all LED traffic signal intersection.** Repairs to a non-LED traffic signal intersection must use Number 14 AWG cable.

Provide either 0.05 x 0.30 inch (1.3 x 7.6 mm) aluminum wrapping tape or 0.06 inch (1.5 mm) stainless steel lashing wire for the purpose of lashing cables, except fiber-optic communications cables, to a messenger cable. Use 0.045-inch (1.14-mm) stainless steel lashing wire for the aerial installation of fiber-optic communications cable to messenger cable.

1.2. Signal Heads (1098-2)

Page 10-223, Subarticle 1098-2(A)

In paragraph 5, sentence 4, revise "1 3/8 inch (32 mm) vertical conduit entrance hubs" to "1 1/4 inch (32 mm) vertical conduit entrance hubs" and revise "1 5/8 inch (40 mm) horizontal hubs" to "1 1/2 inch (40 mm) horizontal hubs."

In the last paragraph, sentence 3, revise "2/5 x 3/4 inch (9.5 mm x 19.1 mm) square head bolts" to "3/8 x 3/4 inch (9.5 mm x 19.1 mm) square head bolts."

Page 10-225, Subarticle 1098-2(C)

Replace paragraphs 2 and 3 with the following paragraphs:

Unless otherwise required by the plans, provide single-section countdown pedestrian heads with 6 inch (150 mm) minimum deep traditional visors that prevent the sun phantom illumination of the indication.

Where required by the plans, provide two-section pedestrian signal heads with traditional three-sided, rectangular visors 12 inches (300 mm) long.

Replace the last paragraph with the following:

Provide lead-in cable that complies with the loop lead-in cable section of these project special provisions.

Pages 10-225-227, Subarticle 1098-2(E) **[Light Emitting Diode (LED) Sections]**

Replace the entire subarticle with the following two subarticles:

(1) Vehicular

Provide light emitting diode (LED) 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°C to +74°C (-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.

Ensure, unless otherwise stated in these specifications, that each module meets or exceeds the requirements 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). Ensure arrow displays meet or exceed the electrical and environmental operating requirements of VTCSH-2 sections 3 and 5, 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. Design the modules to operate from a 60 ±3 HZ AC line voltage ranging from 80 volts to 135 volts. 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, and measure all parameters at this voltage.

Table 1098-1
Maximum Power Consumption (in Watts) at 25°C (77°F)

	Red	Yellow	Green
300 mm circular	17	34	24
200 mm circular	10	16	12
300 mm arrow	9	10	11

Certify that the module has a power factor of 0.90 or greater, and that total harmonic distortion (THD) (current and voltage) induced into an AC power line by the module does not exceed 20 percent for modules with power ratings above 15W, and 40 percent for modules with power ratings of 15W or less. Design the module's onboard circuitry to include voltage surge protection to withstand high repetition noise transients as stated in Section 2.1.6 of NEMA Standard TS-2, 1992. Ensure all wiring meets the requirements of Section 13.02 of the ITE Publication: Equipment and Material Standards, VTCSH-2. Provide 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 greater, and on-state to be 40 Vrms or greater. Design the voltage decay to 10 Vrms or less to be 100 milliseconds or less for green and yellow modules. 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 (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 Tables 1098-2, 3, and 4. Test all ball modules for luminous intensity at 25°C (77°F) to meet 115% of values in tables 1098-2 and 4. 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 modules for maintained luminous intensity (Tables 1098-2, 3, and 4) at 74°C (165°F) (ITE 6.4.2.2). Use LEDs that conform to the chromaticity requirements of VTCSH-2, Section 8.04 throughout the warranty period over the operating temperature range. Make chromaticity coordinate compliance measurements at 25°C (77°F).

Table 1098-2
Specification for 12 inch (300 mm) Extended View Signals

Minimum Luminous Intensity Values (In Candelas)				
Expanded View Vertical Angle	Horizontal Angle (Left/Right)	RED	YELLOW	GREEN
+/-2.5	2.5	339	678	678
	7.5	251	501	501
	12.5	141	283	283
	17.5	77	154	154
+/-7.5	2.5	226	452	452
	7.5	202	404	404
	12.5	145	291	291
	17.5	89	178	178
	22.5	38	77	77
	27.5	16	32	32
+/-12.5	2.5	50	101	101
	7.5	48	97	97
	12.5	44	89	89
	17.5	34	69	69
	22.5	22	44	44
	27.5	16	32	32
+/-17.5	2.5	22	44	44
	7.5	22	44	44
	12.5	22	44	44
	17.5	22	44	44
	(Not Extended View) 22.5	20	41	41
	(Not Extended View) 27.5	16	32	32
+/-22.5	2.5	20	40	40
	17.5	20	40	40

Notes
1. Design signal modules to meet these requirements as a minimum throughout the warranty period.
2. Design signal modules to have a minimum initial intensity equal to 115% of Table 2 at 25°C.
3. Independent laboratory test reports are required to validate the initial intensity.

Table 1098-3
Minimum Initial and maintained Intensities for Arrow Indications (in cd/m2)

	Red	Yellow	Green
Arrow Indication	5,500	11,000	11,000

Table 1098-4
Specification for 8 inch (200 mm) Extended View Signals

Minimum Luminous Intensity Values (In Candelas)for circular indications				
Expanded View Vertical Angle	Horizontal Angle (Left/Right)	RED	YELLOW	GREEN
+/-2.5	2.5	133	267	267
	7.5	97	194	194
	12.5	57	113	113
	17.5	25	48	48
+/-7.5	2.5	101	202	202
	7.5	89	178	178
	12.5	65	129	129
	17.5	41	81	81
	22.5	18	37	37
	27.5	10	20	20
+/-12.5	2.5	37	73	73
	7.5	32	65	65
	12.5	28	57	57
	17.5	20	41	41
	22.5	12	25	25
	27.5	9	16	16
+/-17.5	2.5	16	32	32
	7.5	14	28	28
	12.5	10	20	20
	17.5	9	16	16
	(Not Extended View) 22.5	6	12	12
	(Not Extended View) 27.5	4	9	9

Notes

4. Design signal modules to meet these requirements as a minimum throughout the warranty period.
5. Design signal modules to have a minimum initial intensity equal to 115% of Table 4 at 25°C.
6. Independent laboratory test reports are required to validate the initial intensity.

Table 1098-5
Chromaticity Standards (CIE Chart)

Red	Y: not greater than 0.308, or less than 0.998 - x
Yellow	Y: not less than 0.411, nor less than 0.995 - x, nor less than 0.452
Green	Y: Not less than 0.506 -.519x, nor less than 0.150 + 1.068x, nor more than 0.730 - x

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°C (-40°F) to +74°C (+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. Wire 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 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 and yellow lens to match the wavelength (chromaticity) of the LED. Provide a green lens that is either colorless or tinted to match the wavelength (chromaticity) of the LED.

For 12-inch (300-mm) arrow modules, ensure that the module meets specifications stated in Section 9.01 of the ITE VTCSH 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.**

Provide test results for ball modules from an independent testing laboratory showing wattage and compliance with ITE VTCSH-2 specifications 6.4.2, 6.4.4.1, 6.4.4.2, 6.4.4.3, 6.4.5, and 6.4.6.1 as a minimum. Ensure the 6.4.2.1 test meets the requirements of Tables 1098-2 and 4 of this specification. The 6.4.2.2 test is for Red and Green only. Ensure that the LED signal modules tested are typical, average production units.

Burn In - Energize the sample module(s) (a sample of one module minimum) for a minimum of 24 hours, at 100 percent on-time duty cycle, at a temperature of +74°C (+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 +25°C (+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 +25°C (+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)

Equipment Compatibility - In addition to the 6.4.4.5 test of modules for compatibility with controllers, conflict monitors, and load switches, perform the following test, and certify the results. Connect each signal module to the output of a standard load switch connected to a variable AC voltage supply (95 to 135 VAC). With the load switch "off," vary the AC voltage from 95 Vrms to 135 Vrms, and measure the drop across the module. Readings greater than 15 Vrms are unacceptable.

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 (300-mm) ball module is visible at 450 feet (135 meters) during sway conditions (extended view) until obscured by the visor. Ensure each 8-inch ball (200-mm) and 12-inch (300-mm) arrow modules are visible at 300 feet (90 meters) 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 shipment acceptance of the modules. Provide replacement modules within 30 days of receipt of modules that have failed at no cost to the State. Provide warranty documentation to the Department before QPL acceptance. Provide luminous intensity testing at an independent lab, to determine degradation, for two modules of each color provided by NCDOT at the end of two and four years of operation.

Provide testing at an independent laboratory for a designated module to be tested for maintained luminous intensity at 25°C (77°F) once each year during the five year warranty period.

(2) Pedestrian

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 (6.4-mm), 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 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.

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*. Wire 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.

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 (25°C)	165°F (74°C)
Hand	10	12
Man	9	12
Countdown	9	12

Provide 16-inch (400-mm) displays, where required by plan or bid document, that have the hand/man overlay on the left and the countdown on the right. Ensure the hand/man meets the dimension requirements cited in Chapter 3, Table 1 *Symbol Message* for Class 3 displays. Ensure that the countdown number display is at least 7 inches high by 6 inches wide. Configure the signal head with a sufficient number of LEDs to provide an average luminous intensity of at least 342 candela per square feet (3750 candela per square meter) of lighting surface for the "RAISED HAND" and "COUNTDOWN", and 483 candela per square feet (5300 candela per square meter) of lighting surface for the "WALKING PERSON". Ensure they meet this average luminous intensity throughout the warranty period over the operating temperature range.

Provide 12 inch (300 mm) displays, where required by plan or bid document, that meet the dimension requirements cited in Chapter 3, Table 1 *Symbol Message* for Class 2 displays. Furnish three types of modules, the solid hand/man module as an overlay, the solid hand module, and the solid man module. Configure the signal head with a sufficient number of LEDs to provide an average luminous intensity of at least 342 candela per square feet (3750 candela per square meter) of lighting surface for the "RAISED HAND" and "COUNTDOWN", and 483 candela per square feet (5300 candela per square meter) of lighting surface for the "WALKING PERSON". Ensure they meet this average luminous intensity 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 (105 degree C) insulation. Ensure that lead wires are a minimum of 30 inches (760 mm) 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. Solder the LEDs to the circuit board.

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, 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 "The Equipment and Material Standards" of the Institute of Transportation Engineers "Vehicular Traffic Control Signal Heads" (VTCSH) Part 2, Chapter 2A.

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

Provide certification with the signal modules when offered for evaluation that your product complies with the sections of the ITE specification identified in paragraph 1.12 above and this specification. Provide test results showing that the signal modules meet or exceed the luminous intensity requirements of sections 1.8 and 1.9 of this specification.

Ship each module as a complete kit designed for retrofitting existing pedestrian signal sections with an LED display module. 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 (45 meters) in bright sunlight with a visor on the housing or which drops below the luminous intensity output requirements. Warrant failure due to workmanship, materials, and manufacturing defects during the first 60 months after the date of installation. Repair or replace any failed modules within 30 calendar days of notification at no cost to the Department.

Page 10-227, Subarticle 1098-2(F)

Replace the first sentence in the paragraph with the following:

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.

1.3. Wood Poles (1098-6)

Page 10-228, Article 1098-6

Replace the entire article with the following:

Provide poles of treated southern pine or treated Douglas fir that meet the requirements of ANSI 05.1. Provide Class 3 or better wood poles that are a minimum length of 40 feet (12.2 meters) unless otherwise shown on the plans and are of a sufficient length to maintain minimum required distances above the roadway, obstructions and affected railroad tracks. Mark each pole in accordance with ANSI 05.01. First roof and bore poles and then give them a full-length preservative treatment.

Provide poles with pentachlorophenol or chromated copper arsenate (CCA) preservative, in accordance with AWPA Standard C4-99. Ensure the retention of preservative is a minimum of 0.45 lb. per cubic foot (7.2 kg per cubic meter) for pentachlorophenol and 0.6 lb. per cubic foot (9.6 kg per cubic meter) for CCA.

1.4. Guy Assemblies (1098-7)

Page 10-228, Article 1098-7

Add the following to paragraph two:

Anchor assemblies with double-strand eyes may be used in lieu of those with the tripleye feature when only one guy cable is to be attached. Ensure anchor assemblies are 7 feet (2.13 meters) minimum in length.

1.5. Loop Lead-In Cable (1098-9)

Page 10-230, Article 1098-9

Replace the entire article with the following:

Furnish lead-in cable with conductors of size 18 AWG that are fabricated from stranded copper, and that complies with IMSA Specification 50-2 except as follows:

- Provide the following two pair (4 conductor) conductor insulation pair colors: clear-brown and blue-pink.
- Provide the following four pair (8 conductor) conductor insulation pair colors: clear-brown, blue-pink, clear with black stripe tracer-brown with black stripe tracer, and blue with black stripe tracer-pink with black stripe tracer. Apply continuous stripe tracer on conductor insulation with a longitudinal or spiral pattern.
- Ensure one spirally-wrapped Aluminum Mylar tape is applied with the aluminum side out to completely cover the conductor assembly.
- Provide cable jacket formed from black polyethylene. Ensure the finished jacket provides environmental stress resistance, outdoor weatherability, toughness, low temperature performance, and ultraviolet resistance.
- Provide a ripcord to allow the cable jacket to be opened without using a cutter.

1.6. Fiber-optic Cable (1098-11)

Page 10-233, Subarticle 1098-11(A)

In paragraph 3, sentence 5, delete "Construct buffer tubes with an inner layer made of polycarbonate and an outer layer made of polyester."

1.7.Type 170E Cabinets (1098-19)

Page 10-241, Subarticle 1098-19(B)

Add the following paragraphs:

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 call 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

Pages 10-245-247, Subarticle 1098-19 (D) (**Model 2010 Enhanced Conflict Monitor)**

Replace Subarticle (D) with the following:

Furnish Model 2010 Enhanced Conflict Monitors with 16 channels. In addition to CALTRANS requirements, ensure that 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 that the monitor will trigger upon detection of a fault and will remain in the triggered (failure detected) state until the 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 valid 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 that the monitor will trigger and put the intersection into flash. If the absence of any indication condition lasts less that 750 ms when used with a 170 controller and

1200 ms when used with a 2070L controller, ensure that the conflict monitor will not trigger. Have red monitoring occur when the P20 Connector is installed and both of the following input conditions are in effect: a) the 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 Vrms and 70 Vrms), and b) and 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 ± 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 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" in effect on the date of advertisement. 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:

170		**Conflict Monitor DB-9**
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

2070L		**Conflict Monitor DB-9**
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

Pages 10-247, Subarticle 1098-19(E)

Replace Subarticle (E) with the following:

Furnish external electrical service disconnects with a single pole 50 ampere circuit breaker with a minimum of 10,000 RMS symmetrical amperes short circuit current rating in a lockable NEMA 3R enclosure. Ensure service disconnects are UL listed and marked as being suitable for use as service equipment. Fabricate enclosure from galvanized steel and electrostatically apply dry powder paint finish, light gray in color, to yield a minimum thickness of 2.4 mils (60 μm). Provide ground bus and neutral bus with a minimum of four terminals with a minimum wire capacity range of number 14 through number 4.

Furnish a NEMA Type 3R outdoor enclosure, 100 Ampere rated meter base. Furnish a 4 terminal, 600 volt, single phase, 3 wire meter base that complies with the following:

- Line, Load, and Neutral Terminals accept #8 to 2/0 AWG Copper/Aluminum wire
- Ringless Type without bypass

- Made of galvanized steel
- Meet the UL-414 standard
- Overhead and underground service entrance

Provide meter bases in which the ampere rating of the meter sockets are based on the meter sockets being wired with a minimum of 167 degrees F (75 degrees C) insulated wire. Ensure that the meter bases have an electrostatically applied dry powder paint finish, light gray in color, with a minimum thickness of 2.4 mils (60 μm).

Furnish 1-inch (25-mm) watertight hub for threaded rigid conduit with meter base.

If meter base and electrical service disconnect are supplied in the same enclosure, ensure assembly is UL listed and marked as being suitable for use as service equipment.

1.8. Type 2070L Controllers (1098-20)

Page 10-247, Article 1098-20

Replace the entire article with the following:

Conform to CALTRANS Traffic Signal Control Equipment Specifications and all addenda in effect on the date of advertisement except as required herein. Where an item is no longer cited, the last applicable specification applies.

Furnish Model 2070L controllers. Ensure that removal of the program 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.

Furnish one removable data key with each 2070L controller unit.

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.

2. 2002 Standard Specifications for Roads & Structures – Section 1700 Revisions

The 2002 Standard Specifications are revised as follows:

2.1. General Requirements (1700)

Page 17-1, Subarticle 1700-3 (C), replace the 3rd paragraph with the following paragraph:

The Department will be responsible for direct payment of monthly utility company usage charges. The Contractor will be responsible for all expenses associated with utility installation costs, hookups, etc.

Page 17-2, Subarticle 1700-3 (D), add the following paragraph:

Except for damages and malfunctions caused by the contractor's work activities, the contractor will not be held responsible for pre-existing conditions that were reported to the Engineer before starting traffic signal work at the specific intersection. The contractor will assume responsibility for all maintenance and emergency services necessary once traffic signal work has begun at the specific intersection, and for all damages and malfunctions caused either directly or indirectly by the contractor's work activities.

In the event the contractor fails to perform in accordance with the plans and specifications within the time frame specified, the Department reserves the right to perform the maintenance and emergency service necessary to assure continuous traffic signal operation. Further, all expenses incurred by the Department in implementing this option will be deducted from the payment due the contractor, plus a $2,500 liquidated damage per occasion, per day, or any portion thereof, until corrected. The liquidated damages are due to increased public hazard resulting from the malfunction.

Page 17-2, Subarticle 1700-3 (F)

In paragraph 2, sentence 2, delete "type 1."

Page 17-3, Subarticle 1700-3 (J)

In paragraph 2, sentence 2, revise "detectable metallic burial tape" to "marker tape."

Page 17-3, Article 1700-3, add Subarticle (K) to read as follows:

(K) Electrical Bonding

Using an approved termination means, connect a Number 14 AWG min. 19-strand copper conductor (Type THW) with green insulation to serve as an equipment grounding conductor to metal poles with mast arm supports, vehicular and pedestrian signal pedestals, and other metallic components which are not otherwise bonded through means approved by the Engineer.

2.2. Messenger Cable (1710)

Page 17-6, Article 1710-3

In paragraph 5, revise "provide a minimum of 30 feet (9.1 m)" to "provide a minimum of 27 feet (8.2 m)".

2.3. Underground Conduit (1715)

Page 17-8, Subarticle 1715-3(A)

Add the following paragraph:

Install metallic conduit at all locations where conduits traverse railroad tracks or as shown on the plans. For all other locations, install nonmetallic conduit unless otherwise shown on the plans. Backfill with excavated material and compact to 95% of its original density. Remove any rock and debris from backfill material.

Page 17-8, Subarticle 1715-3(C)

Delete the first paragraph.

Page 17-8, Subarticle 1715-3(D)

Replace reference to Article 342-3 with reference to Article 1540-3 (A&B).

Page 17-8, Subarticle 1715-3(E)

Revise the last sentence to:

Label all tracer wires. Terminate tracer wire to equipment ground bus as specified in the plans.

2.4. Wood Poles (1720)

Page 17-10, Article 1720-3

Replace the fourth paragraph with the following paragraph:

On joint use poles and NCDOT owned poles, at signal and intelligent transportation systems equipment installations (i.e. controller cabinets, CCTV cabinets, DMS cabinets, etc.), bond the messenger cable to the existing pole ground using burndy clamps at each end and at 1300-foot intervals. On multiple messenger cable arrangements, connect all messenger cable ends with #6 solid bare copper wire and bond with split bolt connectors or burndy clamps (UCG25RS) or equivalent. On joint use and NCDOT owned poles, if an existing pole ground does not exist, install a grounding system consisting of a #6 AWG bare copper wire that is exothermically welded to a ground rod.

In the last paragraph, last sentence, revise "5/8 inch x 8 foot (16 mm x 2.4 m) ground rod" to "5/8 inch x 10 foot (16 mm x 3.0 m) ground rod."

2.5. Riser Assemblies (1722)

Page 17-12, Article 1722-3

In paragraph 4 add the following after the last sentence:

Install condulet on all risers for lead-in cable.

2.6. Inductive Detection Loops (1725)

Page 17-13, Article 1725-3

Add the following paragraph before paragraph 1:

All work performed in this section must be done in the presence of the Engineer.

Replace paragraph 6 with the following:

Before sealing loop conductors, test that impedance from the loop wire to ground is at least 100 megohms. For each location with inductive loops, submit a completed "Inductive Detection Loop & Grounding Test Results" form and place copy in controller cabinet. Ensure all loops are included on form. The form is located on the Department's website at:

http://www.ncdot.org/doh/preconstruct/traffic/tmssu/ws/default.htm

2.7. Loop Lead-In Cable (1726)

Page 17-14, Article 1726-3

Replace paragraph 1 with the following:

Install lead-in cable.

Delete paragraph 3.

In paragraph 4, delete "type 1."

In paragraph 6, revise "less than 0.0036 ohms per foot (0.012 ohms per meter)" to "less than 0.00885 ohms per foot (0.0295 ohms per meter)."

Page 17-15, Article 1726-4

Replace the last sentence with the following:

No measurement will be made between 2-pair and 4-pair lead-in cable as this will be considered incidental to furnishing and installing lead-in cable.

2.8. Controllers with Cabinets (1751)

Page 17-34, Subarticle 1751-3(A)

In paragraph 3, replace sentence 2 with the following:

For all other installations, do not program the controller for late night flashing operation unless otherwise directed.

Page 17-34, Subarticle 1751-3(B)

Add the following paragraph after the first paragraph:

Program telemetry command sequences and enable devices necessary for testing of communication between local controllers and field master controllers, and between field master controllers and the Department-furnished central computer.

Page 17-34, Article 1751-4

Replace paragraph 2 with the following:

Actual number of each type of detector cards (2-channels) furnished, installed, and accepted. If 4-channel detector cards are used in order to fulfill the requirements of the plans, payment will be allowed for two detector cards for each 4-channel detector card.

In paragraph 3, revise "No measurement will be made..." to include "modems and meter bases."

Page 17-35, Article 1751-5

Replace paragraph 2 with the following:

The quantity of detector cards, measured as provided above, will be paid for at the contract unit price each for "Detector Card (_____)."

In paragraph 3, revise "Detector Channel" to "Detector Card."

3. GENERAL REQUIREMENTS

Comply with the requirements of Division 17 of the 2002 Standard Specifications for Roads and Structures.

4. 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.

5. DIRECTIONAL DRILLING

5.1. DESCRIPTION

Furnish and install conduit and all necessary hardware by using the horizontal directional drilling method in accordance with the plans and specifications.

5.2. MATERIALS

A. General:

Provide conduit that is suitable for underground use in an ambient temperature range of -30 to 130 degrees F (-35 to 55 degrees C) without degradation of material properties.

Provide conduit that is resistant to benzene, calcium chloride, ethyl alcohol, fuel oil, gasoline, lubricating oil, potassium chloride, sodium chloride, sodium nitrate, and transformer oil, and is protected against degradation due to oxidation and general corrosion.

Provide conduit with an outer diameter to minimum wall thickness ratio that complies with ASTM-D3035, Standard Dimension Ratio (SDR) 13.5.

Provide conduit that meets or exceeds the following:

ASTM-D638	Tensile Strength - 3,000 psi (20 Mpa), minimum
Elongation - 400 percent, minimum	
ASTM-D1238	Melt Index - 0.4 maximum
ASTM-D1505	Density - (0941-0955 g/cc)
ASTM-D1693	Condition B - 20 percent failure, maximum
ASTM-D2444	Impact - NEMA Standards Publication Number TC7
ASTM-D3350	Cell classification - 334420 or 344420

Furnish conduits with a coefficient of friction of 0.09 or less in accordance with Belcore GR-356.

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.

Furnish ½-inch (12.7-mm), prelubricated, woven polyester tape, pull line with a minimum rated tensile strength of 2,500 lb (11 kN).

B. Polyethylene Conduit:

Furnish factory lubricated, low friction, coilable conduit constructed of virgin high-density polyethylene (HDPE). Furnish conduits with inside diameter as required by the plans. Provide conduit with a smooth outer wall and ribbed inner wall and ensure the conduit is capable of being coiled on reels in continuous lengths, transported, stored outdoors, and subsequently uncoiled for installation without affecting its properties or performance.

Furnish duct plugs that provide a watertight barrier when installed in an unused conduit. Furnish duct plugs sized in accordance with the conduit furnished. Provide duct plugs that are removable.

Furnish mechanical sealing devices that provide a watertight barrier between the conduit and communications cable. Furnish mechanical sealing devices sized in accordance with the conduit furnished and with appropriately sized holes for the communications cable. Provide mechanical sealing devices that are removable.

5.3. CONSTRUCTION METHODS

A. Pre-Approvals and Minimum Depth Requirements:

Obtain the Engineer's approval before beginning drilling operations.

At all points where the proposed conduit will traverse under city streets, state roads, driveways, sidewalks, and/or "Controlled Access Areas" including entrance/exit ramps, ensure the conduit maintains a minimum depth of 4 feet (1.2 meters) or 8 times the back reamer's diameter, whichever is deeper. For an installation that runs parallel to a controlled access area or entrance and exit ramps ensure the conduit maintains a minimum depth of 30 inches (760 mm) below grade. Maintain a minimum clearance of 30 inches (760 mm) below grade when crossing ditch lines. For the following man-made structures, the minimum clearance requirements are shown in the table below:

Man-made Structure	**Minimum Clearance Requirement**
Bridge foundation	5' (1.5 m) horizontal & 4' (1.2 m) vertical (clearances greater than minimum horizontal should continue to use the 4V:5H ratio, i.e., 10' horizontal should be no deeper than 8')
Drainage pipes less than 60"	1' (0.3 m) above or below [while maintaining a minimum depth of 30" (760 mm) below grade]
Drainage pipes greater than 60"	1' (0.3 m) above or 4' (1.2 m) below [while maintaining a minimum depth of 30" (760 mm) below grade]
Box Culverts	1' (0.3 m) above or 4' (1.2 m) below [while maintaining a minimum depth of 30" (760 mm) below grade]
Slope protection	2' (0.6 m) below
Slope protection foundation footing	5' (1.5 m) below

Guarantee the drill rig operator and digital walkover locating system operator are factory-trained to operate the make and model of the equipment provided and have a minimum of one year's experience operating the make and model of drill rig. Submit written documentation of the operators' training and experience for review by the Engineer at least two weeks before beginning directional drilling operations.

Provide a means of collecting and containing drilling fluid/slurry that returns to the surface such as a slurry pit. Provide measures to prevent drilling fluids from entering drainage ditches and storm sewer systems. Prevent drilling fluid/slurry from accumulating on or flowing onto sidewalks, other pedestrian walkways, driveways or streets. Immediately remove any drilling fluids/slurry that is accidentally spilled.

B. Directional Drill Operations:

Provide grounding for the drill rig in accordance with the manufacturer's recommendations.

Place excavated material near the top of the working pit and dispose of as required. Backfill pits or trenches excavated to facilitate drilling operations immediately after the drilling has been completed.

Use a drill head suitable for the type of material being drilled and sized no more than 2 inches (50 mm) larger than the outer diameter of the conduit to be installed. Direct the drill head as needed to obtain the proper depth and desired destination. Pressure grout with an approved bentonite/polymer slurry mixture to fill any voids. Do not jet alone or wet bore with water.

During each drilling operation, locate the drill head every 10 feet (3 meters) along the drill path and before traversing any underground utility or structure. Use the digital walkover locating system to track the drill head during the directional drilling operation. Ensure the locating system is capable of determining the pitch, roll, heading, depth and horizontal position of the drill head at any point. Unless otherwise approved, do not deviate from the proposed line and grade by more than two percent.

Once the drill head has reached its final location, remove the head, and install a reamer of appropriate size (no more than 2 inches (50 mm) larger than the outer diameter of the ducts) to simultaneously facilitate back drilling of the drill hole and installation of the conduit. The reamer is sized larger than the actual conduits to ensure the conduits are not subjected to extraneous deviations caused by the original drill operation and are as straight as possible in their final position.

The intent of these specifications is to limit the diameter of the actual drill shaft/hole such that it is no more than 2 inches (50 mm) larger than the conduit outer diameter. The 2-inch (50-mm) larger diameter can be accomplished during the original bore or during the back reaming/conduit installation process.

Once the physical installation of the conduit has started, continue performing the installation without interruption to prevent the conduit from becoming firmly set. Ensure the bentonite/polymer slurry mixture is applied as the conduit installation process is occurring.

Upon completion of the conduit installation perform a mandrel test on the conduit system to ensure that no conduit has been damaged. Furnish a non-metallic mandrel having a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred, replace the entire length of conduit.

Extend the ends of the conduit such that upon completion of the installation the conduit will extend a minimum of 2 inches (50 mm) above concrete surfaces and 4 inches (100 mm) above crushed stone bases.

C. Drilling Fluids:

Furnish and use lubrication for subsequent removal of material and immediate installation of the pipe. The use of water and other fluids in connection with the directional drilling operation will be permitted only to the extent necessary to lubricate cuttings. Do not jet alone or wet bore with water. Use a drilling fluid/slurry consisting of at least 10 percent high-grade bentonite to consolidate excavated material and seal the walls of the drill hole.

Transport waste drilling fluid/slurry from the site and dispose of such slurry in a method that complies with Local, State and Federal laws and regulations.

D. Splicing of the Conduit:

Do not splice or join sections of conduit. Upon approval, a junction box may be installed at locations where splicing or coupling of the conduit is necessary due to problems encountered with the installation.

E. Duct Plugs and Mechanical Sealing Devices:

Following the installation of the conduit where the communications cable is not immediately installed use a duct plug to seal the ends of the conduit. Secure the pull line to the duct plug in such a manner that it will not interfere with the installation of the duct plug and provide a watertight seal.

In conduits containing communications cable, seal the conduit with an approved mechanical sealing device. Ensure the installation provides a watertight seal.

F. Plan of Record Drawings:

Upon completion of the drilling operation and conduit installation furnish the Engineer with a plan of record profile drawing and a plan drawing for the drilled conduit showing the horizontal and vertical locations of the installed conduit.

5.4. MEASUREMENT AND PAYMENT

Measured horizontal linear feet (meters) of directionally drilled polyethylene conduit furnished, installed and accepted. Measurement of the drill path will be from point-to-point horizontally along the approximate centerline.

As examples, an installation of a single 1.25" HDPE conduit would be paid as:

Directional Drill Polyethylene Conduit, (1.25")(1) .....Linear Foot (Meter)

An installation of two 1.25" and four 2" HDPE conduits would be paid as:

Directional Drill Polyethylene Conduit, (1.25")(2)&(2")(4).....Linear Foot (Meter)

No additional payment will be made for vertical and horizontal sweeps, excavation of drill pits, backfill, site restoration, seeding and mulching, removal of excess material, duct organizers, mechanical sealing devices, duct plugs, pulling lubricants, mandrel test, and plan of record drawings, as these will be considered incidental to the directional drill and/or conduit installation.

Payment will be made under:

Directional Drill Polyethylene Conduit, (Size)(Qty) .....Linear Foot (Meter)

6. FIBER-OPTIC SELF-HEALING RING TRANSCEIVERS

6.1. DESCRIPTION

Furnish and install fiber-optic self-healing ring transceivers with all necessary hardware in accordance with the plans and specifications.

Furnish shelf mounted, modular designed, single mode, self-healing-ring fiber-optic transceivers and all necessary hardware that are compatible with the system equipment and designed for RS-232 drop-and-repeat communications. Do not provide transceivers that are internal to the system equipment. Provide identical transceivers at all locations that are capable of being interchanged throughout the system.

6.2. MATERIALS

Furnish shelf mounted, self-healing ring fiber-optic transceivers that are capable of supporting RS-232 C/D, RS-422, or RS 485 protocols and support communications in an asynchronous, simplex or full-duplex operating mode. Ensure transceivers are switch selectable for either local or master operation. Ensure that transceivers are capable of operating at distances up to 5 miles (8 kilometers) without the need to boost the signal and without distortion of the signal.

Provide LEDs on the front panel of transceivers for power, and transmitting and receiving indication. Comply with the following:

Input Power:	115 VAC
Minimum Loss Budget:	12dB with corresponding receiver
Operating Wavelength:	1310 or 1550nm
Optical Connector:	ST
Signal Connector:	Female Plug Type
Temperature Range:	0 to 150 degrees F (-17 to 65 degrees C)

6.3. CONSTRUCTION METHODS

Install fiber-optic self-healing ring transceivers in each equipment cabinet and comply with the manufacturer's installation instructions.

6.4. MEASUREMENT AND PAYMENT

Actual number of fiber-optic self-healing ring transceivers furnished, installed, and accepted.

Payment will be made under:

Fiber-Optic Transceiver – Self-Healing Ring.....Each

7. FIBER-OPTIC SYSTEM SUPPORT EQUIPMENT

7.1. DESCRIPTION

Furnish fiber-optic system support equipment with all necessary hardware in accordance with the plans and specifications.

7.2. 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 fiber-optic system support equipment.

B. 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.

7.3.MEASUREMENT AND PAYMENT

Actual number of fiber-optic transceivers furnished and accepted.

Payment will be made under:

Furnish Fiber-optic Transceiver.....Each

8. METAL TRAFFIC SIGNAL SUPPORTS

8.1. METAL TRAFFIC SIGNAL SUPPORTS – ALL POLES

A. General:

Furnish and install metal strain poles, grounding systems, and all necessary hardware. 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, rods, stay braces, clamps or U-bolts, except where noted otherwise. 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.

If plans call for Standard Metal Signal Supports, comply with Subarticle 1098-1A "General Requirements" for QPL submittals.

B. Materials:

Fabricate shafts of the tapered tubular type and steel conforming to ASTM A-595 Grade A or an approved equivalent.

Galvanize in accordance with ASTM A-123, including field-drilled holes.

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.

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 or an approved equivalent.

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. Provide anchor bolts with a circular anchor bolt lock plate at the embedded end secured with a washer and nut.

Ensure cap is cast aluminum conforming to Aluminum Association Alloy 356.0F.

C. Construction Methods:

Connect poles to grounding electrodes and the intersection grounding systems.

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.
2. Install the structural element on the anchor bolts, and tighten nuts in compliance with steps 3, 4, and 5 below. Do not attach cantilever arms or overhead truss components 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.). Lubricant shall be 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.
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.

8.2. 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.

8.3. 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 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.

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.

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 (7.9 meters).

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 (0.3, 0.8, 1.5, 2.3, 3.0, 4.6, 6.1 and 7.9 meters). Discontinue the boring if one of the following occurs:

- A total of 100 blows have been applied in any 2 consecutive 6-in. (0.15-m) intervals.
- A total of 50 blows have been applied with < 3-in. (.08-m) 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. 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:

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

$$Y = (N@1')^2 + (N@2.5')^2 + \ldots\ldots (N@\text{Deepest Boring Depth})^2$$

$$Z = (N@1' + N@2.5' + \ldots\ldots N@\text{Deepest Boring Depth})$$

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

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 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 7) 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.

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 (3 meters) 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 as follows:

1) Go to www.NCDOT.org/business/.
2) Click on "Geotechnical Engineering Unit Forms."
3) Click on "Metal Pole Standard Foundation Selection Form."

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 that results in a horizontal lateral movement of less than 1 inch (25 mm) at the top of the pier and a horizontal rotational movement of less than 1 inch (25 mm) 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 (75 mm) 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 (125 mm) above and 2 inches (50 mm) 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 (7 mm). 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 EXL	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

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 (50 mm).

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 (75 mm).

In order to ensure a minimum of 3 inches (75 mm) 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 (75 mm) "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 (3-m) 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 (31.0 MPa) at 28 days. The foundation will be considered acceptable for loading when the concrete reaches a minimum compressive strength of 3000 psi (20.7 Mpa). 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. 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^3 (380 kg/m^3) and a maximum cement content of 800 lbs/yd^3 (475 kg/m^3); 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 (1.2 kg) of fly ash per lb (kg) of cement removed.
- If Type IP blended cement is used, use a minimum of 665 lbs/yd^3 (395 kg/m^3) Type IP blended cement and a maximum of 833 lbs/yd^3 (494 kg/m^3) 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 (125 and 175 mm) for dry placement of concrete or 7 and 9 inches (175 and 225 mm) 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 (32°C) 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 (1067 to 1220 mm) 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 (3 m) above the bottom of the casing being removed. Maintain the concrete level at least 10 feet (3 m) 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 (150 mm) per half hour, the concrete placement is considered dry. If the water inflow rate is greater than 6 inches (150 mm) 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 in the excavation. Extend the tremie tube or pump pipe into the concrete a minimum of 5 feet (1.5 m) 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 (3 m) 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.

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 (6 m) radius of the drilled pier.

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 (31.0 Mpa). 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.

8.4. MEASUREMENT AND PAYMENT

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

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

Actual volume of concrete poured in cubic yards (cubic meters) of drilled pier foundation furnished, installed and accepted.

Payment will be made under:

Metal Strain Signal Pole ..... Each
Soil Test ..... Each
Drilled Pier Foundation ..... Cubic Yard (Cubic Meter)

9. CABINET BASE EXTENDER

9.1. DESCRIPTION

Furnish and install cabinet base extenders in accordance with the plans and specifications.

9.2. MATERIALS

Fabricate base extenders out of the same materials and with the same finish as the cabinet housing. Fabricate the base extender in the same manner as the controller cabinets, meeting all applicable specifications called for in Section 6.2.2 of the CALTRANS Traffic Signal Control Equipment Specifications (TSCES). Provide base extenders that are a minimum height of 12 inches (300 mm).

9.3. CONSTRUCTION METHODS

Install a cabinet base **extender** at every location requiring a new Model 332A cabinet on a new foundation or an existing Model 332A cabinet that does not have a cabinet base extender.

Use a permanent, flexible waterproof sealing material to:

- Seal between the base of the cabinet and the cabinet base extender,
- Seal the seams of a two-piece cabinet base extender, and
- Seal the space between the cabinet base extender and the foundation.

9.4. MEASUREMENT AND PAYMENT

Actual number of cabinet base extenders furnished, installed, and accepted.

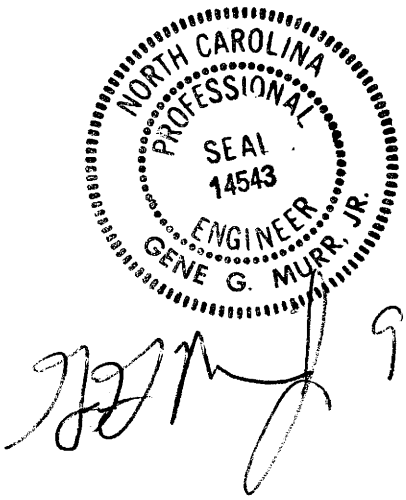
Payment will be made under:

Cabinet Base Extender.....Each

Project Special Provisions

Intelligent Transportation Systems

Prepared By: ITS Section
24-Aug-06



9-25-06

Contents

1. 2002 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES – SECTION 1098 REVISIONS 1-1

1.1. GENERAL REQUIREMENTS (1098-1) 1-1
1.2. WOOD POLES (1098-6) 1-1
1.3. FIBER-OPTIC CABLE (1098-11) 1-2

2. 2002 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES – SECTION 1700 REVISIONS 2-2

2.1. GENERAL REQUIREMENTS (1700) 2-2
2.2. UNDERGROUND CONDUIT (1715) 2-2
2.3. WOOD POLES (1720) 2-2
2.4. FIBER-OPTIC SPLICE CENTERS (1731) 2-3

3. GENERAL REQUIREMENTS 3-4

3.1. DESCRIPTION 3-4
A. General 3-4
B. Domestic Steel and Iron Products 3-6
C. Other Codes and Standards 3-7
3.2. BASIS OF PAYMENT 3-7

4. ELECTRICAL AND PHONE SERVICE 4-7

4.1. DESCRIPTION 4-7
4.2. MATERIAL 4-7
4.3. CONSTRUCTION METHODS 4-8
A. Electrical Service 4-8
B. External Electrical Service Disconnect 4-8
C. Phone Service 4-8
4.4. METHOD OF MEASUREMENT 4-8
4.5. BASIS OF PAYMENT 4-9

5. JUNCTION BOXES 5-9

5.1. DESCRIPTION 5-9
5.2. MATERIALS 5-9
A. Junction Boxes 5-9
B. Graded Stone 5-9
5.3. CONSTRUCTION METHODS 5-9
A. General 5-9
B. Reuse Existing Junction Boxes 5-10
5.4. METHOD OF MEASUREMENT 5-10
5.5. BASIS OF PAYMENT 5-10

6. DIRECTIONAL DRILLING 6-10

6.1. DESCRIPTION 6-10
6.2. MATERIALS 6-10
A. General 6-10
B. Polyethylene Conduit 6-11
6.3. CONSTRUCTION METHODS 6-11
A. Pre-Approvals and Minimum Depth Requirements 6-11
B. Directional Drill Operations 6-12
C. Drilling Fluids 6-13
D. Splicing of the Conduit 6-13
E. Duct Plugs and Mechanical Sealing Devices 6-13
F. Plan of Record Drawings 6-13
6.4. METHOD OF MEASUREMENT 6-14
6.5. BASIS OF PAYMENT 6-14

7. UNDERGROUND POLYETHYLENE CONDUIT 7-14

7.1. DESCRIPTION 7-14
7.2. MATERIALS 7-14
7.3. CONSTRUCTION METHODS 7-15
A. General 7-15
B. Underground Polyethylene Conduit Installation in Trench 7-16
C. Underground Polyethylene Conduit Installation by Plowing 7-16
D. Splicing of Underground Polyethylene Conduits 7-17
E. Plan of Record Drawings 7-17
7.4. METHOD OF MEASUREMENT 7-17
7.5. BASIS OF PAYMENT 7-17

8. CCTV FIELD EQUIPMENT 8-17

8.1. DESCRIPTION 8-17
8.2. MATERIALS 8-18
A. General 8-18
B. Camera and Lens 8-18
C. Camera Housing 8-19
D. Pan and Tilt Unit 8-19
E. Control Receiver/Driver 8-19
F. CCTV Camera Attachment to Pole 8-20
G. Surge Suppression 8-20
H. CCTV Camera Wood Pole 8-20
I. Model 336 Field Equipment Cabinet 8-21
8.3. METHOD OF CONSTRUCTION 8-23
A. General 8-23
B. Electrical and Mechanical Requirements 8-23
C. Model 336 Field Equipment Cabinet 8-23
D. RS-232 to RS-485/RS-422 Converter 8-24
8.4. METHOD OF MEASUREMENT 8-24
8.5. BASIS OF PAYMENT 8-24

9. HIGH POINT TOC VIDEO EQUIPMENT 9-24

9.1. DESCRIPTION 9-24
9.2. MATERIALS 9-25
A. Video Switch 9-25
9.3. CONSTRUCTION METHODS 9-25
9.4. METHOD OF MEASUREMENT 9-25
9.5. BASIS OF PAYMENT 9-26

10. FIBER OPTIC COMMUNICATIONS SYSTEM 10-26

10.1. DESCRIPTION 10-26
10.2. MATERIALS: 10-27
A. SMFO Transceivers for CCTV Cameras and Control: 10-27
10.3. CONSTRUCTION METHODS: 10-27
10.4. METHOD OF MEASUREMENT: 10-28
10.5. BASIS OF PAYMENT: 10-28

11. SYSTEM INTEGRATION 11-28

11.1. INTEGRATION WITH EXISTING EQUIPMENT 11-28
11.2. VIDEO MANAGEMENT SOFTWARE 11-29
11.3. CONSTRUCTION METHODS 11-30
11.4. METHOD OF MEASUREMENT 11-30
11.5. BASIS OF PAYMENT 11-30

12. SYSTEM OPERATIONAL TEST AND OBSERVATION PERIOD 12-30

12.1. DESCRIPTION 12-30

12.2. TEST PROCEDURES/ SOFTWARE AND SYSTEM TESTS 12-31
12.3. INSTALLED HARDWARE AND DOCUMENTATION 12-31
12.4. HALT OF SYSTEM OPERATIONAL TEST 12-31

13. 60-DAY OBSERVATION PERIOD 13-32

14. EMERGENCY RESTORATION EQUIPMENT 14-32

14.1. DESCRIPTION 14-32
14.2. MATERIALS 14-32
14.3. METHOD OF MEASUREMENT 14-33
14.4. BASIS OF PAYMENT 14-33

15. DYNAMIC MESSAGE SIGN (DMS) SYSTEM 15-33

15.1. DESCRIPTION 15-33
15.2. MATERIALS 15-34
A. Environmental Requirements 15-34
B. Full Matrix LED Dynamic Message Sign (DMS) 15-35
C. DMS Enclosure Structure Mounting 15-40
D. DMS / DMS Controller Interconnect 15-41
E. DMS Controller and Cabinet 15-41
15.3. CONSTRUCTION METHODS 15-53
A. Description 15-53
B. Layout 15-53
C. Construction Submittal 15-53
D. Conduit 15-54
E. Wiring Methods 15-54
F. Equipment and Cabinet Mounting 15-55
G. Cabinet and System Grounding 15-55
H. Work Site Clean-Up 15-55
15.4. METHOD OF MEASUREMENT 15-55
15.5. BASIS OF PAYMENT 15-56

16. DMS TESTING REQUIREMENTS 16-57

16.1. GENERAL TEST PROCEDURE 16-57
16.2. DESIGN APPROVAL TESTS 16-58
A. Procedure and Requirements 16-58
B. Environmental Tests 16-59
16.3. OPERATIONAL FACTORY TESTS 16-60
A. Operational Factory Test 16-60
B. NTCIP Acceptance Testing 16-71
C. NTCIP Submittal 16-72
D. Operational Field Test (On-Site Commissioning) 16-72
16.4. 30-DAY BURN-IN PERIOD 16-73
16.5. CONSTRUCTION METHODS 16-73
16.6. METHOD OF MEASUREMENT 16-73

17. DYNAMIC MESSAGE SIGN ASSEMBLY 17-74

17.1. DESCRIPTION 17-74
17.2. MATERIAL 17-74
17.3. CONSTRUCTION METHODS 17-74
A. General 17-74
B. Shop Drawing 17-75
C. Design and Fabrication 17-75
D. Location 17-77
17.4. METHOD OF MEASUREMENT 17-77
17.5. BASIS OF PAYMENT 17-77

18. DMS DIRECT TENSION INDICATORS 18-78

18.1. GENERAL 18-78
18.2. MATERIAL REQUIREMENTS 18-78
18.3. TEST DOCUMENTS 18-78
18.4. REQUIRED TEST SAMPLES 18-78
18.5. CONSTRUCTION METHODS 18-78
A. Installation *18-78*
B. Inspection *18-79*
18.6. METHOD OF MEASUREMENT 18-79

1. 2002 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES – SECTION 1098 REVISIONS

The 2002 Standard Specifications for Roads and Structures are revised as follows:

1.1. GENERAL REQUIREMENTS (1098-1)

Page 10-220, Subarticle 1098-1(A)

In the last paragraph, sentence 1, revise "by the date of advertisement of the project" to "by the date of equipment installation."

Page 10-220, Subarticle 1098-1(D)

Replace the entire article with the following:

All of the equipment and workmanship supplied will be fully warranted. Unless otherwise required herein, provide manufacturer's warranties on all Contractor-furnished equipment for material and workmanship that are customarily issued by the equipment manufacturer and that are at least one (1) year in length from the completion of the 60-day Observation Period. Include unconditional coverage for all parts and labor necessary or incidental to the repair of defective equipment or workmanship and malfunctions that arise during the warranty period. Ensure that all Contractor-furnished equipment, including hardware, firmware, software, middle-ware, internal components, and subroutines which perform any date or time data recognition function, calculation, or sequencing will support a four-digit year format for a period of at least 50 years.

Upon successful completion of the 60-day Observation Period, transfer manufacturer's warranties with proper validation by the manufacturer to the Department or its designated maintaining agency.

Pages 10-223 Subarticle 1098-1(E)

Replace the entire article with the following:

Provide the Department with an unlimited license to duplicate all central programs and remote site programs to facilitate the addition of future sites throughout North Carolina. Provide three (3) copies of all software packages on CD-ROM.

Ensure software and firmware performance upgrades that occur during the warranty period are available to the Department at no additional cost.

Pages 10-223 Subarticle 1098-1(H)

Replace paragraph 4 with the following paragraph:

Provide either 1.3 x 7.6 mm (0.05 x 0.30 in) aluminum wrapping tape or 1.5 mm (0.06 in) stainless steel lashing wire for the purpose of lashing cables, except fiber-optic communications cables, to a messenger cable. Use 1.14-mm (0.045 in) stainless steel lashing wire for the aerial installation of fiber-optic communications cable to messenger cable.

1.2. WOOD POLES (1098-6)

Page 10-228, Article 1098-6

Replace the entire article with the following:

Provide poles of treated southern pine or treated Douglas fir that meet the requirements of ANSI 05.1. Provide Class 3 or better wood poles that are a minimum length of 18.3 m (60 ft) unless otherwise shown on the plans. Mark each pole in accordance with ANSI 05.01. First roof and bore poles and then give them a full-length preservative treatment.

Provide poles with pentachlorophenol or chromated copper arsenate (CCA) preservative, in accordance with AWPA Standard C4-99. Ensure the retention of preservative is a minimum of 0.45 lb. per cubic foot (7.2 kg per cubic meter) for pentachlorophenol and 0.6 lb. per cubic foot (9.6 kg per cubic meter) for CCA.

1.3. FIBER-OPTIC CABLE (1098-11)

Page 10-233, Subarticle 1098-11(A)

In paragraph 3, sentence 5, delete "Construct buffer tubes with an inner layer made of polycarbonate and an outer layer made of polyester."

2. 2002 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES – SECTION 1700 REVISIONS

The 2002 Standard Specifications for Roads and Structures are revised as follows:

2.1. GENERAL REQUIREMENTS (1700)

Page 17-3, Subarticle 1700-3 (J)

In paragraph 2, sentence 2, revise "detectable metallic burial tape" to "marker tape."

2.2. UNDERGROUND CONDUIT (1715)

Page 17-8, Subarticle 1715-3(C)

Replace paragraph 1 with the following paragraphs:

Install metallic conduit in all paved trenching areas. Paved areas include streets, roads, and commercial driveways. Install nonmetallic conduit in areas under sidewalks, parking lots, and residential driveways.

Where metallic conduit is required, backfill the excavated area with a Class B, or better concrete backfill. For all other conduit installations, backfill the trench with the excavated material and compact to 95% of its original density. Remove any rock and debris from backfill material.

Page 17-8, Subarticle 1715-3(D)

Replace reference to Article 342-3 with reference to Article 1540-3 (A&B).

2.3. WOOD POLES (1720)

Page 17-10, Article 1720-3

Replace the fourth paragraph with the following paragraph:

On joint use poles and NCDOT owned poles, at signal and intelligent transportation systems equipment installations (i.e. controller cabinets, CCTV cabinets, DMS cabinets, etc.), bond the

messenger cable(s) to the existing pole ground using Burndy clamps at each end and at 1300 foot intervals. On multiple messenger cable arrangements, connect all messenger cable ends with #6 solid bare copper wire and bond with split bolt connectors or Burndy clamps (UCG25RS) or equivalent. On joint use and NCDOT owned poles, if an existing pole ground does not exist, install a grounding system consisting of a #6 AWG bare copper wire that is exothermically welded to a ground rod.

In the last paragraph, last sentence, revise "16 mm x 2.4 m (5/8 in x 8 foot) ground rod" to "16 mm x 3.0 m (5/8 in x 10 foot) ground rod."

2.4. FIBER-OPTIC SPLICE CENTERS (1731)

Page 17-19, Article 1731-1

In the first paragraph, revise "Furnish and install fiber-optic interconnect centers...in accordance with the plans and specifications." to "Furnish, install, and modify fiber-optic interconnect centers... in accordance with the plans and specifications."

Include in the first paragraph: Modify existing splice centers as indicated in the splice details.

Page 17-19, Article 1731-3 (A)

Include: Fusion splice 1 to 6 fibers as indicated in the splice details.

Include in the entire section new and existing (modify) interconnect centers and splice enclosures.

Page 17-19, Article 1731-3 (B)

Include in the entire section Termination and Splicing within New and Existing Interconnect Centers.

Page 17-19, Article 1731-3 (C)

Include in the entire section Termination and Splicing within New and Existing Aerial Splice Enclosures.

Page 17-20, Article 1731-3 (D)

Testing shall include splices made into existing interconnect centers and aerial splice enclosures.

Page 17-21, Article 1731-4

Include the following to the Method of Measurement:

Actual number of fusion splices into existing splice centers. Actual number of modified, existing interconnect centers. No measurement will be made for splicing into new interconnect centers or aerial splice enclosures as this is considered incidental to furnishing and installing new interconnect centers or aerial splice enclosures.

Page 17-21, Article 1731-5

Include the following to the Basis of Payment:

The quantity of modify existing interconnect centers, measured as provided in Article 1731-4, will be paid for at the contract unit price for "Modify Existing Interconnect Center."

The quantity of fusion splices, measured as provided in Article 1731-4, will be paid for at the contract unit price for "Fusion Splice 1 Fiber."

The quantity of fusion splices, measured as provided in Article 1731-4, will be paid for at the contract unit price for "Fusion Splice 2 Fibers."

The quantity of fusion splices, measured as provided in Article 1731-4, will be paid for at the contract unit price for "Fusion Splice 3 Fibers."

The quantity of fusion splices, measured as provided in Article 1731-4, will be paid for at the contract unit price for "Fusion Splice 4 Fibers."

The quantity of fusion splices, measured as provided in Article 1731-4, will be paid for at the contract unit price for "Fusion Splice 5 Fibers."

The quantity of fusion splices, measured as provided in Article 1731-4, will be paid for at the contract unit price for "Fusion Splice 6 Fibers."

Payment will be made under:

Modify Existing Interconnect Center.....Each
Fusion Splice 1 Fiber.....Each
Fusion Splice 2 Fibers..... Each
Fusion Splice 3 Fibers..... Each
Fusion Splice 4 Fibers..... Each
Fusion Splice 5 Fibers..... Each
Fusion Splice 6 Fibers..... Each

3. GENERAL REQUIREMENTS

3.1. Description

A. General

Conform to these Project Special Provisions; the Plans; and the 2002 Standard Specifications for Roads and Structures (also referred to herein as the "Standard Specifications"). The current edition of these specifications and publications in effect on the date of advertisement will apply.

Conform to the requirements of the pay items included in these Project Special Provisions. All other pay items for items in the plans but not described in these Project Special Provisions are included in the Standard Specifications and must be conformed to as described in those specifications unless modified herein. In the event of a conflict between these Project Special Provisions and Standard Specifications, these Project Special Provisions will govern.

Append the following to Article 1700-1 of the Standard Specifications:

Furnish, install, integrate, and test new fiber optic communications cable, existing fiber optic communications cable, new central equipment, existing central equipment, new field equipment, and existing field equipment. Complete equipment modifications and software integration to provide communications and system access from the Piedmont Triad Regional Transportation Management Center (PTRTMC) and the City of High Point Traffic Operations Center (TOC). Furnish, install, integrate, test and make fully operational two (2) new DMSs operated from the PTRTMC utilizing the existing Daktronics Vanguard software. When complete, the system will have functionality that includes:

- Video switching/selection from existing operator workstations of eight (8) new CCTV units that will terminate at the TOC.
- Video sharing between the PTRTMC and TOC. This sharing will include switching/selection and control from existing operator workstations of up to 8 CCTV units currently terminated in the PTRTMC or the TOC.
- Access and control of two (2) new DMS units installed under this project from the PTRTMC.

The ITS portion of this project has been divided into two segments. Following is a description of each segment and some of the construction activities included in each segment. Additional detail describing work to be performed under described segments is contained in these Project Special Provisions and Plans. All completion times and intermediate completion times are as prescribed in these ITS Project Special Provisions, the Traffic Control Project Special Provisions and the Plans.

Segment A:

- Install new fiber optic communications cable along US 311 (High Point East Belt) from Johnson St. to I-85B/US29-70.
- Install new fiber optic communications cable from NC 68 (Eastchester Dr.) at Gallimore Dairy Rd. to South of Centennial St. in High Point.
- Install new fiber optic communications cable from East Green St. to Centennial St. and Brentwood St. to I-85B
- Install and integrate 5 new CCTV cameras as shown on the Plans.
- Install and integrate 2 new DMS as shown on the Plans.
- Install new CCTV central equipment in the City of High Point TOC and integrate with the existing equipment.
- Integrate with existing equipment at the PTRTMC.

This work can begin on the first day of availability. The completion day for this segment of work is February 29, 2008.

Segment B:

- Install new fiber optic communications cable along US 311 from I-85 B to north of I-85 Bypass
- Install and integrate 3 CCTV cameras as shown on the Plans.
- Integrate with Segment A

Append the following to Article 1098-1(G) of the Standard Specifications:

Provide real world coordinates for all field devices (including but not limited to controller cabinets, closed circuit television cameras, dynamic message signs, and oversized junction boxes) installed and/or modified under this project. Provide the coordinates in feet units using the North Carolina State Plane coordinate system (1983 North American Datum also known as NAD '83). Furnish coordinates that do not deviate more than 1/2 meter (1.7 ft) in the horizontal plane and 1 meter (3.3 ft) in the vertical plane. Global positioning system (GPS) equipment able to obtain the coordinate data within these tolerances may be used. Submit cut sheets on the GPS unit proposed to collect the data for approval by the Engineer. For equipment cabinets, obtain and provide the location of the cabinet.

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

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

Provide plans of record for all splicing that differs or deviates from the splicing diagrams shown in the plans. Provide one durable hard copy to the Engineer at the completion of the project. Make available, upon request by the Engineer, documentation of splicing that differs or deviates from the plans during the life of the project.

B. Domestic Steel and Iron Products

All steel and iron products which are permanently incorporated into this project shall be produced in the United States except minimal amounts of foreign steel and iron products may be used provided the combined project cost of the bid items involved does not exceed one tenth of one percent (0.1 percent) of the total amount bid for the entire project or $2,500.00, whichever is greater. This minimal amount of foreign produced steel and iron products permitted for use by this Special Provision is not applicable to fasteners. Domestically produced fasteners are required for this project.

All steel and iron products furnished as "domestic products" shall be melted, cast, formed, shaped, drawn, extruded, forged, fabricated, produced, or otherwise processed and manufactured in the United States. Raw materials including pig iron and processed pelletized and reduced iron ore used in manufacturing "domestic" steel products may be imported; however, all manufacturing processes to produce the products, including coatings, must occur in the United States.

Before each steel or iron product is incorporated into this project or included for partial payment on a monthly estimate, the Contractor shall furnish the Resident Engineer a notarized certification

certifying that the product conforms to the above requirements of this Special Provision. The Resident Engineer will forward a copy of each certification to the Materials and Tests Unit.

Each purchase order issued by the Contractor or a subcontractor for steel and iron products to be permanently incorporated into this project shall contain in bold print a statement advising the supplier that all manufacturing processes to produce the steel or iron shall have occurred in the United States. The Contractor and all affected subcontractors shall maintain a separate file for steel products permanently incorporated into this project so that verification of the Contractor's efforts to purchase "domestic" steel and iron products can readily be verified by an authorized representative of the Department or the Federal Highway Administration.

C. Other Codes and Standards

All electrical equipment must conform to the latest version of the applicable standards of the National Electrical Manufacturer's Association (NEMA), the Underwriters' Laboratories, Inc. (UL), the Electronic Industries Association (EIA), the International Municipal Signal Association (ISMA), and the National Electrical Safety Code (NESC). Furnish material and workmanship conforming to the NEC, NESC, UL, American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI) and all local safety codes in effect on the date of advertisement.

3.2. BASIS OF PAYMENT

There will be no direct payment for work covered in this section. Payment at the contract unit prices for the various items in the contract will be full compensation for all work covered in this section.

4. ELECTRICAL AND PHONE SERVICE

4.1. DESCRIPTION

Install new electrical service or modify existing electrical service as indicated on the Plans at DMS and CCTV camera sites. Comply with the Standard Specifications and these Project Special Provisions. At locations called out in the Plans, install new electrical and/or telephone services. All work involving these services shall be coordinated with the appropriate utility company. Install new electrical and phone service for the successful installation and operation of the DMSs and CCTV cameras. Final locations of the DMSs and CCTVs camera should consider placement to minimize the services connection costs associated with the installation.

4.2. MATERIAL

Construct electrical and phone service installations in accordance with the Standard Specifications. Furnish and install all materials necessary from the point of connection with the utility company to the equipment cabinet.

Install new electrical service for the successful installation and operation of the DMSs and CCTV cameras. Coordinate all work involving electrical service with the local agency serving the specific site and install new services. Final locations of electrical services should consider connection costs associated with the installation of electrical services. Fees associated with the

electrical and phone connections will be the sole responsibility of the Contractor. The Department will not reimburse the Contractor for connection fees.

For new electrical service, provide a service that includes a new external service disconnect (breaker box) and a meter base.

Service cables must run separately to each of the cabinets in 25 mm (1") rigid metallic conduit.

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

4.3. 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. 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). Route the electrical service through the meter base and service disconnect to the controller cabinet to form a complete electrical service assembly. 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.

C. Phone Service

At locations where new phone service is required, coordinate with the local Phone Company, provide all required equipment, hardware, wires, cable, conduits, poles, and etc. for successful delivery, installation, connection, and activation of the service.

4.4. METHOD OF MEASUREMENT

The actual number of new electrical service locations furnished, installed, and accepted. No measurement will be made of electrical conductors, grounding system components, 25 mm (1") riser with weatherhead, vertical sections of 25 mm (1") rigid metallic conduit, meter base, connection to equipment cabinet, and service disconnect as these will be considered incidental to furnishing and installing electrical service.

The actual number of modified existing electrical service locations furnished, installed, and accepted. No measurement will be made of electrical conductors, grounding system components, 25 mm (1") conduit, circuit breakers, and connection to equipment cabinet as these will be considered incidental to furnishing and installing modified electrical service.

The actual number of new phone service locations furnished, installed, and accepted. No measurement will be made of equipment, hardware, wires, cable, conduits, poles, etc. for successful

delivery, installation, connection, and activation of the service as these will be considered incidental to furnishing and installing new phone service.

4.5. BASIS OF PAYMENT

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

The quantity of modified electrical service, measured as provided above, will be paid for at the contract unit price each for "Modify Existing Electrical Service."

The quantity of new phone service, measured as provided above, will be paid for at the contract unit price each for "New Phone Service."

Payment will be made under:

New Electrical Service ..... **Each**
Modify Existing Electrical Service ..... **Each**
New Phone Service ..... **Each**

5. JUNCTION BOXES

5.1. DESCRIPTION

Furnish and install junction boxes (pull boxes) with all necessary hardware in accordance with the Plans and these Project Special Provisions.

Furnish junction boxes with covers, graded stone, grounding systems, and all necessary hardware.

5.2. MATERIALS

A. Junction Boxes

Comply with Article 1098-5 of the Standard Specifications.

B. Graded Stone

Comply with Articles 545-2 and 545-3 of the Standard Specifications.

5.3. CONSTRUCTION METHODS

A. General

Comply with Article 1411-3 of the Standard Specifications except as noted herein:

Install the junction boxes flush with finished grade. Do not install sealant compound between junction boxes and covers.

Install junction boxes at maximum intervals of 457 m (1500 ft), or where shown on the Plans and at locations where underground splicing of lead-in cable is necessary, whichever is less.

B. Reuse Existing Junction Boxes

At certain locations shown in the Plans, reuse existing pull boxes. Precaution shall be taken to prevent damage to the existing conduit or cables. Coil 10 m (30 ft) of each new fiber optic cable entering each existing pull box.

5.4. METHOD OF MEASUREMENT

The actual number of junction boxes of each size and type furnished, installed and accepted.

No measurement will be made of covers, graded stone, and required grounding systems as these will be considered incidental to furnishing and installing junction boxes.

5.5. BASIS OF PAYMENT

The quantity of oversized junction boxes, measured as provided above, will be paid for at the contract unit price each for "Junction Box (Oversized)".

Payment will be made under:

Junction Box (OverSized) ..... **Each**

6. DIRECTIONAL DRILLING

6.1. DESCRIPTION

Furnish and install conduit(s) and all necessary hardware by using the horizontal directional drilling method in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

6.2. MATERIALS

A. General

Provide conduit that is suitable for underground use in an ambient temperature range of -35 to 55 degrees C (-30 to 130 degrees F) without degradation of material properties.

Provide conduit that is resistant to benzene, calcium chloride, ethyl alcohol, fuel oil, gasoline, lubricating oil, potassium chloride, sodium chloride, sodium nitrate, and transformer oil, and is protected against degradation due to oxidation and general corrosion.

Provide conduit(s) with an outer diameter to minimum wall thickness ratio that complies with ASTM-D3035, Standard Dimension Ratio (SDR) 13.5.

Provide conduit(s) that meet or exceeds the following:

ASTM-D638	Tensile Strength – 20 Mpa (3,000 psi), minimum
	Elongation - 400 percent, minimum
ASTM-D1238	Melt Index - 0.4 maximum
ASTM-D1505	Density - (0941-0955 g/cc)
ASTM-D1693	Condition B - 20 percent failure, maximum

ASTM-D2444	Impact - NEMA Standards Publication Number TC7
ASTM-D3350	Cell classification - 334420 or 344420

Furnish conduits with a coefficient of friction of 0.09 or less in accordance with Belcore GR-356.

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.

Furnish 12.7-mm (½ in), prelubricated, woven polyester tape, pull line with a minimum rated tensile strength of 11 kN (2,500 lb).

B. Polyethylene Conduit

Furnish factory lubricated 31.75 mm (1.25 in) inside diameter, low friction, coilable, conduit constructed of virgin high-density polyethylene. Provide conduit with a smooth outer wall and ribbed inner wall and ensure the conduit is capable of being coiled on reels in continuous lengths, transported, stored outdoors, and subsequently uncoiled for installation without affecting its properties or performance.

Furnish duct plugs that provide a watertight barrier when installed in an unused conduit. Furnish duct plugs sized in accordance with the conduit furnished. Provide duct plugs that are removable.

Furnish mechanical sealing devices that provide a watertight barrier between the conduit and communications cable. Furnish mechanical sealing devices sized in accordance with the conduit furnished and with appropriately sized holes for the communications cable. Provide mechanical sealing devices that are removable.

6.3. CONSTRUCTION METHODS

A. Pre-Approvals and Minimum Depth Requirements

Obtain the Engineer's approval prior to beginning drilling operations.

At all points where the proposed conduit will traverse under city streets, state roads, driveways, sidewalks, and/or "Controlled Access Areas" including entrance/exit ramps, ensure the conduit(s) maintains a minimum depth of 1.2 m (4 ft) or 8 times the back reamer's diameter, whichever is deeper. In these cases, the conduit shall reach the minimum depth specified above at a minimum distance from the edge of pavement of 1.2 m (4 ft) or 8 times the back reamer's diameter, whichever is greater. For deeper depths, maintain a 1V:1H ratio. For example, a 2.4 meter (8 ft) depth would have to be maintained to 2.4 m (8 ft) off the edge of pavement.

For an installation that runs parallel to city streets, state roads, driveways, sidewalks, and/or "Controlled Access Areas" including entrance/exit ramps, ensure the conduit maintains a minimum depth of 760 mm (30 in) below grade and a minimum distance of 760 mm (30 in) from edge of pavement or as shown on plans.

Maintain a minimum clearance of 760 mm (30 in) below grade when crossing ditch lines.

For the following installations, the minimum clearance requirements are shown in the table below:

Installation:	Minimum Clearance Requirement:
Traverse under city streets, state roads, driveways, sidewalks, and/or "Controlled Access Areas"	1.2 m (4 ft) or 8 times the back reamer's diameter below grade and 1.2 m (4 ft) or 8 times the back reamer's diameter from edge of pavement
Parallel to city streets, state roads, driveways, sidewalks, and/or "Controlled Access Areas"	760 mm (30 in) below grade and a minimum distance of 760 mm (30 in) from edge of pavement
Ditch lines	760 mm (30 in) below grade
Bridge foundation	1.5 m (5 ft) horizontal & 1.2 m (4 ft) vertical (clearances greater than minimum horizontal should continue to use the 4V:5H ratio, i.e., 3 m (10 ft) horizontal should be no deeper than 2.4 m (8 ft)
Slope protection	.6 m (2 foot) below
Slope protection foundation footing	1.5 m (5 foot) below
Drainage pipes less than 60"	300 mm (12 in) above or below
Drainage pipes greater than 60"	300 mm (12 in) above or 1.2 m (4 ft) below
Box Culverts	300 mm (12 in)

B. Directional Drill Operations

Provide grounding for the drill rig in accordance with the manufacturer's recommendations.

Guarantee the drill rig operator and digital walkover locating system operator are factory-trained to operate the make and model of the equipment provided and has a minimum of one year's experience operating the make and model of drill rig. Submit written documentation of the operators' training and experience at least two weeks prior to commencing directional drilling operations for review by the Engineer.

Provide a means of collecting and containing drilling fluid/slurry that returns to the surface such as a slurry pit. Provide measures to prevent drilling fluids from entering drainage ditches and storm sewer systems. Prevent drilling fluid/slurry from accumulating on or flowing onto sidewalks, other pedestrian walkways, driveways or streets. Immediately remove any drilling fluids/slurry that is accidentally spilled.

Place excavated material near the top of the working pit and dispose of as required. Backfill pits or trenches excavated to facilitate drilling operations immediately after the drilling has been completed.

Utilize a drill head suitable for the type of material being drilled and sized no more than 50 mm (2 in) larger than the outer diameter of the conduit to be installed. Direct the drill head as needed to obtain the proper depth and desired destination. Pressure grout with an approved bentonite/polymer slurry mixture to fill any voids. Jetting alone or wet boring with water will not be permitted.

For directional drilling of multiple ducts, utilize a drill head suitable for the type of material being drilled and sized no more than 2" larger than the minimum outside diameter needed to circumscribe the set of multiple conduits. Direct the drill head as needed to obtain the proper depth and desired destination. Use an approved bentonite/polymer slurry mixture drilling fluid. Jetting alone or wet boring with water shall not be permitted.

During each drilling operation, locate the drill head every 3 m (10 ft) along the drill path and prior to transversing any underground utility or structure. Use the digital walkover locating system to track the drill head during the directional drilling operation. Ensure the locating system is capable of determining the pitch, roll, heading, depth and horizontal position of the drill head at any point. Unless otherwise approved, do not deviate from the proposed line and grade by more than two percent.

The intent of these specifications is to limit the diameter of the actual drill shaft/hole such that it is no more than 50 mm (2 in) larger than the conduit(s) outer diameter. The 50 mm (2 in) larger diameter can be accomplished during the original bore or during the back reaming/conduit installation process.

Once the physical installation of the conduit has started, continue performing the installation without interruption to prevent the conduit from becoming firmly set. Ensure the bentonite/polymer slurry mixture is applied as the conduit installation process is occurring.

Upon completion of the conduit installation perform a mandrel test on the conduit system to ensure that no conduit(s) has been damaged. Furnish a non-metallic mandrel having a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred, replace the entire length of conduit.

Extend the ends of the conduit such that upon completion of the installation the conduit will extend a minimum of 50 mm (2 in) above concrete surfaces and 100 mm (4 in) above crushed stone bases.

C. Drilling Fluids

Furnish and use lubrication for subsequent removal of material and immediate installation of the pipe. The use of water and other fluids in connection with the directional drilling operation will be permitted only to the extent necessary to lubricate cuttings. Jetting alone or wet boring with water shall not be permitted. Use a drilling fluid/slurry consisting of at least 10 percent high-grade bentonite to consolidate excavated material and seal the walls of the drill hole.

Transport waste drilling fluid/slurry from the site and dispose of such slurry in a method that complies with Local, State and Federal laws and regulations.

D. Splicing of the Conduit

Do not splice or join sections of conduit(s). Upon approval, a junction box may be installed at locations where splicing or coupling of the conduit is necessary due to problems encountered with the installation.

E. Duct Plugs and Mechanical Sealing Devices

Following the installation of the conduit(s) where the communications cable is not immediately installed use a duct plug to seal the ends of the conduit. Secure the pull line to the duct plug in such a manner that it will not interfere with the installation of the duct plug and provide a watertight seal.

In conduits containing communications cable seal the conduit with an approved mechanical sealing device. Ensure the installation provides a watertight seal.

F. Plan of Record Drawings

Upon completion of the drilling operation and conduit installation furnish the Engineer with a plan of record profile drawing and a plan drawing for the drilled conduit showing the horizontal and vertical locations of the installed conduit.

6.4. METHOD OF MEASUREMENT

Measured horizontal linear meters of two 31.75 mm (1.25 in) directionally drilled polyethylene conduits furnished, installed and accepted. Measurement of the drill path will be from point-to-point horizontally along the approximate centerline.

No additional payment will be made for vertical and horizontal sweeps, excavation of drill pits, backfill, site restoration, seeding and mulching, removal of excess material, duct organizers, mechanical sealing devices, duct plugs, pulling lubricants, mandrel test, and plan of record drawings, as these will be considered incidental to the directional drill and/or conduit installation.

6.5. BASIS OF PAYMENT

The quantity of two directional drilled 31.75 mm (1.25 in) polyethylene conduits, measured as provided above, will be paid for at the contract unit price per linear meter as " Directional Drill Polyethylene Conduit, (31.75 mm) (Two Conduits)"

Payment will be made under:

Directional Drill Polyethylene Conduit, (31.75 mm) (Two Conduits).....Linear Meter

7. UNDERGROUND POLYETHYLENE CONDUIT

7.1. DESCRIPTION

Furnish and install underground polyethylene conduit systems with all necessary hardware in accordance with specifications. Comply with the provisions of Section 1700 of the 2002 *Standard Specifications for Roads and Structures.*

7.2. MATERIALS

Furnish factory lubricated, low friction, coilable conduit constructed of virgin high-density polyethylene (HDPE). Provide individual conduits with smooth outer walls and ribbed inner walls and ensure the conduit is capable of being coiled on reels in continuous lengths, transported, stored outdoors, and subsequently uncoiled for installation without affecting its properties or performance.

Provide conduit that is suitable for underground use in an ambient temperature range of – 30 to 130 degrees F (-35 to 55 degrees C) without degradation of material properties.

Provide conduit that is resistant to benzene, calcium chloride, ethyl alcohol, fuel oil, gasoline, lubricating oil, potassium chloride, sodium chloride, sodium nitrate, and transformer oil, and is protected against degradation due to oxidation and general corrosion.

Provide conduit(s) with an outer diameter to minimum wall thickness ratio that complies with ASTM-D3035, Standard Dimension Ratio (SDR) 13.5.

Provide conduit(s) that meets or exceeds the following:

ASTM-D638	Tensile Strength - 3,000 psi (20 Mpa), minimum Elongation - 400 percent, minimum

ASTM-D1238	Melt Index - 0.4 maximum
ASTM-D1505	Density - (0941-0955 g/cc)
ASTM-D1693	Condition B - 20 percent failure, maximum
ASTM-D2444	Impact - *NEMA Standards Publication Number TC7*
ASTM-D3350	Cell classification - 334420 or 344420

Furnish conduits with a coefficient of friction of 0.09 or less in accordance with *Belcore GR-356.*

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.

Furnish conduit organizers at all points where multiple conduits enter and exit a junction box or cabinet. Furnish conduit organizers that are appropriately sized with regards to the conduits. Provide conduit organizers that are removable.

Furnish duct plugs that provide a watertight barrier when installed in an unused conduit. Furnish duct plugs sized in accordance with the conduit furnished. Provide duct plugs that are removable.

Furnish mechanical sealing devices that provide a watertight barrier between the conduit and communications cable. Furnish mechanical sealing devices sized in accordance with the conduit furnished and with appropriately sized penetration holes for the communications cable. Provide mechanical sealing devices that are removable.

Furnish conduit spacers to bind the individual conduits together when installed in a common trench. Furnish conduit spacers that are appropriately sized with regards to the conduits.

Furnish 12.7 mm (½ in), prelubricated, woven polyester tape, pull line with a minimum rated tensile strength of 11 kN (2,500 lb) in all conduit(s).

Furnish non-detectable underground marker tape with the wording "WARNING -- Fiber Optic Cable" in all trenches.

7.3. CONSTRUCTION METHODS

A. General

Pull tracer wire simultaneously with the fiber-optic communications cable in a continuous length. When multiple pulls of fiber-optic cable are required, only one tracer wire is required. Where tracer wire is spliced, provide waterproof butt splices. Splicing is allowed only in cabinets and junction boxes. Label and connect the tracer wire(s) to the equipment ground bus bar in all cabinets and as directed by the plans.

In non-used/spare conduits, seal each end of the conduit with a duct plug. Secure each end of the pull line to the duct plug prior to installing the duct plug. Ensure that the placement of the pull line does not interfere with the installation of the duct plug and provides a watertight seal.

In conduits containing communications cable seal the conduit with an approved mechanical sealing device. Ensure the installation provides a watertight seal.

For underground polyethylene conduit installations (trenched or plowed), backfill in accordance with Section 300-7 of the Standard Specifications.

B. Underground Polyethylene Conduit Installation in Trench

Install underground polyethylene conduit system along the route of the trench. Install conduit organizers at points where multiple conduits enter or exit the junction box or cabinet, etc.

Maintain a minimum trench depth of 760 mm (30 in) below finished grade or 150 mm (6 in) below roadway subgrade, whichever is deeper.

Install longitudinal runs of conduit at a minimum of 300 mm (1 ft) from the back of curb or 1.8 m (6 ft) from the edge of pavement in the absence of curb.

Install the non-detectable marker tape approximately 380 mm (15 in) below the finished grade.

Extend the ends of the conduits such that upon completion of the installation the conduits will extend a minimum of 50 mm (2 in) above concrete surfaces and 100 mm (4 in) above crushed stone bases.

Remove all rock and debris from backfill material. Remove excess material from the site and compact the excavation according to Section 300-7 of the Standard Specifications.

Finish unpaved areas flush with the surrounding natural ground. Restore damaged grassed areas. Seed and mulch within 7 days after the occurrence of the damage.

Finish paved areas with materials matching the damaged area within 7 days of the occurrence of the damage. Cut neatly and replace only the width of the trench for damages caused by trenching. Place graded stone material to temporarily maintain traffic where repairs cannot be performed immediately. Comply with Section 545 of the 2002 Standard Specifications for Roads and Structures.

Backfill the trench at locations along the trench path where non-movable objects, such as rocks and boulders, cannot be avoided, thus causing a deviation in the elevation height of the underground polyethylene conduit system. The purpose of the backfill is to provide a gradual change in the elevation of the trench, from the bottom elevation to the highest point of the obstruction such that excessive bending and stress will not be transferred to the conduits once the underground polyethylene conduit system is installed.

After the installation of the conduits and upon completion of the tamping and backfill process, perform a mandrel test on each individual conduit to ensure that no conduit has been damaged. Furnish a non-metallic mandrel having a diameter of approximately 50% of the inside diameter of the conduit in which it is to be pulled through. If damage has occurred replace the entire length of conduit.

C. Underground Polyethylene Conduit Installation by Plowing

Direct plow the number of HDPE ducts called for in the plans simultaneously using chute plow method. Direct plow ducts at a minimum depth such that the top of the highest duct is 760 mm (30 in) deep unless otherwise approved by the Engineer.

Use equipment that is of a sufficient size and horsepower to accommodate the chute plowing of up to two (2) reels of duct to the depth called for in these Project Special Provisions. Do not exceed reel dimensions, burial depths, and weight limits called for by the equipment manufacturer. Follow all procedures required or recommended by the equipment manufacturer.

Provide sufficient personnel to feed chute, operate prime mover and equipment carrying reels (if separate equipment is used), observe chute feeding, observe plowing, and observe reel payout. Use chute with adequate dimensions to allow for passage of duct and cable without damage to either.

During the plow operation, continuously check the chute opening and path to be sure there are no obstructions and monitor the payout reels to be sure that the reels are turning at a steady rate.

D. Splicing of Underground Polyethylene Conduits

Splicing or joining of underground polyethylene conduits is prohibited. With the Engineer's Approval, install a junction box at all locations where splicing or coupling of the underground polyethylene conduits would be necessary due to problems encountered with the installation method.

E. Plan of Record Drawings

Upon completion of the underground polyethylene conduit system installation, furnish the Engineer with a plan of record profile drawing and plan drawing showing the horizontal and vertical locations of the installed conduit system.

7.4. METHOD OF MEASUREMENT

Measured horizontal linear meters of each HDPE system (containing the individual conduit(s) called for in the plans) that is furnished, installed underground (via plowed and/or trench and backfill), and accepted. Measurement of the HDPE conduit system will be from point-to-point horizontally along the approximate centerline.

Vertical segments will not be paid for as these will be considered incidental to the installation of the conduit system.

No additional payment will be made for trenching (paved or unpaved), seeding and mulching, removal of excess material, furnishing and placing incidental stone, furnishing and placing paved material, marker tape, pull lines, mechanical sealing devices, duct plugs, pulling lubricants, mandrel test, and plan of record drawings, as they will be considered incidental.

7.5. BASIS OF PAYMENT

The quantity of four HDPE conduits installed underground, measured as provided above, will be paid for at the contract unit price per linear meter as "Trench/Plow Underground Conduit, (31.75 mm) (Two Conduits)."

Payment will be made under:

Trench/Plow Underground Conduit, (31.75 mm) (Two Conduits) .....Linear Meter

8. CCTV FIELD EQUIPMENT

8.1. DESCRIPTION

Furnish equipment that is compatible, interoperable, and completely interchangeable with existing Pelco Spectra III, or approved equivalent, high-performance dome equipment currently in use in the Region. The unit shall be fully compatible with all features of the existing matrix

switcher at the PTRTMC and the CCTV control software, unless otherwise approved by the Engineer.

8.2. MATERIALS

A. General

Furnish and install, at the locations shown on the Plans, new CCTV camera assemblies. Each assembly consists of the following:

- One Pelco Spectra Series III Dome CCTV or approved equal that contains in a single enclosed unit with 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 cable, 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 equal.

B. Camera and Lens

B.1 Cameras

Furnish new charged coupled device (CCD) color cameras. The cameras shall provide automatic gain control (AGC) for clear images in varying light levels. The cameras shall meet 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.
- 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

B.2 Zoom lens

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

- Focal length: 4 mm (0.16") – 86.25 mm (3.45"), 22X optical zoom, 12X electronic zoom
- Preset positioning: 64 Presets

The lens shall be capable of both automatic and remote manual control iris and focus override operation. The lens shall be 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. The operating voltages of the lens shall be compatible with the outputs of the camera control.

C. Camera Housing

Furnish new dome style enclosure for the CCTV assemblies that are Pelco Spectra III high performance integrated dome system or approved equal. Equip each housing with a mounting assembly for attachment to the CCTV camera pole. The enclosures shall be equipped with a sunshield and be fabricated from corrosion resistant aluminum and finished in a neutral color of weather resistant enamel. The enclosure shall meet or exceed NEMA 4X ratings. The viewing area of the enclosure shall be tempered glass. The enclosure must be equipped with factory installed heaters.

D. Pan and Tilt Unit

Each new dome style assembly shall be equipped with a pan and tilt unit. The pan and tilt unit shall be integral to the Pelco Spectra III high performance integrated dome system or approved equal. The pan and tilt unit shall be rated for outdoor operation, provide dynamic braking for instantaneous stopping, prevent drift, and have minimum backlash. The pan and tilt units shall 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

E. Control Receiver/Driver

Each new camera unit shall contain control receiver/driver that is integral to the CCTV dome assembly. The control receiver/driver shall receive serial asynchronous data initiated from a camera control unit, decode the command data, perform error checking, and drive the pan/tilt unit, camera controls, and motorized lens. As a minimum, the control receiver/drivers shall provide 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, each control receiver/driver shall accept status information from pan/tilt unit and motorized lens for preset positioning of those components. The control receiver/driver shall relay pan, tilt, zoom, and focus positions from the field to remote camera control units. The control receiver/driver shall accept "goto" preset commands from the camera control unit, decode the command data, perform error checking, and drive the pan/tilt and motorized zoom lens to the correct preset position. The preset commands from the camera control unit will consist of unique values for the desired pan, tilt, zoom, and focus positions.

F. CCTV Camera Attachment to Pole

At locations shown in the Plans where new CCTV cameras are to be installed on new CCTV poles, design, fabricate, and furnish an attachment assembly for the CCTV camera unit. Use stainless steel banding approved by the Engineer. Submit shop drawings for review and approval by the Engineer prior to installation.

Furnish CCTV attachment that allows for the removal and replacement of the CCTV enclosure as well as providing a weatherproof, weather tight, seal that does not allow moisture to enter the enclosure.

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 20.4 kg (45 pounds).

G. Surge Suppression

All equipment at the top of the pole shall be protected by grounded metal oxide varistors connecting each power conductor to ground.

Coaxial cable from each camera shall be protected by a Vicon V15LP surge protector or an approved equivalent, at each end of the cable.

H. CCTV Camera Wood Pole

Furnish wood poles to mount CCTV units and equipment cabinets that meet or exceed the requirements of Section 1720 of the Standard Specifications unless otherwise noted in the Plans or these Project Special Provisions.

Furnish and install Class 3, 18.4 m (60-foot) wood pole at the CCTV camera locations as shown on the plans. Bury poles 3 m (10 ft).

Furnish poles that when erected and completely installed are at a minimum height of 15 m (50 ft) above the grade of their base.

I. Model 336 Field Equipment Cabinet

I.1 General

Furnish, install and integrate equipment cabinet to house network communications equipment and associated hardware to support CCTV equipment. Comply with the provisions of *Section 1700 of the Standard Specifications*.

Furnish 336 cabinets to house CCTV control and transmission equipment and fiber optic interconnect centers for terminating, splicing, and cross-connecting fiber optic cables. The 336 CCTV cabinet shall consist of a cabinet housing, 483 mm (19 in) 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. 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.

I.2 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, should be provided in the cabinet. The pull-out drawer should extend a minimum of 36 cm (14 in). Minimum interior dimensions of the drawer are 2.5 cm (1 in) high, 33 cm (13 in) deep, and 40.6 cm (16 in) wide. The drawer should support an 18 kg (40 pound) device or component when fully extended.

I.3 Cabinet Light

Equip each CCTV cabinet with two (2) fluorescent lighting fixtures (one front, one back) mounted horizontally inside the top portion of the cabinet. A door-actuated switch should be installed to turn on the applicable cabinet light when the front door or back door is opened. The lights should be mounted not to interfere with the upper door stay.

I.4 Surge Protection for System Equipment

Provide each cabinet with devices to protect the CCTV and communications equipment from electrical surges and over voltages as described below.

I.5 Main AC Power Input

Furnish each CCTV cabinet with a hybrid type power line surge protection device mounted inside the power distribution assembly. Install the protector between the applied line voltage and earth ground. The surge protector should be capable of reducing the effect of lighting transient voltages applied to the AC line. Mount the protector inside the Power Distribution Assembly housing facing the rear of the cabinet. The protector must 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).
- Separate the Main AC line in and the Equipment Line out terminals with a 200 Microhenry (minimum) inductor rated to handle 10 AMP AC Service.
- The first stage clamp should be between Main Line and Ground terminals.
- The second stage clamp should be between Equipment Line Out and Equipment Neutral.
- The protector for the first and second stage clamp should have an MOV or similar solid state device rated at 20 KA and be a completely solid state design (i.e., no gas discharge tubes allowed).
- The Main Neutral and Equipment Neutral Out should be connected together internally and have an 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 must never exceed 350 volts.
- The Protector must be epoxy-encapsulated in a flame retardant material.
- Continuous service current: 10 Amps at 120 VAC RMS.
- The Equipment Line Out must provide power to cabinet CCTV and communications equipment and to the 24V power supply.

I.6 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. METHOD OF CONSTRUCTION

A. General

Install the CCTV camera assemblies on wood poles approximately 13.72 m (45 ft) above ground level. Provide coaxial video cables with BNC connector terminations. A minimum of 2 m (6.5 ft) of slack for each camera lead must be provided in the associated controller cabinet.

Surge Suppression/Bonding: Install coaxial cables with surge suppressors that meet or exceed the following minimum characteristics:

- The clamping voltage must be 11 volts between the shield and center conductor signal line.
- The response time must be five nanoseconds or less.
- Bipolar silicon avalanche diode technology must be used in a single stage device.
- The module must dissipate a minimum of 50 Joules.
- The module must have BNC connectors.

Install RS-232/RS-422 converters as required. Provide the camera control lead-in cables with in-line surge suppression in accordance with manufacturer recommendations.

The Engineer will approve all camera locations.

Mount the CCTV camera on side of pole nearest intended field of view and avoid occluding the view with the pole.

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 fiber optic transmission equipment, equipment cabinet, and equipment cabinet power supply.

B. Electrical and Mechanical Requirements

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

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

Install coaxial cable as required to interconnect fiber optic video transceivers with the CCTV units. Insure that all connections are tight and fully secure.

C. Model 336 Field Equipment Cabinet

For each CCTV Assembly use banding or other method approved by the Engineer to fasten CCTV cabinet to pole.

Install all conduit, condulets, and attachments to equipment cabinets in a manner that preserves the minimum bending radius of the fiber optic cable and creates waterproof connections and seals.

D. RS-232 to RS-485/RS-422 Converter

Install RS-232 to RS-485/422 converter with each new CCTV assembly unit installed. Install inline between CCTV PTZ control feed and VOT-D unit data input. Integrate with cabinet power supply via terminal blocks as required.

8.4. METHOD OF MEASUREMENT

Actual number of CCTV 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 fiber optic communications equipment. No separate measurement will be made for integration of CCTV unit with Central CCTV Control Software.

Actual number of CCTV wood poles furnished and installed. CCTV wood poles include, but are not limited to, wood poles, conduits, risers, weatherheads, grounding system, excavation, restoration of surface areas, and labor equipment.

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

No separate payment will be made for RS-232 to RS-485/422 converter. RS-232 to RS-485/422 converter units, furnished and installed in the quantities required, will be incidental to the "CCTV Assembly" pay item.

8.5. BASIS OF PAYMENT

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

The quantities of CCTV Wood poles as provided above will be paid for at the contract unit price each for "CCTV Wood Pole."

Payment will be made under:

CCTV Assembly ..... Each

CCTV Wood Pole ..... Each

9. HIGH POINT TOC VIDEO EQUIPMENT

9.1. Description

Furnish and install a new video matrix switcher in the City of High Point Traffic Operations Center (TOC). Include all necessary software, hardware, and cables to provide a fully integrated and operational system. For compatibility with existing equipment in the Region, furnish a Pelco Model 9770 or approved equivalent. As a minimum, the switcher must provide 64 inputs and 32 outputs. Furnish and install two joystick control panels that are fully compatible with CCTVs and the new video switch. The connections between the City of High Point TOC and the remote video sites will be provided using a combination of new and existing fiber optic communications system as shown in the Plans.

9.2. Materials

A. Video Switch

Furnish and install one (1) modular full matrix video switch with two (2) desktop joystick controllers and computer software interface. Install all cables, hardware, power supplies, input / output cards and software required to provide a completely integrated and operational system. Provide the capability to route any received videos to any outputs available including workstation monitors, video wall monitors, and projectors. Provide a video switch that can be controlled through a computer, control panel and remote control keypad. Provide capacity for 64 inputs and 32 outputs.

Provide a video matrix switch that meets the following minimum functional requirements:

- Full cross-point video matrix
- RS422 Full duplex communication
- Logical camera selection
- Priority level operation
- Built-in video loss detection and system diagnostics
- Bandwidth: 15 MHz
- S/N ratio: -60 dB
- Crosstalk: -54.4 dB at 3.58 MHz
- Differential gain: 0.52%
- Switching time: 16 milliseconds
- Inputs: 64 (NTSC video with BNC connectors)
- Outputs: 32 (NTSC video with BNC connectors)
- Impedance: 75 ohms
- Operating Temperature: 14 degrees to 122 degrees
- Electrical: 120 VAC, 60 Hz
- Mounting: Fits in standard 19" rack
- UL / CE Certified
- Two (2) Desktop Joystick Controllers

9.3. Construction Methods

Remove the existing video switch in the High Point TOC. Label all connections prior to removal to ensure proper connectivity of the new video switch. Furnish one (1) 64 x 32 video matrix switch and install in the existing equipment rack in the High Point TOC. Install all necessary software, hardware, mounting brackets, cabling, power supplies, and surge suppression.

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

9.4. Method of Measurement

Actual number of Video Switches furnished, installed and accepted.

Actual number of Desktop Joystick Controllers furnished, installed and accepted.

No separate measurement will be made for software, jumper cables, coax cables, communication cables, electrical cables, surge suppressors, mounting hardware, nuts, bolts, brackets, or connectors as these will be considered incidental to the video equipment pay items listed above.

9.5. Basis of Payment

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

The quantity of desktop joystick controllers, measured as provided above, will be paid for at the contract unit price each for "Desktop Joystick Controller."

Payment will be made under:

Video Switch ..... Each
Desktop Joystick Controller ..... Each

10. FIBER OPTIC COMMUNICATIONS SYSTEM

10.1. DESCRIPTION

Furnish encoded digital fiber optic video transceivers with control data that consists of a pair of electronic units referred to as the fiber optic video transmitter with control data and fiber optic video optical receiver with control data. When interconnected by means of a SMFO cable, the units must communicate real-time National Television Standards Committee (NTSC) compliant video from input to output and support full duplex RS-232 or RS-422 digital status and control signal communications. Interface the NTSC video signal by means of a BNC connector with 75 ohms impedance. Provide NTSC RS-250B compatible electrical signal at the BNC output connector driving a 75 ohm impedance. The NTSC output signal level should be 1 volt peak-to-peak.

The function of the video transceiver pair is to communicate NTSC video, associated status, and control data from a CCTV camera location to the system field node using one single-mode fiber. The equipment must not cause rapid aging of the optical receiver, nor allow the optical receiver to reach optical or electrical saturation thereby causing high bit errors.

The Mean Time Between Failure (MTBF) of video transceiver should be a minimum of 43,800 hours when operated as a pair.

Stand-alone units must include their own power supply. Rack chassis installed units must be "hot swappable" into and out of rack unit with no risk of damage to the unit or the rack.

Furnish and install field hardened fiber-optic transceivers with all necessary hardware in accordance with the Plans and Specifications. Furnish and install 483 mm (19") SMFO transceiver racks with power supply in accordance with the Plans and Specifications.

10.2. MATERIALS:

A. SMFO Transceivers for CCTV Cameras and Control:

For compatibility with the existing equipment in the Region, furnish eight (8) IFS Model #VDT14130WDM SMFO Video Transceivers (Field), or an approved equivalent at all CCTV camera field cabinet locations.

For compatibility with the existing equipment in the Region, furnish the following equipment in the City of High Point TOC:

- Eight (8) IFS Model #VDR14130WDM-R3 SMFO Video Transceivers (Central) (or an approved equivalent)
- One (1) 8:1 SMFO Video Multiplexer, IFS Model # VT7830-2DRDT (or an approved equivalent)
- One (1) 1:8 SMFO Video De-Multiplexer, IFS Model # VR7830-2DRDT (or an approved equivalent)
- One (1) SMFO 10/100 Ethernet Transceiver, IFS Model # DE7200-S (or an approved equivalent)
- Two (2) 19" SMFO Transceiver Racks with Power Supply, IFS R3 Series (or an approved equivalent)

For compatibility with the existing equipment in the Region, furnish the following equipment in the PTRTMC:

- One (1) 8:1 SMFO Video Multiplexer, IFS Model # VT7830-2DRDT (or an approved equivalent)
- One (1) 1:8 SMFO Video De-Multiplexer, IFS Model # VR7830-2DRDT (or an approved equivalent)
- One (1) SMFO 10/100 Ethernet Transceiver, IFS Model # DE7200-S (or an approved equivalent)
- One (1) 19" SMFO Transceiver Rack with Power Supply, IFS R3 Series (or an approved equivalent)

10.3. CONSTRUCTION METHODS:

Install eight (8) SMFO Video Transceivers in the CCTV field cabinets as shown on the Plans.

Install the following equipment in the City of High Point TOC:

- Eight (8) SMFO Video Transceivers
- One (1) 8:1 SMFO Video Multiplexer
- One (1) 1:8 SMFO Video De-Multiplexer
- One (1) SMFO 10/100 Ethernet Transceiver
- Two (2) 483 mm (19") SMFO Transceiver Racks with Power Supply

Install the following equipment in the PTRTMC:

- One (1) 8:1 SMFO Video Multiplexer
- One (1) 1:8 SMFO Video De-Multiplexer
- One (1) SMFO 10/100 Ethernet Transceiver
- One (1) 483 mm (19") SMFO Transceiver Rack with Power Supply

10.4. METHOD OF MEASUREMENT:

Actual number of "SMFO Video Transceivers (Field)" furnished, installed and accepted.

Actual number of "SMFO Video Transceivers (Central)" furnished, installed and accepted.

Actual number of "8:1 Video Multiplexers" furnished, installed and accepted.

Actual number of "1:8 Video De-Multiplexers" furnished, installed and accepted.

Actual number of "SMFO 10/100 Ethernet Transceivers" furnished, installed and accepted.

Actual number of "Transceiver Racks with Power Supply" furnished, installed and accepted.

The above items include all cabling necessary to accomplish the complete integration of the video and data channels. Variable optical attenuators will be considered incidental to the cost of the fiber optic video transceivers. Integration at the Piedmont Triad Regional TMC will be considered incidental. Integration at the City of High Point TOC will be considered incidental. No separate payment will be made for mounting hardware, SMFO jumpers, connectors, adapters, power supplies as such work is considered incidental to the work covered by these items.

10.5. BASIS OF PAYMENT:

The quantity of SMFO transceivers (CCTV), measured as provided above, will be paid for at the contract unit price each for "SMFO Transceiver (CCTV)." The quantity of SMFO transceiver racks measured as provided above, will be paid for at the contract unit price each for "SMFO Transceiver Rack."

Payment will be made under:

SMFO Video Transceivers (Field).....Each

SMFO Video Transceivers (Central).....Each

8:1 Video Multiplexer..... Each

1:8 Video De-Multiplexer..... Each

SMFO 10/100 Ethernet Transceiver..... Each

Transceiver Rack with Power Supply.....Each

11. SYSTEM INTEGRATION

11.1. Integration With Existing Equipment

Integrate the following equipment at the City of High Point TOC:

- New CCTV Cameras installed under this project

- New Video Switch
- New SMFO Tranceivers
- New SMFO Video Multiplexers
- New SMFO Video De-Multiplexers
- New SMFO 10/100 Ethernet Transceivers
- New Transceiver Racks with Power Supplies
- New SMFO Communications System
- New Desktop Joystick Controllers
- New CCTV and Video Switch Control Software
- Existing CCTV Cameras
- Existing SMFO Transceivers
- Existing Large Screen Monitor
- Existing Video Monitors
- Existing Video Multiplexers
- Existing SMFO Communications System
- Existing Computer Workstations
- Existing City of High Point Traffic Web Site for CCTVs

Integrate the following equipment at the Piedmont Triad Regional TMC:

- New CCTV Cameras installed under this project
- New SMFO Video Multiplexers
- New SMFO Video De-Multiplexers
- New SMFO 10/100 Ethernet Transceivers
- New Transceiver Rack with Power Supply
- New SMFO Communications System
- Existing CCTV Cameras
- Existing SMFO Transceivers
- Existing Large Screen Monitor
- Existing Video Monitors
- Existing Video Multiplexers
- Existing SMFO Communications System
- Existing Computer Workstations
- Existing SmartLink™ CCTV Web Site

11.2. Video Management Software

Furnish and install Video Management Software on all CCTV workstations in the City of High Point TOC and at the Piedmont Triad Regional TMC. Provide Commercial Off The Shelf (COTS) software interfaces to access and control the new video switch at the City of High Point TOC and integrate with the existing software at the Piedmont Triad TMC. This software will enable the City of High Point TOC to control eight (8) outputs on the existing video switch at the Piedmont Triad Regional TMC. This software will also enable the Piedmont Triad Regional TMC to control eight (8) outputs on the new video switch at the City of High Point TOC.

This software must provide capability to access and control the video switches and route any available video input to any available display device. Furnish software that allows for installation via an automated, self-extracting, and self-installing program that steps the user through the

configuration of the software. Provide a software license that gives the Department the right to use the software at any location deemed appropriate in the State.

The software should be flexible and allow for new and enhanced protocols to be implemented as equipment evolves. The system will be password protected and will allow an administrator to easily make configuration changes as required.

11.3. Construction Methods

Integrate the new equipment installed under this project with the existing equipment at the City of High Point TOC and at the Piedmont Triad Regional TMC. Integrate all CCTV workstations with the Video Management Software. Configure the Video Management Software on all workstations.

11.4. Method of Measurement

The "System Integration" of the new equipment and software with the existing equipment and software at the City of High Point TOC and the Piedmont Triad Regional TMC will be paid for on a lump sum basis, furnished, installed and accepted.

This lump sum payment will be for both the City of High Point TOC and the Piedmont Triad Regional TMC. No separate measurement will be made software, cabling, connectors or hardware, as these will be considered incidental to system integration.

11.5. Basis of Payment

Payment for system integration, measured as provide above, will be paid for at the lump sum price for "System Integration."

Payment will be made under:

System Integration ..... Lump Sum

12. SYSTEM OPERATIONAL TEST AND OBSERVATION PERIOD

12.1. Description

Once all hardware and software has been installed and the system integration is complete, perform a System Operational Test, which fully exercises all functions of the system. Submit a test plan a minimum of fifteen (15) days prior to the scheduled start of the test. The Engineer will either approve or indicate changes that are required for approval of the test plan within fifteen (15) days of receipt.

12.2. Test Procedures/ Software and System Tests

Demonstrate that all equipment and software furnished has been installed properly and operates as specified in these Project Special Provisions.

Demonstrate software launch and login procedures. Ensure that defined users are allowed to login to the system and undefined users are not allowed to login to the system. Demonstrate creating, modifying, and deleting users and passwords. Demonstrate at least two permission levels, i.e. Administrator and User. Ensure that "users" logged on to the system are prohibited from adding, removing, or otherwise modifying any of the configuration settings in the software. Ensure that "administrators" logged on to the system have full permissions for adding, removing, or otherwise modifying any of the configuration settings in the software.

Demonstrate GUI controls and features. Ensure software is menu-driven with easy to use drop-down type menus for cameras, video switch, and video sharing between the City of High Point and the Piedmont Triad Regional TMC. Demonstrate selection and display of several CCTV images from each remote site. Demonstrate ability to display any CCTV image on any monitor. CCTV images displayed, monitors used for display, and multi-view settings will be chosen at random by the Engineer during the System Operational Test.

Demonstrate PTZ control for cameras from the Operator Workstations. Demonstrate PTZ controls for all connected cameras. Demonstrate PTZ controls from both Operator Workstations. Demonstrate the ability to define preset locations for each camera.

Demonstrate software's ability to handle future expansion. Ensure software configurations can be easily modified to accommodate new inputs, monitor outputs, multiplexers, and switches should additional equipment be installed at a later date.

Repair or replace any components or modules, which fail the System Operational Test.

Ensure that all software licenses have been furnished.

12.3. Installed Hardware and Documentation

Inspect all installed equipment. Ensure that the Equipment Racks, SMFO Transceivers, Video Switch, Video Multiplexers, Ethernet switches are installed in accordance with these Project Special Provisions. Ensure that all equipment is properly labeled. Ensure all wiring and cabling is neatly installed and properly labeled. Ensure that adequate surge protection for equipment is installed as required.

Demonstrate that all documentation has been provided. Ensure that bound user manuals and reproducible system diagrams & wiring diagrams have been furnished as specified in these Project Special Provisions.

12.4. Halt of System Operational Test

In the event that any component of the system malfunctions or operates below the level specified the System Operational Test must be halted. The Contractor will determine and correct

the problems, including repair or replacement of equipment, at no cost to the Department. Upon correction of the problems to the satisfaction of the Engineer, testing will resume.

13. 60-DAY OBSERVATION PERIOD

Upon completion of all project work, the successful completion of the System Operational Test and the correction of all known deficiencies, including minor installation items, and the 30 day DMS burn-in period, a 60-day Observation Period will commence. This Observation Period will consist of a 60-day period of normal operation without any failures. The 60-day Observation Period will 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 these Project Special Provisions over an extended length of time.

Respond to system or component failures (or reported failures) that occur during the 60-day Observation Period within 48 hours. Correct said failures within 72 hours. Failures that can not be corrected within 72 hours will suspend the timing of the 60-day Observation Period beginning at the time when the failure occurred. After the cause of such failures has been corrected, timing of the 60-day Observation Period will resume. Failures that necessitate a redesign of any major component will terminate the Observation Period. Once the components have been redesigned or replaced, the 60-Day Observation Period will be restarted from zero. Failures in any of the components exceeding a total of three (3) occurrences will terminate the 60-day Observation Period. Once the failures have been corrected, the 60-day Observation Period will be restarted from zero.

All documentation must be completed prior to the end of the 60-day Observation Period. The 60-day Observation Period will not be considered part of the contract time.

Final acceptance will occur upon the successful completion of the 60-day Observation Period and after all documentation requirements have been fully satisfied.

14. EMERGENCY RESTORATION EQUIPMENT

14.1. DESCRIPTION

This section identifies system support equipment materials and specifications.

14.2. MATERIALS

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

- Two (2) SMFO Video Transceivers (Field)
- Two (2) SMFO Video Transceivers (Central)
- Two (2) 8:1 Video Multiplexers
- Two (2) 1:8 Video De-Multiplexers
- Two (2) SMFO 10/100 Ethernet Tranceivers

14.3. METHOD OF MEASUREMENT

Actual number of SMFO Video Transceiver (Field) units furnished and accepted.

Actual number of SMFO Video Transceiver (Central) units furnished and accepted.

Actual number of 8:1 Video Multiplexer units furnished and accepted.

Actual number of 1:8 Video De-Multiplexer units furnished and accepted.

Actual number of SMFO 10/100 Ethernet Tranceiver units furnished and accepted.

14.4. BASIS OF PAYMENT

The quantity of SMFO Video Transceiver (Field) as provided above will be paid for at the contract unit price each for "Furnish SMFO Video Transceiver (Field)".

The quantity of SMFO Video Transceiver (Central) as provided above will be paid for at the contract unit price each for "Furnish SMFO Video Transceiver (Central)".

The quantity of 8:1 Video Multiplexer as provided above will be paid for at the contract unit price each for "Furnish 8:1 Video Multiplexer".

The quantity of 1:8 Video De-Multiplexer as provided above will be paid for at the contract unit price each for "Furnish 1:8 Video De-Multiplexer".

The quantity of SMFO 10/100 Ethernet Tranceiver as provided above will be paid for at the contract unit price each for "Furnish SMFO 10/100 Ethernet Tranceiver".

Payment will be made under:

Furnish SMFO Video Transceiver (Field) ..... **Each**

Furnish SMFO Video Transceiver (Central) ..... **Each**

Furnish 8:1 Video Multiplexer ..... **Each**

Furnish 1:8 Video De-Multiplexer ..... **Each**

Furnish SMFO 10/100 Ethernet Tranceiver ..... **Each**

15. DYNAMIC MESSAGE SIGN (DMS) SYSTEM

15.1. DESCRIPTION

To ensure compatibility with the existing DMS control software deployed in the State, furnish NTCIP compliant DMSs that are Daktronics model number VF-2000-27X90 or approved equivalent. Integrate the new DMSs in the system. Demonstrate that the new DMSs are fully responsive to all Vanguard software commands and controls. Partial or marginal performance of the new DMSs under Vanguard will not be acceptable. Furnish, install, test, integrate and make fully operational the new DMSs at location shown on the ITS/Signing Plans.

Furnish an operating Dynamic Message Sign system consisting of, but not limited to, the following:

- LED Dynamic Message Sign (DMS),

- DMS structure and mounting hardware,
- DMS controller, Uninterruptible Power Supply (UPS), cabinet and accessories with interconnect and power cabling and conduit,
- Service equipment,
- All other equipment and incidentals required for furnishing, installing, and testing system components.

Use only UL listed and approved electronic and electrical components in the DMS system.

Provide an installation that meets latest NEC and NESC requirements and all applicable local and state codes.

These Project Special Provisions reference the following:

- Latest edition of National Transportation Communications for ITS Protocol (NTCIP) Joint Standards Committee Recommended Standards applicable to DMS system and requirements of these Project Special Provisions,
- AASHTO 2001, 4th edition and 2002 Interim *to Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals.*

15.2. MATERIALS

A. Environmental Requirements

Construct the Dynamic Message Sign and DMS controller-cabinet so the equipment within is protected against moisture, dust, corrosion, and vandalism.

Design the DMS, controller, cabinet, and accessories for a nominal performance within an ambient temperature range of -30° F to 165° F (-34° C to 74° C) with up to 95% relative humidity. Add fans, heaters and thermostats to the DMS enclosure to meet the operating temperature requirements above. Add a thermostatically controlled fan and thermostat to the cabinet as described in the subsection titled "DMS Interior Environment Control." Design the system so that interior condensation does not occur and result in reduced visibility or legibility of the DMS elements.

Construct the DMS and housing so that it can withstand AASHTO 2002 fifty (50) year wind speed.

Design the DMS, controller, and associated equipment so that continuous vibration due to wind and traffic do not damage and affect system performance or reduce the legibility of the DMS message.

Transient voltages, surges and sags normally experienced on commercial power lines must not affect the operation of the equipment. Check with the local power and telephone companies to determine if any special design is needed. Include any extra cost, if required, in the contract price for Dynamic Message Sign System.

The presence of ambient electromagnetic fields such as those produced by overhead transmission lines, transformers, and motors must not hinder the performance of the system.

If a DMS or communications line fails, it must not affect the operation of any other non-associated DMS on the system.

Furnish DMS field equipment that meets the latest NEMA Standards for Power Interruption and Transients, Power Service for Traffic Control Systems.

B. Full Matrix LED Dynamic Message Sign (DMS)

Construct the DMS to display at least three lines of text that, when installed, are clearly visible and legible to a person with 20/20 corrected vision from a distance of 275m (900 ft) in advance of the DMS at an eye height of 3.5 ft (1 m) along the axis.

When displaying three lines, each line must display at least fifteen (15) equally spaced and equally sized alphanumeric individual characters. Each character must be at least 457 mm (18 in) in height and composed from a luminous dot matrix.

The message (all characters from far left to the far right of the display) must be legible from all travel lanes from 274 m (900 ft) in advance of the sign to 15 m (50 ft) in advance of the sign. These requirements apply to both shoulder mounted and overhead DMS installations.

It is the contractor responsibility to select LEDs with the appropriate viewing parameters to meet legibility requirements stated above.

B.1 DMS Enclosure

Construct the DMS with a metal walk-in enclosure excluding the face. Provide an aluminum walking platform inside the enclosure that is at least 711 mm (28 in) wide. The width of the walking platform shall be free of obstructions to a height of 2 m (7 ft). Construct the enclosure of welded aluminum type 6061-T6, 5052-H38, 5052-H34, or of an Engineer approved alternate at least 3.175mm (1/8 in) thick. Perform all welding of aluminum and aluminum alloys in accordance with the latest edition of AWS D1.2, Structural Welding Code - Aluminum. Continuously weld the seams using Gas Metal Arc Welding (GMAW).

All exterior and interior DMS enclosure surfaces shall be natural, mill-finish aluminum. All grind marks and discoloration shall be removed from the surfaces.

All nuts, bolts, washers, and other mounting and bonding parts and components used on the exterior of the DMS enclosure shall be corrosion resistant and sealed against water intrusion.

Design and construct the enclosure to resist torsional twist and warp, to present a clean and neat appearance, and to protect the equipment within from moisture, dust, and corrosion.

Provide one key lockable, hinged, gasket-sealed inspection door for service and maintenance along each side of the enclosure. Install one appropriately sized fire extinguisher within 50 mm (12 in) of each maintenance door. Provide a maintenance walkway that extends from the DMS inspection door to 0.9 meter (3 ft) over the edge of shoulder. Leave no gap between the walkway and the inspection door. Install safety handrails on both sides of the walkway. Equip the DMS enclosure with internal fluorescent lighting controlled by timers installed close to each inspection door. No light emitted from the fluorescent tubes or any other light source inside the enclosure not comprising the display shall leak to the outside of the enclosure. Equip the door with a door-hold-open device. Install duplex utility receptacles every 6 ft (1.8m) along the width of the DMS in convenient locations for powered service tools.

The sign face excluding the front panel shall be covered with a flat black, UV treated, colorfast material such as 3M™ Scotchcal™ non-reflective sheeting. Prior to the application of the sheeting, all surfaces shall be prepared for application per the sheeting manufacturer's

recommendation. UV-treat the border and make it colorfast. Construct the border with a minimum width of 457mm (18 in).

Do not place a manufacturer name, logo, or other information on the front face of the DMS or shield visible to the motorist.

Provide three photoelectric sensors installed inside the DMS enclosure monitoring front, back, and bottom of the sign or the north sky.

Install an EIA/TIA-232E port inside the DMS enclosure to enable a maintenance technician to communicate with the DMS controller that is installed in the roadside cabinet.

Provide power supply monitoring circuitry to detect power failure in the DMS and to automatically report this fault to the Control Software. This requirement is in addition to reporting power failure at the controller cabinet.

Do not paint the stainless steel bolts on the Z-bar assembly used for mounting the enclosure.

B.2 DMS Interior Environment Control

Design the local field controller to monitor and control the interior DMS environment. Design environmental control to maintain the internal DMS temperature within +/- 10° F (5.6° C) of the outdoor ambient temperature. Provide the DMS environmental control system with four primary subsystems as follows:

- Internal Temperature Sensors – Provide the DMS with two internally mounted temperature sensors which are equipped with external thermocouples and which the Field Controller continuously monitors. Design the Field Controller to use this temperature information to determine when to activate and deactivate the environmental control systems described herein. Locate sensors on opposite ends of the upper 1/3 of the LED display matrix with their external thermocouples attached to and making contact with an LED pixel circuit board. Design the thermocouple and LED board to be easily detachable, in the event that one of the units requires removal and replacement. Provide sensors capable of measuring temperatures from -40° F to +185° F (-40° C to +85° C). Design the Field Controller to automatically shut down the LED display whenever one or both sensors indicates that LED board temperature has exceeded +140° F, and to automatically restart the LED display whenever the suspect temperature falls below +130° F. Design both shutdown and re-start temperature thresholds to be user-programmable. Design the field controller to report sensor temperatures and DMS shutdown/re-start events to the DMS Control Software.

- Housing Cooling System – Provide the DMS housing with a cooling system which circulates outside air into the DMS housing whenever LED board temperature exceeds a user-programmable threshold. Provide this system with enough ventilation fans to exchange the internal DMS housing air volume at a minimum rate of 4 times per minute. Provide ball-bearing type fans. Mount fans in a line across the upper rear wall of the DMS housing to direct air out of the cabinet. Provide one filtered air intake port for each exhaust fan. Locate intake ports in a line across the lower rear wall of the DMS housing. Provide intake ports with a removable filter that will remove airborne particles measuring 500 microns in diameter and larger. Provide a filter that is of a size and style that is commercially readily available. Initially program the Field Controller to activate the DMS housing cooling system whenever the LED board temperature exceeds +90° F

(+32° C) and to turn the cooling system off whenever LED board temperature falls below +85° F (+29° C). On the DMS housing rear exterior wall, cover all air intake and exhaust ports on their top, front, and sides by an aluminum shroud fabricated from 2.28 mm (0.090 in) aluminum sheeting. Taper the shrouds at the top to discourage birds from nesting in them. Securely fasten shrouds to the DMS housing, and provide gaskets at the interface to prevent water from entering the DMS. Design all air filters and fans to be removable from inside the DMS housing. Provide the DMS housing cooling system with an adjustable timer that will turn fans off after the set time has expired. Provide a timer that is adjustable to at least four (4) hours, and locate it just inside the DMS housing door, within easy reach of a maintenance technician standing outside the DMS doorway.

- LED Display Cooling System – Provide the DMS with an LED display cooling system which directs air across the LED display modules whenever LED board temperature exceeds a user-programmable threshold. Direct fan-forced air vertically across the backside of the entire LED display matrix using multiple ball-bearing fans. Initially program the Field Controller to activate the LED cooling fan system whenever LED board temperature exceeds +90° F (+32° C) and to deactivate the system whenever LED board temperature falls to +85° F (+29° C). Locate cooling fans so as not to hinder removal of LED display modules and driver boards.

- Front Face Panel Defog/Defrost System – Provide the DMS with a defog/defrost system which circulates warm, fan-forced air across the inside of the polycarbonate front face whenever LED board temperature falls below a user-programmable threshold. Provide multiple ball-bearing fans that provide uniform airflow across the face panel. Initially program the Field Controller to activate the defog/defrost system whenever LED board temperature falls below +40° F (+4° C) and to deactivate the defog/defrost system whenever LED board temperature exceeds +106° F (+41° C). Mount a 100-watt pencil-style heating element in front of each defog/defrost fan to warm the air directed across the DMS face. Design heating elements to be on only when the defog/defrost fans are on.

Install additional fans and/or heaters as needed to maintain the temperature inside the DMS enclosure within the operating temperature range of the equipment within the DMS enclosure as recommended by the equipment manufacturer(s).

B.3 Front Panel

Protect the DMS face with contiguous, weather-tight, removable panels. Manufacture these panels of sheets of polycarbonate, methacrylate, GE Lexan Type SG300 or equivalent that are ultraviolet protected, have an antireflection coating, and are a minimum of 6 mm (¼ in) thick. For substitutes, submit one 300 mm x 300 mm (12 in x 12 in) sample of the proposed material together with a description of the material attributes to the Engineer for review and approval.

Design the panels so they will not warp nor reduce the legibility of the characters. Differential expansion of the DMS case and the front panel must not cause damage to either component or allow openings for moisture or dust. Glare from sunlight, roadway lighting, commercial lighting, or vehicle headlights must not reduce the legibility or visibility of the DMS. Cover the areas of the panels between characters and lines with a flat black, UV-treated, colorfast material to reduce glare.

Install the panels so that a maintenance person can easily remove or open them for cleaning.

B.4 Display Modules

Manufacture each display module with a standard number of pixels, not to exceed an array of 9 x 5 and be easily removable. Assemble the modules onto the DMS assembly contiguously to form a continuous matrix to display the required number of lines, characters, and character height.

Design display modules that are interchangeable and replaceable without using special tools. All power and communication cables connected to a display module shall be plug-in types to allow easy removal for maintenance and repair.

Construct each display module as a rectangular array of 5 horizontal pixels by 7 to 9 vertical pixels. Provide the module with an equal vertical and horizontal pitch between pixels, and columns that are perpendicular to the rows (i.e., no slant). Design each module to display:

- All upper case letters.
- All punctuation marks.
- All numerals 0 to 9.
- Special user-created characters.

Display upper-case letters and numerals over the complete height of the module. Optimize the LED grouping and mounting angle within a pixel for maximum readability.

B.5 Discrete LEDs

For shoulder-mounted DMS installations, provide discrete LEDs with a MINIMUM nominal viewing cone of 30 degrees with a half-power angle of 15 degrees measured from the longitudinal axis of the LED. Viewing cone tolerances shall be as specified in the LED manufacturer's product specifications and shall not exceed +/- 3 degrees half-power viewing angle of 30 degrees.

For overhead DMS installations, provide LEDs with a MINIMUM nominal viewing cone of 15 degrees with a half-power angle of 7.5 degrees measured from the longitudinal axis of the LED. Viewing cone tolerances shall be as specified in the LED manufacturer's product specifications and shall not exceed +/- 3 degrees.

Provide LEDs that are untinted, non-diffused, high output solid state lamps utilizing indium gallium aluminum phosphide (InGaAlP) technology manufactured by Toshiba or Hewlett-Packard. No substitutions will be allowed. Provide T1 ¾, 5mm size LEDs that emit a true amber color at a wavelength of 590 ± 5 nm.

Provide LEDs with a MTBF (Mean Time Before Failure) of at least 100,000 hours of permanent use at an operating point of 140° F (60° C) or below at a specific forward current of 20mA. Discrete LED failure is defined as the point at which the LED's luminous intensity has degraded to 50% or less of its original level.

Obtain the LEDs used in the display from a single LED manufacturer that have a single part number. Obtain them from batches sorted for luminous output, where the highest luminosity LED is not more than fifty percent more luminous than the lowest luminosity LED when the LEDs are driven at the same forward current. Dot not use more than two successive and overlapping batches in the LED display. Document the procedure to be used to comply with this requirement as part of the catalog cut submittal.

Individually mount the LEDs on circuit boards that are at least 1/16" thick in a manner that promotes cooling. Protect all exposed metal on both sides of the LED pixel board, except the power connector, from water and humidity exposure by a thorough application of acrylic conformal coating. Design the boards so bench level repairs to individual pixels, including discrete LED replacement and conformal coating repair is possible.

Operate the LED display at a low internal DC voltage not to exceed 24 Volts.

Design the LED display operating range to be –20° F to +140° F (-29° C to 60° C) at 95% relative humidity, non-condensing.

Supply the LED manufacturer's technical specification sheet with the catalog cuts.

If a superior LED or construction method becomes available between the period that the sign assembly is procured and prior to the actual construction of a given sign assembly, the Engineer has the option to direct the manufacturer to utilize the new technology. At such time, the number of populated pixels may be re-evaluated. Any cost increase or decrease associated with such an order will be restricted to documented changes in material and labor cost.

B.6 LED Power Supplies

Power the LED Display by means of multiple regulated switching DC power supplies that operate from 120 volts AC input power and have an output of 24 volts DC or less. Wire the supplies in a redundant parallel configuration that uses multiple power supplies per display. Provide the supplies with current sharing capability that allows them to provide equal amounts of current to their portion of the LED display. Provide power supplies rated such that if one supply fails the remaining supplies will be able to operate their portion of the display under full load conditions (all pixels on at maximum brightness) and at a temperature of 140° F (60° C).

Provide power supplies to operate within a minimum input voltage range of +90 to +135 volts AC and within a temperature range of –22° F to 140° F (-30° C to +60° C). Power supply output at 140° F must not deteriorate to less than 65% of its specified output at 70° F (21° C). Provide power supplies that are overload protected by means of circuit breakers, and that have an efficiency rating of at least 75%, a power factor rating of at least .95, and are UL listed. Provide all power supplies from the same manufacturer and with the same model number. Design the power driver circuitry to minimize power consumption.

Design the Field Controller to monitor the operational status (normal or failed) of each individual power supply and be able to display this information on the Client Computer screen.

B.7 LED Pixels

A pixel is defined as the smallest programmable portion of a display module that consists of a cluster of closely spaced discrete LEDs. Design each pixel to be a minimum of 50 mm (2") in diameter.

Pixels shall be constructed with two strings of LED's. The number of LEDs in each string shall be determined by the manufacturer to produce the candela requirement as stated herein.

Each pixel shall produce a luminous intensity of 40 Cd when driven with an LED drive current of 20 mA per string.

LED pixels shall be driven with direct-drive pulse width modulation. Maximum pulse amplitude shall not exceed 30 mA.

Power the LEDs in each pixel in strings. Use a redundant design so that the failure of an LED in one string does not affect the operation of any other string within the pixel. Provide the sign controller with the ability to detect the failure of any LED string and identify which LED string has failed. Submit a complete schematic of the LED power and driver circuits with the catalog cuts.

Protect LEDs from degradation due to sunlight via flat black louvers or a functionally equivalent methodology. Place these louvers or equivalent behind the front panel. Use a method that does not reduce the display viewing-angle below that provided by the LED. Install the louvers or equivalent in such a way as to promote cooling of the LEDs and so that they are easily removable for cleaning or maintenance.

B.8 Character Display

Design display modules to be easily removable without the use of tools. Position cooling fans so they do not prevent removal of an LED pixel board or driver board.

Use continuous current to drive the LEDs at the maximum brightness level. Use Pulse Width Modulation (PWM) to dim the sign to achieve the proper brightness for a given condition. Design the light levels to be adjustable for each DMS / controller so the Engineer may set levels to match the luminance requirements at each installation site.

Design the controller to automatically detect failed LED strings or drivers and initiate a report of the event to the Control Software. Design the controller to be able to read the internal temperature of the DMS enclosure and the ambient temperature outside the DMS enclosure and report these to the Control Software.

B.9 Display Capabilities

Design the DMS with at least the following message displays:

- Static display
- Flashing display with Dynamic flash rates
- At least two alternating Static and / or Flashing sequences (multi-page messages)

C. DMS Enclosure Structure Mounting

Mount the DMS enclosure and interconnect system securely to supporting structures of the type specified in the Plans. Design the DMS enclosure supports and structure to allow access to the DMS enclosure inspection door.

Submit plans for the DMS enclosure, structure, mounting description and calculations to the Engineer for approval. Have such calculations and drawings approved by a Professional Engineer registered in the state of North Carolina, and bear his signature, seal, and date of acceptance.

Provide removable lifting eyes or the equivalent on the DMS enclosure rated for its total weight to facilitate handling and mounting the DMS enclosure.

Design the DMS structure to conform to the applicable requirements of the *Standard Specifications for Structural Supports for Highway Signs, Luminaires*, and the section titled "Dynamic Message Sign Assembly" of these Project Special Provisions.

D. DMS / DMS Controller Interconnect

Furnish and install all necessary cabling, conduit, and terminal blocks to connect the DMS and the DMS controller. Use approved manufacturer's specifications and project plans for cable and conduit types and sizes.

E. DMS Controller and Cabinet

Furnish and install one DMS controller with accessories per DMS in a protective cabinet. Mount the controller cabinet on the DMS vertical support structure so height to cabinet middle is 1.2 m (4 ft). Route power, communication wires and cable entering and exiting the cabinet in separate rigid metallic conduits.

Provide the DMS controller as a software-oriented microprocessor and with resident software stored in non-volatile memory. The Control Software, controller and communications must comply with the NTCIP Standards identified in these Project Special Provisions. Provide sufficient non-volatile memory to allow storage of at least 500 multi-page messages and a test pattern program.

Furnish the controller cabinet with, but not limited to, the following:

- Power supply and distribution with back panel
- Power line filtering hybrid surge protectors
- Radio Interference Suppressor
- Communications surge protection devices
- Industrial-Grade UPS system and local disconnect
- Microprocessor-based controller
- Lamp driver and control system (unless integral to the DMS)
- Industrial-grade dial-up modem and interface cable
- Industrial-grade telephone line surge and lightning protector
- Serial interface port for local laptop computer
- Local control panel with Remote / Local control switch
- Interior lighting and duplex receptacle
- Adjustable shelves as required for components
- Temperature control system
- All interconnect harnesses, connectors, and terminal blocks
- All necessary installation and mounting hardware

Furnish the DMS controller and associated equipment completely housed in a NEMA 3R cabinet made from 5052-H32 sheet aluminum at least 3.175 mm (1/8") thick. Use natural aluminum cabinets and apply an anodized finish after welding. Perform all welding of aluminum and aluminum alloys in accordance with the latest edition of AWS D1.2, Structural Welding Code - Aluminum. Continuously weld the seams using Gas Metal Arc Welding (GMAW).

Slant the cabinet roof away from the front of the cabinet to prevent water from collecting on it.

Do not place a manufacturer name, logo, or other information on the faces of the controller cabinet visible to the motorist.

Provide cabinets capable of housing the components and sized to fit space restrictions. Design the cabinet layout for ease of maintenance and operation, with all components easily accessible. Submit a cabinet layout plan for approval by the Engineer.

Locate louvered vents with filters in the cabinet to direct airflow over the controller and auxiliary equipment, and in a manner that prevents rain from entering the cabinet. Fit the inside of the cabinet, directly behind the vents, with a replaceable, standard-size, commercially available air filter of sufficient size to cover the entire vented area.

Provide a torsionally rigid door with a continuous stainless steel hinge on the side that permits complete access to the cabinet interior. Provide a gasket as a permanent and weather resistant seal at the cabinet door and at the edges of the fan / exhaust openings. Use a non-absorbent gasket material that will maintain its resiliency after long-term exposure to the outdoor environment. Construct the doors so that they fit firmly and evenly against the gasket material when closed. Provide the cabinet door with louvered vents near the bottom, and with air filters as described in the paragraph above.

Provide a Plexiglas rack of appropriate size at a convenient location on the inside of the door to store the cabinet wiring diagrams and other related cabinet drawings. Provide a Corbin #2 main door lock made of non-ferrous or stainless steel material. Key all locks on the project alike, and provide ten (10) keys to the Engineer. In addition, design the handle to permit padlocking.

Provide the interior of the cabinet with ample space for housing the controller and all associated equipment and wiring; use no more than 50% of the useable space in the cabinet. Leave a minimum of 20% of all shelf space free for future expansion after all required equipment is installed. Provide ample space in the bottom of the cabinet for the entrance and exit of all power, communications, and grounding conductors and conduit. Provide an additional 50 mm (2") conduit entrance for future use.

Arrange the equipment so as to permit easy installation of the cabling through the conduit so that they will not interfere with the operation, inspection, or maintenance of the unit. Provide adjustable metal shelves, brackets, or other support for the controller unit and auxiliary equipment. Leave a 75 mm (3") minimum clearance from the bottom of the cabinet to all equipment, terminals, and bus bars.

Provide power supply monitoring circuitry to detect power failure and to automatically report the occurrence to the Control Software.

Install two 15-watt fluorescent light strips with shields, one in the top of the cabinet and the other under the bottom shelf. Design both lights to automatically turn on when the cabinet door is opened and turn off when the door closes.

Mount and wire a 120V (±10%) GFI duplex receptacle of the 3-wire grounding type in the cabinet in a location that presents no electrical hazard when used by service personnel for the operation of power tools and work lights.

No cabinet resident equipment shall utilize the GFI receptacle. There shall be one spare non-GFI receptacle for future addition of equipment.

Mount a bug-proof and weatherproof thermostatically controlled fan and safety shield in the top of the cabinet. Size the fan to provide at least for two air exchanges per minute. Fuse the fan at

125% of the capacity of the motor. The magnetic field of the fan motor must not affect the performance of the control equipment. Use a fan thermostat that is manually adjustable to turn on between 80°F and 160°F (26°C and 72°C) with a differential of not more than 10°F (4°C) between automatic turn-on and turn-off. Mount it in an easily accessible location, but not within 150 mm (6") of the fan.

Install additional fans and/or heaters as needed to maintain the temperature inside the cabinet within the operating temperature range of the equipment within the cabinet as recommended by equipment manufacturer(s).

E.1 Wiring

The requirements stated herein shall apply whenever and wherever electrical wiring is needed for any DMS system assemblies and subassemblies such as controller cabinet, DMS enclosure, electrical panel boards and etc.

Neatly arrange and secure the wiring inside the cabinet. Where cable wires are clamped to the walls of the control cabinet, provide clamps made of nylon, metal, plastic with rubber or neoprene protectors, or similar. Lace and jacket all harnesses, or tie them with nylon tie wraps spaced at 150 mm (6") maximum to prevent separation of the individual conductors.

All conductors shall be individually and uniquely labeled. All conductor labels shall be clearly visible without moving the conductor. All terminal conductors shall connect to the terminal strip in right angles. Excess conductor shall be removed before termination of the conductor. The conductor shall be molded in such a fashion as to retain its relative position to the terminal strip if removed from the strip. No conductor shall run across a work surface with the exception of connecting to that work surface. No conductor bundles can be support by fasteners that support work surfaces. All connectors, devices and conductors shall be installed in accordance to manufactures guidelines. All wiring shall comply with the latest NEC guideline in effect during installation. No conductor or conductor bundle may hang loose or create a snag hazard. All conductors shall be protected from damage. All solder joints shall be completed using industry accepted practices and shall not fail due to vibration or movement. All welds must be in a manner that will not fail due to vibration. Lamps and control boards shall be protected from damage.

Insulate all conductors and live terminals so they are not hazardous to maintenance personnel.

Route and bundle all wiring containing line voltage AC and / or shield it from all low voltage control circuits. Install safety covers to prevent accidental contact with all live AC terminals located inside the cabinet.

Use industry standard, keyed-type connectors with a retaining feature for connections to the Controller.

Label all equipment and equipment controls clearly.

Supply each cabinet with three complete sets of wiring diagrams that identify the color-coding or wire tagging used in all connections. Furnish a water-resistant packet adequate for storing wiring diagrams, operating instructions, and maintenance manuals with each cabinet.

E.2 Power Supply and Circuit Protection

Design the DMS and controller for use on a system with a line voltage of 120V ± 10% at a frequency of 60 Hz ± 3 Hz. Under normal operation, do not allow the voltage drop between no load and full load of the DMS and its controller to exceed 3% of the nominal voltage.

Blackout, brownout, hunting, line noise, chronic over-voltage, sag, spike, surge, and transient effects are considered typical AC voltage defects. Protect the DMS system equipment so that these damaging defects do not interrupt its operation. Equip all cabinets with devices to protect the equipment in the cabinet from damage due to lightning and external circuit power and current surges.

E.3 Circuit Breakers

Protect the DMS controller, accessories, and cabinet utilities with thermal magnetic circuit breakers. Provide the controller cabinet with a main circuit breaker sized according to the NEC. Use appropriately sized branch circuit breakers to protect the controller and accessories and for servicing DMS equipment and cabinet utilities.

E.4 Surge Suppressor

Install and clearly label filtering hybrid power line surge protectors on the load side of the branch circuit breakers in a manner that permits easy servicing. Ground and electrically bond the surge protector to the cabinet within 50 mm (2").

Design the power line surge protector to meet the following requirements:

Peak surge current occurrences	20 minimum
Peak surge current for an 8 x 20 microsecond waveshape	20,000 amperes
Clamp voltage	280 volts @ 20KA
Response time	Voltage never exceeds 250 volts during surge
Maximum current for filtered output	20 amperes for 120VAC*
Temperature range	-10°F to +150°F (-40°C to +85°C)

* Capable of handling the continuous current to the equipment

E.5 Radio Interference Suppressor

Provide each controller cabinet with sufficient electrical and electronic noise suppression to enable all equipment in it to function properly. Provide one or more radio interference suppressors (RIS) connected between the stages of the power line surge suppressor that minimize interference generated in the cabinet in both the broadcast and the aircraft frequencies. Each RIS must provide a minimum attenuation of 50 decibels over a frequency range of 200 KHz to 75 MHz. Clearly label the suppressor(s) and size them at least at the rated current of the main circuit breaker but not less than 50 amperes.

Provide RIS that are hermetically sealed in a substantial metal case which is filled with a suitable insulating compound and have nickel-plated 10/24 brass stud terminals of sufficient external length to provide space to connect #8 AWG wires. Mount them so that the studs

cannot be turned in the case. Properly insulate ungrounded terminals from each other, and maintain a surface linkage distance of not less than ¼" (6.3 mm) between any exposed current conductor and any other metallic parts. The terminals must have an insulation factor of 100-200 MΩ, dependent on external circuit conditions. Use RIS designed for 120 VAC ± 10%, 60Hz, and which meet the standards of UL and the Radio Manufacturers Association.

E.6 Communications Surge Protector

Equip the cabinet with properly labeled hybrid data line surge protectors that meet the following general requirements:

Surge current occurrences at 2000 ampere, 8 x 20 microsecond waveform	> 80
Surge current occurrences at 400 ampere, 10x700 microsecond waveform	> 80
Peak surge current for 8 x 20 microsecond waveform	10,000 A (2500 A/line)
Peak surge current for 10x700 microsecond waveform	500 A/line
Response time	< 1 nanosecond
Series resistance	< 15 Ω
Average capacitance	1500 pF
Temperature range	-10°F to 150°F
Clamp Voltage	As required to match equipment in application

E.7 Lightning Arrester

Protect the system with an UL-approved lightning arrester installed at the main service disconnect. It shall meet the following requirements:

Type of design	Silicon Oxide Varistor
Voltage	120/240 Single phase, 3 wires
Maximum current	100,000 amps
Maximum energy	3000 joules per pole
Maximum number of surges	Unlimited
Response time one milliamp test	5 nanoseconds
Response time to clamp 10,000 amps	10 nanoseconds
Response time to clamp 50,000 amps	25 nanoseconds
Leak current at double the rated voltage	None

Ground Wire	Separate

Protective devices may share a common neutral bus line from their point of attachment to the back panel neutral bus.

E.8 Uninterruptible Power Supply (UPS)

Provide the cabinet with an industrial grade UPS unit with AC line voltage conditioning capability, operating on a 120 volts AC, 60 Hz commercial line voltage. The unit must supply continuous power to operate the equipment connected to it if the primary power fails. The UPS must detect a power failure and provide backup power within twenty (20) milliseconds. Transition to the UPS source from primary power must not cause loss of data or damage to the equipment being supplied with backup power. Provide an UPS with at least three outlets for supplying conditioned AC voltage to the DMS controller and an industrial-grade dial-up modem. Equipment connected to the UPS must operate without interruption during line voltage variations of 88 volts AC to 140 volts AC. Provide an UPS capable of operating within an ambient temperature range from -40° F to +185° F (-40° C to +85° C) and at up to 95% humidity, non-condensing.

Provide a **Clary SP 1000U** or an approved equivalent UPS unit capable of supplying thirty (30) minutes of continuous backup power to the equipment connected to it when these equipment are operating at full load.

E.9 Communications Interface

The controller will have the following interface ports:

- An EIA/TIA-232E serial interface port to drive an asynchronous industrial-grade modem for communications with the Server, Client, or Laptop Computer over dial-up lines or on point-to-point and multi-point networks.
- An EIA/TIA-232E serial interface port to allow onsite access by an operator with a Laptop Computer. Permanently install a cable for communications between the two in an easily accessible location inside the DMS controller cabinet.

Include circuitry to automatically reset the modem after power interruption or fluctuation.

Equip the controller cabinet with all modems and other equipment necessary to allow the controller to be addressed across a dial-up or cellular phone link. Provide communications data transmission at a user-selectable asynchronous rate between 1200 and 33.6 kbps.

E.10 Telephone Modem

Modem shall be an external industrial-grade unit. The modem design must have integral transient protection and Galvanic Isolation between line, RS232/422/485 ports, and power connections. The modem must have a watchdog circuitry to continuously monitor the power supply, internal hardware, and operational software. In the event of a hardware or software problem the modem shall automatically reset itself. The unit must meet the following minimum specifications:

Telephone Modem	
Max Data Rate	33.6 kbps (V.34)

Compatibility	V.34, V.32bis, V.32, V.22, V.22A/B, V.23, V.21, Bell212a &103
Settings	AT-Commands & Switches
Transmission	Asynchronous and Synchronous
Data Compression	V.42bis and MNP5
Error Correction	V.42, MNP2-4, and MNP10
REN	0.3 - 1.0
Line Jack	RJ11/12
Phone Jack	RJ11/12
RS 232 Port	
Max RS232 Rate	115.2 kbps
RS232 Signal Support	TXD, RXD, CTS, RTS, DCD, DTR, DSR, RI, GND
RS232 Connector	DB9 Female
Command Set	All Standard AT and S Register commands including Class 1 and Class 2 fax commands
RS422/485 Port	
RS422 Mode	4 wires full duplex
RS485 Mode	2 or 4 wires party-line operation (halfduplex)
Signal Rate	Standard Rates up to 115.2 kbps
RS422/485 distance	Up to .80 km (0.5 miles)
Status LEDs	
Carrier Detect (CD)	The modem has detected a carrier on the phone line
Data Terminal Ready (TR)	The PC has established a connection to the modem and is ready
Received Data (RD)	Flashes as data is received from the phone line
Transmit Data (TD)	Flashes as data is sent out the phone line
Power	On when power is present
General Specifications	
Input power	10-60 VDC or 115 VAC
Operating Temperature	-22 ° F to 158 ° F (-30° C to 70° C)
Storage Temperature	-40° F to 185 ° F (-40° C to 85° C)
Humidity	Up to 95%RH
Flammability	UL94V-0 MATERIAL
EMI Emissions	FCC part 15, ICES-003, EN5502

EMC Immunity	EN50082-1, IEC801-2,3,4
Electrical Safety	UL 508, CSA C22.2/14, IEC1010
Surge Withstand	IEEE-472 (ANSI C37.90)
Hazardous Locations	UL 1604, CSA C22.2/213-M1987, EN50021 (Zone 2)
PLC Discrete I/O Interface (if required by the Project Special Provisions or to implement a functional requirement)	
Trigger Input from PLC	Connects to PLC output. Starts auto dialing upon transition from OFF to ON. Modem will stay connected while input is ON
Voltage Range	9 to 30 VDC
Input Current	6.5 mA @ 24VDC
Max OFF Voltage	5VDC
On-Line Output (to PLC)	Output is ON as long as a connection exists (carrier detect)
Output Characteristics	Sourcing - Switches supply power
Max Output Current	100 mA

E.11 Modem and Field Controller Reset Device

Install a device in the controller cabinet to remotely rest the modem and the DMS field controller.

E.12 Telephone Line Surge and Lightning Protector

Provide phone line surge and lightning protectors that are UL rated for industrial use and meet the following specifications:

Technology	Solid state sidactors with fast acting fuses and resistors
Usage	Telephone Line
Ports Protected	1 (2 lines per port)
Connectors	RJ11/12
Surge Capacity	1.9 kA / line
Clamp & Rated Voltage	270 V and 200 V
Max Frequency	50 MHz
Operating Temperature	-40° F to 185 ° F (-40° C to +85° C)
Max Inline Resistance	22 Ohms
Ratings	UL 497A, IEC801-5, CCITT (ITU-T) K17

E.13 Local Control Panel

Provide a Local Control Panel (LCP) with waterproof switches for at least the following functions:

- On / Off Switch: controls power to the DMS and the DMS controller. You may locate this switch elsewhere in the cabinet with the approval of the Engineer.
- Control Mode Switch: for setting the DMS operation mode to either Remote (Server/Client) Mode or Local Mode.
- Message Selection Switch: Selects either a blank message or any of the messages stored in the DMS controller when in the Local Control Mode. There shall be a LCD display allowing messages to be previewed prior to activation. While a message is being previewed, any failed pixel within the message or outside the message area shall be flashing so they would be repaired prior to the message activation.
- Message Activation Switch: to activate the message selected.

The LCP displays at least the following:

- Controller On
- Number of message displayed
- Error or fault detected along with indication of error type

E.14 Controller Address

Assign each DMS controller a unique address that is set by hard wiring the appropriate conductors to the ground chassis in the controller cabinet or by an Engineer-approved alternate method. Preface all commands from the Control Software with a particular DMS controller address. The DMS controller compares its address with the address transmitted; if the addresses match, then the controller processes the accompanying data.

E.15 Controller Modes of Operation

Provide each controller with two possible modes of operation based on the point of control:

- Remote Mode: The Control Software controls DMS display
- Local Mode: An on-site operator controls DMS display using the LCP or a laptop computer

The controller will report its operational mode status to the Control Software when polled.

E.16 Controller Functions

Design the DMS controller to continuously control and monitor the DMS independent of the Control Software.

Link the DMS controller to the Control Software; it will decode the address of every transmission made to it from the Control Software and reject any transmission that does not begin with its unique address.

Design the controller to display on the sign a message sent by the Control Software, a message stored in the sign controller memory, or a message input on-site by an operator.

The Control Software can direct the controller to perform the following major tasks: create, edit, and / or delete messages and their parameters, stop or change the message being displayed, and perform diagnostic and test programs.

Include the following functions in the controller and software:

- The DMS controller acknowledges all transmissions from the Control Software; sending a negative response if an error is detected, or a confirming response if it receives a valid transmission,
- The DMS controller is able to start up the DMS,
- Message Creation: The DMS Control Software is able to write and erase messages to the DMS remotely, and store the messages in non-volatile memory remotely,
- Display one of three message types: static, flashing, or a multi-page message of at least two pages,
- Display any message stored in non-volatile memory,
- Change existing messages in non-volatile memory,
- Enter new messages into non-volatile memory.

For each message, the operator may define a display time in minutes (65,000 minutes max.). When this display time has expired, the controller will blank the sign and extinguish all LEDs.

For alternating or multi-page messages, the operator may define a display time for each message and a blank-out time (from 0.3 sec to 25 sec in 0.1sec increments) between messages.

For flashing messages, the operator may define a flash rate with a minimum range of 0.5 seconds to 3 seconds, adjustable in half-second increments.

Provide each DMS controller with error detection and reporting features that guard against incomplete or inaccurate transmission, including:

- Validating the contents of all received transmissions for logic or data errors.
- Monitoring the status of communication lines to detect a malfunction or break.

i. Error and Failure Reports:
   - Power failure
   - Data transmission error
   - Receipt of invalid data
   - Communications failure recovery
   - DMS controller failure
   - Power recovery
   - LED and module status

ii. Error and Failure Responses:

- Power Failure: The controller initiates a report of the event to the Control Software. The controller automatically resumes normal operation after the AC power restoration and reports this to the Control Software
- LED, LED Driver, or Power Supply Failure: The controller detects the failure and automatically reports it to the Control Software
- Communications Failure with the Control Software while in the remote Mode: the controller displays a pre-programmed message unless the link has been restored before a user-selectable period (between 0 and 24 hours) has elapsed

Provide the DMS controller with a watchdog timer to detect controller failures and to reset the microprocessor, and with a battery backed-up clock to maintain an accurate time and date reference. Set the clock through an external command from the Control Software or the LCP.

E.17 DMS Controller Commands

Include these commands at a minimum in the controller:

1. Displays the last command from Control Software.
2. Status request: Provides status report including:
   - DMS ID or address
   - DMS operational mode: Remote or Local
   - Pixel status: Shows operational status of all pixels on the DMS
   - Power supply status
3. Message display command: Shows text and display parameters of the message currently displayed on the DMS.
4. Light level switching command: Selects Dim, Normal, or Bright Light level control in two modes: automatic (photoelectric sensor control), Control Software override.
5. Program command: Programs the display of a message in memory at a selected date and time.
6. Abort and / or Sign off command.

E.18 DMS Controller Memory

Design each DMS controller with its own local non-volatile memory capable of storing at least one test pattern sequence and 500 messages containing a minimum of two pages of 45 characters per page. The Engineer may furnish a set of messages to be stored messages into both the Control Software library and the DMS controller's non-volatile memory. The Control Software can upload messages into and download messages from each controller's non-volatile memory remotely.

Messages uploaded and stored in the controller's non-volatile memory may be erased and edited using the Control Software and the controller. New messages may be uploaded to and stored in the controller's non-volatile memory using the Control Software and the controller. These actions shall be accomplished without removing the non-volatile memory from the controller and installing another non-volatile memory in the controller.

E.19 Photo-Electric Sensors

Install three photoelectric sensors with 12.5mm (½") minimum diameter photosensitive lens inside the DMS enclosure. Use sensors that will operate normally despite continual exposure to direct sunlight. Place the sensors so they are accessible and field adjustable. Point one sensor north or bottom of the sign. Place the other two perpendicular to and pointed away from the front and rear of the DMS, respectively.

Provide controls so that the Engineer can field adjust the following:

- The light level emitted by the pixels elements in each Light Level Mode.
- The ambient light level at which each Light Level Mode is activated.

E.20 Circuit Breakers, Panels, and Enclosures

Use circuit breakers and panels that meet the requirements of UL Standard 489 "Molded-Case Circuit Breakers and Circuit-Breaker Enclosures, and UL Standard 67 "Electric Panelboards". Provide corrosion resistant enclosures that meet UL Standard for Safety for Cabinets and Boxes, and UL Standard for Safety for Industrial Control Equipment and sections 1098 and 1700 of the Standard Specifications and applicable addenda and typical drawings.

Use only molded case, thermal magnetic trip type breakers. Use circuit breaker panelboard enclosures, marked as suitable for use as service equipment, and neatly and permanently label them as shown on the plans. Use circuit breaker panelboard enclosures that are lockable with padlocks without modifying the enclosure. Provide enclosures marked as suitable for service equipment.

E.21 Service Poles

Use service poles for this project that meet requirements of these Project Special Provisions. Install separate conduits on the service pole for telephone and electrical service. The Engineer must approve the locations of service poles.

E.22 Equipment List

Provide a general description of all equipment and all information necessary to describe the basic use or function of the major system components. Include a general "block diagram" presentation. Include tabular charts listing auxiliary equipment, if any is required. Include the nomenclature, physical and electrical characteristics, and functions of the auxiliary equipment unless such information is contained in an associated manual; in this case include a reference to the location of the information. Include an itemized list of equipment costs.

Include a table itemizing the estimated average and maximum power consumption for each major piece of equipment.

E.23 Character Set Submittal

Submit an engineering drawing of the DMS character set including 26 upper case letters, 10 numerals, a dash, a plus sign (+), a designated lane diamond, a slash, an ampersand, and arrows at 0, 45, 90, 135, 180, 225, 270, and 315 degrees.

E.24 Wiring Diagrams and Theory of Operation

Provide a wiring diagram for each DMS and each controller cabinet, as well as interconnection wiring diagrams for the system as a whole.

Provide the theory of operation of the system components in a clear, concise manner supported by detailed and complete schematics to component level, logic and data flow diagrams,

one-function diagrams, and voltage levels. Include timing and waveform diagrams of the column and row driving signals, the enable signals, and other pertinent output signals. Provide schematic and pictorial diagrams that are complete and accurate as required to supplement the text material and which make the books a self-contained technical information source. Use a logical development starting with a system block level and proceeding to a circuit analysis. Include details in these analyses whenever circuits are not normally found in standard textbooks. Fully describe the application of new theoretical concepts. Where the design allows for operation in several different modes, include an operational description of each mode. Include a pictorial diagram of all components on circuit boards. Document procedures to program the DMS controller memory, including conversion tables of message characters to the codes stored in memory.

Complete and detailed schematic diagrams to component level shall be provided for all DMS assemblies and subassemblies such as driver boards, control boards, DMS controller, power supplies, and etc. Such schematics shall enable an electronics technician to successfully identify any component on a board or assembly and trace its incoming and outgoing signals.

15.3. CONSTRUCTION METHODS

A. Description

This article establishes practices and procedures and gives minimum standards and requirements for the installation of Dynamic Message Sign systems, auxiliary equipment and the construction of related structures.

Provide electrical equipment described in this specification that conforms to the standards of NEMA, UL, or Electronic Industries Association (EIA), wherever applicable. Provide connections between controllers and electric utilities that conform to NEC standards. Express wire sizes according to the American Wire Gauge (AWG).

Provide stainless steel screws, nuts, and locking washers in all external locations. Do not use self-tapping screws unless specifically approved by the Engineer. Use parts made of corrosion-resistant materials, such as plastic, stainless steel, brass, or aluminum. Use construction materials that resist fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.

B. Layout

The Engineer will establish the actual location of each Dynamic Message Sign assembly. Provide the proper elevation, offset, level, and orientation of all DMS assemblies. The location of service poles and controller cabinets as well as conduit lengths as shown in the plans are approximate based on available project data. Make actual field measurements to place conduit and equipment at the required location. Mark the proposed location of circuits and all other components for the Engineer's approval prior to installation. Submit a drawing showing all underground conduits and cables dimensioned from fixed objects or station marks.

C. Construction Submittal

When the work is complete, submit "as built" plans, inventory sheets, and any other data required by the Engineer to show the details of actual construction and installation and all changes made during installation.

The "as built" plans will show: the DMS, controller, and service pole locations; DMS enclosure and controller cabinet wiring layouts; and wire and conduit routing. Include detailed drawings that

identify the routing of all conductors in the system by cable type, color code, and function. Clearly label all equipment in the DMS system, controller cabinet, and DMS enclosure.

D. Conduit

Install the conduit system in accordance with NEC requirements for an approved watertight raceway.

Make bends in the conduit so as not to damage it or change its internal diameter. Install watertight and continuous conduit with as few couplings as standard lengths permit.

Clean conduit before, during, and after installation. Install conduit in such a manner that temperature changes will not cause elongation or contraction that might damage the system.

Attach the conduit system to and install along the structural components of the DMS structure assembly with beam clamps or stainless steel strapping. Install strapping according to the strapping manufacturer's recommendations. Do not use welding or drilling to fasten conduit to structural components. Space the fasteners at no more than 1.2 m (4 ft) for conduit 40 mm (1.5") and larger, or 1.8 m (6 ft) for conduit 30 mm (1.25") and smaller. Place fasteners no more than 900 mm (3 ft) from the center of bends, fittings, boxes, switches, and devices.

Locate underground conduit as shown in the Plans in a manner consistent with these Project Special Provisions.

Where conduit is required beneath pavement, bury it at the required depth prior to laying new pavement, or bore and jack it beneath existing pavement. "Water jetting" is not an acceptable installation method. Plug any abandoned opening for bored or jacked conduit as directed by the Engineer.

Extend conduit stubs for controller cabinets at least 150 mm (6") upward and at least 900 mm (3 ft) downward from the top of the foundation.

Provide caps or plugs made of the same material as the conduit on stub-outs for future use.

Clean conduit after installation by "snaking" with a mandrel of a diameter not less than 85% of the nominal diameter of the conduit. Ensure all conduit runs are free of moisture, trash, and debris before pulling cable. Seal the ends of underground conduit with temporary caps and, after installation of circuits, plug the ends as specified in these Project Special Provisions. Coat field-cut threads and other uncoated metal or damaged galvanizing with 2 coats of zinc-rich paint meeting the requirements of Article 1080-9 of the Standard Specifications. Ream the ends of rigid conduit.

Do not exceed the appropriate fill ratio on all cable installed in conduit as specified in the NEC.

E. Wiring Methods

Do not pull permanent wire through a conduit system until the system is complete and has been cleaned.

Color-code all conductors per the NEC (grounded neutral-WHITE, grounding-BARE or GREEN, and phase conductors RED and BLACK). Use approved marking tape, paint, sleeves or continuous colored conductors for No.8 AWG and larger. Do not mark a white conductor in a cable assembly any other color. You may strip a white, red, or black conductor at all accessible points and use it as a bare equipment-grounding conductor.

Bury underground circuits at the depth shown in the plans and surround with at least 75mm (3") of sand or earth back-fill free of rocks and debris. Compact backfill in 150 mm (6") layers. Do not splice underground circuits unless specifically noted in the plans.

F. Equipment and Cabinet Mounting

Mount equipment securely at the locations shown in the plans, in conformance with the dimensions shown, and plumb and level. Install fasteners as recommended by the manufacturer and space them evenly. Use all mounting holes and attachment points for attaching DMS enclosures (and controller cabinets, if required) to structures.

Drill holes for expansion anchors of the size recommended by the manufacturer of the anchors and thoroughly clean them of all debris.

Provide one key-operated, pin tumbler, dead bolt padlock, with brass or bronze shackle and case, conforming to Military Specification MIL-P-17802E (Grade I, Class 2, Size 2, Style A) for each electrical panel and switch on the project. Key all padlocks alike, and provide 10 keys to the Engineer.

Provide cabinets with all mounting plates, anchor bolts, and any other necessary mounting hardware in accordance with the Signal Specifications and the project plans.

Seal all unused conduit installed in cabinets at both ends to prevent water and dirt from entering the conduit and cabinet.

Install a ground bushing attached inside the cabinet on all metal conduits entering the cabinet. Connect these ground bushings to the cabinet ground bus.

G. Cabinet and System Grounding

Ground the controller cabinet, DMS enclosure, DMS structure, and service entrance equipment per Sections 1098 and 1700 of the Standard Specifications, applicable addenda, typical drawings, the Plans and these Project Special Provisions. Provide grounding circuits that are permanent and electrically continuous with a current carrying capacity high enough and an impedance low enough to limit the potential above ground to a safe level.

Run the power company neutral, conduit grounds, and all equipment grounds directly and independently of the ground bus. Use ground clamps, grounding and bonding bushings, lock nuts, and grounding electrodes that comply with UL Standard Electric Grounding and Bonding Equipment. Use ground rods of 5/8" (16mm) minimum diameter, 3 m (10 ft) long, and made of copper-clad steel.

Make connections between ground electrodes and the ground wire using an exothermic welding process, cadweld or equivalent.

Ensure completed cabinet grounds have a resistance to ground of not more than 20 Ohms.

H. Work Site Clean-Up

Clean the site of all debris, excess excavation, waste packing material, wire, etc. Clean and clear the work site at the end of each workday. Do not throw waste material in storm drains or sewers.

15.4. METHOD OF MEASUREMENT

Each Dynamic Message Sign System consists of Full Matrix LED Dynamic Message Sign, communications equipment, strapping hardware, controller, UPS, cabinet, conduit and conduit bodies, wire, connectors, circuit protection equipment, photo-electric sensors, service pole, electrical and telephone service installation, and related service equipment, tools, materials, all related testing, cost of labor, cost of transportation, incidentals, and all other equipment necessary to furnish and install a DMS system as detailed in the previous pages.

15.5. BASIS OF PAYMENT

The quantities of each Dynamic Message Sign System as measured will be paid for at the contract lump sum price for "Dynamic Message Sign "DMS - __".

Payment will be made under:

Dynamic Message Sign "DMS – 1"..... Lump Sum

Dynamic Message Sign "DMS – 2"..... Lump Sum

16. DMS TESTING REQUIREMENTS

16.1. General Test Procedure

Test the DMS system in a series of design approved and functional tests. The results of each test must meet the specified requirements. These tests should not damage the equipment. The Engineer will reject equipment that fails to fulfill the requirements of any test. Resubmit rejected equipment after correcting non-conformities and re-testing; completely document all diagnoses and corrective actions. Modify all equipment furnished under this contract, without additional cost to the North Carolina Department of Transportation, to incorporate all design changes necessary to pass the required tests.

Provide 4 copies of all test procedures and requirements to the Engineer for review and approval at least 40 days prior to the testing start date.

Only use approved procedures for the tests. Include the following in the test procedures:

- A step-by-step outline of the test sequence, showing a test of every function of the equipment or system tested
- A description of the expected nominal operation, output, and test results, and the pass / fail criteria
- An estimate of the test duration and a proposed test schedule
- A data form to record all data and quantitative results obtained during the test.
- A description of any special equipment, setup, manpower, or conditions required by the test

Provide all necessary test equipment and technical support. Use test equipment calibrated to National Institute of Standards and Technology (NIST) standards. Provide calibration documentation upon request.

The Contractor shall notify the Engineer forty days in advance of factory tests.

Failure to conform to the requirements of any test and these specifications shall be counted as a complete failure, and the equipment shall be rejected. Rejected equipment/tests may be retested after all deviations have been corrected. After successful completion of all factory tests, the DMS for this contract will be accepted for shipment to the installation site. The Contractor shall provide the documentation to the Engineer of all test and results.

The approval of test procedures and the Engineers acceptance of DMS tests shall not relieve the Contractor of his responsibility to provide a completely acceptable operating DMS system that meets the requirements as stated herein.

Provide 4 copies of the quantitative test results and data forms containing all data taken, highlighting any non-conforming results and remedies taken, to the Engineer for approval before the next project stage is started. An authorized representative of the manufacturer must sign the test results and data forms.

16.2. Design Approval Tests

A. Procedure and Requirements

Perform the following Design Approval Tests at the manufacturer's facility on the DMS modules, controller, controller cabinet, communications, and all other associated equipment before beginning full production on the units supplied for this Contract.

PROTOTYPE – Manufacture a prototype Dynamic Message Sign and controller of the type and size described in these Project Special Provisions. Test the prototype according to the Design Approval and Operational Tests. When all corrections and changes (if any) have been made, the Department may accept the prototype DMS and controller as the physical and functional standard for the system furnished under this contract. You may use the prototype units on this project if, after inspection and rework (if necessary), they meet all physical and functional specifications. In the case of standard product line equipment, if the Contractor can provide test results certified by an independent testing facility as evidence of prior completion of successful design approval tests, then the Engineer may choose to waive these tests. If the Engineer so chooses, reduce the contract price by the amount bid for these tests.

In each Design Approval Test designated below, successfully perform the tests described in the Check Test below, under the conditions described. Apply the extreme conditions to all associated equipment unless stated otherwise in these Project Special Provisions.

Perform the following Check Tests as a minimum:

- Start-up and operate the DMS locally using the Control Software.
- Use automatic (photoelectric sensor controlled), remote control using Control Software, and local control using Control Software to switch between "dim", "normal", and "bright" light levels.
- Operate the DMS with all display elements flashing continuously for 15 minutes at the maximum flash rate.
- Exercise the DMS by displaying static messages, flashing messages, and alternating static and flashing message sequences.
- Automatically poll the DMS using Control Software at various intervals and verify data received by the Control Software from the DMS.
- Download and edit messages.
- Execute status request on the DMS controller.
- Normal operations during uploading and downloading.
- Display a two-phase flashing message sequence of 45 characters.
- Select messages from the sign controller's local control panel.
- Activate the test sequence at chosen intervals.
- Display and verify several stored messages.
- Display a 2-page diagonal test pattern with half the pixels on and half off, alternating pixels on each page. Display this pattern for 1 hour.

B. Environmental Tests

B.1 Temperature

a. Stabilize the equipment -10° F (–23° C). After stabilization at this temperature, perform the Check Tests without degradation or failure at both the low and high ends of the input power voltages.

b. Stabilize the equipment at 140 ° F (60 ° C) and operate it as per part a. above.

B.2 Humidity

a. Maintain the equipment at 140° F (60° C) with a relative humidity of 95% for 48 hours. At the conclusion of the 48 hours period, perform the Check Tests without degradation or failure at both the low and high ends of the input power voltages.

B.3 Primary Power Variation

a. Voltage: Operate the field equipment with the input line voltage set first at 132V and then at 108V (120V +/- 10%). Operate the equipment for at least 15 minutes at each of these voltages while successfully performing the Check Tests.

b. Frequency: Operate the field equipment with the input line frequency set first at 63 Hz and then at 57 Hz (60Hz +/- 3Hz). Operate the equipment for at least 15 minutes at each of these frequencies while successfully performing the Check Tests.

c. High Frequency: Check Test the field equipment when subjected to the high frequency and voltage transient interference specified in the Transients, Power Service section of the NEMA Standards for Traffic Control Systems while successfully performing the Check Tests.

B.4 Vibration and Shock:

Subject the field equipment to the vibration and shock tests described in the Vibration Test and Shock Test sections of the NEMA Standards for Traffic Control Systems. This test must not cause degradation of mechanical structure, soldered components, or plug-in components. Successfully perform the Check Tests immediately after completing the Vibration Test.

B.5 Water Spray Test :

Perform the following water spray test on controller cabinet and DMS enclosure. Spray water from a point directly overhead at an angle of 60° from the vertical axis. Repeat this procedure for each of eight equally spaced positions around the cabinet/enclosure for a period of not less than two minutes in each position. Spray the water using a domestic type sprinkling nozzle at a rate of not less than 3.78 liters (1 gallon) per minute per .09 square m (1 square foot) of surface area. Then check the cabinet/enclosure for leakage. Reject or repair the cabinet/enclosure if there is any evidence of leakage and repeat the test.

B.6 LED Pixel Light Output Test:

Perform a test to confirm that the light output intensity conforms to the requirements of "LED Pixels".

16.3. Operational Factory Tests

Perform Operational Factory Tests on the assembled DMS system at the manufacturer's facility prior to shipping. Perform Operational Field Test on each system after it is shipped, installed, and operational.

A. Operational Factory Test

A.1 Physical Examination

Examine each piece of equipment to verify that the materials, design, construction, markings, and workmanship comply with the mechanical, dimensional, and assembly requirements of these Project Special Provisions.

Perform the following tests as a minimum:

- Verify that all surfaces are free of dents, scratches, weld burns, or abrasions. Round sharp edges and corners.
- Verify bend radius of cables is not excessive or could potentially cause damage.
- Verify all modules, lamps, and components are properly secured.
- Verify that there are no exposed live terminals.

A.2 Continuity Test

Check the wiring to assure it conforms with the requirements of the appropriate paragraphs of this Specification.

A.3 Functional Tests

Operate each unit of equipment in the system long enough to permit the equipment temperature to stabilize, and to check and record performance characteristics to ensure compliance with the latest edition of NTCIP Standards as required in these Project Special Provisions.

Conduct approved DMS functional tests on the equipment with the Control Software. Exercise all remote and local monitoring and control functions required by these specifications and display the return status codes from the controller for a period of 72 hours.

Include the following functional tests as a minimum:

- NTCIP exerciser/other testing on the assembled DMS system
  - Verification of all memory requirements
  - Start-up and operation of the DMS locally using the Control Software
- Use automatic (photoelectric sensor controlled), remote control using Control Software, and local control using Control Software to switch between "dim", "normal", and "bright" light levels
- Operation of the DMS with all display elements flashing continuously for one hour at the maximum flash rate
- Exercise the DMS by displaying static messages, flashing messages, and alternating static and flashing message sequences

- Automatically poll the DMS using Control Software at various intervals and verify data received by the Control Software from the DMS
- Demonstration of the writing speed to meet specified requirements.
- Downloading and editing messages
- Execute status request on the DMS controller
- Normal operations during uploading and downloading
- Display two-phase flashing message sequence of 45 characters
- Selection of messages from the sign controller's local control panel
- Test sequence activation at chosen intervals
- Display and verification of all stored messages
- Resumption of standard operation upon interruption of electrical power
- Demonstrate no loss of RAM memory during a 24 hour electrical power outage
- Demonstration of the Failure Detection and Response functions
- Demonstrate proper operation of the Failure Log
- Watchdog timer detection of microprocessor failures and the resetting of the microprocessor
- Non-volatile memory reprogramming requirements
- Set controller clock using the Control Software
- Execute system shut-down using first the Control Software emulator device, and local control panel
- Detection of power failure in the DMS enclosure and reporting of such failure to the Control Software
- Detection of UPS overload. Logging and reporting of such event to the Control Software

Approval of Operational Factory Test does not relieve the Contractor of the requirements to conform to the specifications in these Project Special Provisions.

A.4 NTCIP Requirements

This portion of the specification defines the detailed NTCIP requirements for the Dynamic Message Signs covered by the procurement package.

iii. Definitions

The following terms shall apply within the scope of this procurement specification:

DMS - A Dynamic Message Sign, includes the sign display, controller, cabinet, and other associated field equipment. The specific type of dynamic message sign (i.e., blank-out sign, changeable message sign, character matrix sign, full-matrix sign, etc.) for this procurement is specified elsewhere within this procurement specification.

FSORS - Full, Standardized Object Range Support for, and proper implementation of, all valid values of an object as defined within the object's OBJECT-TYPE macro in the subject NTCIP standard; this is further defined in two distinct sub-requirements. (1) If the ACCESS of the object is read-write, a Management System shall be able to set the object to any valid value as defined by the SYNTAX and DESCRIPTION fields (except that the value of 'other' need not be supported when such a value is defined) and the indicated functionality shall be provided. (2) The value indicated by the object (e.g., in response to a 'get'), regardless of the ACCESS, shall reflect the current condition per the rules specified in the object's DESCRIPTION.

Management System – A computer system used to control an NTCIP component. This includes any laptop software used for field control as well as the control software.

NTCIP Component – A DMS or a Management System.

NTCIP System – A Management System plus the various DMSs controlled by the Management System.

Response Time – The time to prepare and begin transmission of a complete response containing the requested Application Layer information. This is measured as the time from receipt of the closing flag of the request to the transmission of the opening flag of the response when the device has immediate access to transmit.

iv. References

This specification references several standards through their NTCIP designated names. The following list provides the full reference to the current version of each of these standards. In many cases, the standard is more widely known by its original NEMA assigned number; in these cases, the NEMA number is also identified. The content of the NEMA standard is identical to that of the NTCIP standard.

Each NTCIP Component covered by these project specifications shall implement the most recent version of the standard including any and all Approved or Recommended Amendments to these standards. It is the ultimate responsibility of the VENDOR to monitor NTCIP activities to discover any more recent documents.

Table 1: NTCIP Standards

Abbreviated Number	Full Number	Title	Known Amendments
NTCIP 1101	**NTCIP 1101:1997** (NEMA TS 3.2-1996)	*Simple Transportation Management Framework*	Amendment #1 dated November 2, 1998
NTCIP 1201	**NTCIP 1201:1997** (NEMA TS 3.4-1996)	*Global Object Definitions*	Amendment #1 dated November 2, 1998
NTCIP 1203	**NTCIP 1203:1997** (NEMA TS 3.6-1997)	*Object Definitions for Dynamic Message Signs*	Amendment #1 dated July 3, 2001
NTCIP 2001	**NTCIP 2001:1997**	*Class B Profile*	Amendment #1 dated

	(NEMA TS 3.3-1996)		November 2, 1998
NTCIP 2101	**NTCIP 2101**	*SP-PMPP/232* *Subnet Profile for PMPP over RS-232*	Amendment #1 dated November 2, 1998
NTCIP 2102	**NTCIP 2102**	*SP-PMPP/FSK* *Subnet Profile for PMPP over FSK Modem*	
NTCIP 2103	**NTCIP 2103**	*SP-PPP/232* *Subnetwork Profile for PPP over RS232 (Dial Up)*	
NTCIP 2104	**NTCIP 2104**	*SP-Ethernet* *Subnet Profile for Ethernet*	
NTCIP 2201	**NTCIP 2201**	*TP-Null* *Transport Profile*	
NTCIP 2202	**NTCIP 2202** (NEMA TS 3.Internet v99.01.03)	*TP-Internet* *Internet Transport Profile (TCP/IP and UDP/IP)*	
NTCIP 2301	**NTCIP 2301**	AP-STMF AP for Simple Transportation Management Framework	

v. General Requirements

Subnet Level

Each serial port on each NTCIP Component shall support NTCIP 2103 over a dial-up connection with a contractor provided external modem with data rates of 28.8 kbps, 19.2 kbps, 14.4 kbps, 9600 bps, 4800 bps, 2400 bps, 1200 bps, 600 bps, and 300 bps. The NTCIP Component shall be able to make outgoing and receive incoming calls as necessary and support the following modem command sets:

- Hayes AT - Command Set
- MNP5
- MNP10
- V.42bis

Each serial port on each NTCIP Component shall support NTCIP 2103 over a null-modem connection with data rates of 19.2 kbps, 14.4 kbps, 9600 bps, 4800 bps, 2400 bps, 1200 bps, 600 bps, and 300 bps.

Each serial port on each NTCIP Component shall support NTCIP 2101 with data rates of 9600 bps, 4800 bps, 2400 bps, 1200 bps, 600 bps, and 300 bps.

Additionally, NTCIP components shall support NTCIP 2102 and NTCIP 2104.

NTCIP Components may support additional Subnet Profiles at the manufacturer's option. At any one time, only one Subnet Profile shall be active on a given serial port of the NTCIP Component. The NTCIP Component shall be configurable to allow the field technician to activate the desired Subnet Profile and shall provide a visual indication of the currently selected Subnet Profile.

Transport Level

Each NTCIP Component shall comply with NTCIP 2201 and 2202.

NTCIP Components may support additional Transport Profiles at the manufacturer's option. Response datagrams shall use the same Transport Profile used in the request. Each NTCIP Component shall support the receipt of datagrams conforming to any of the identified Transport Profiles at any time.

Application Level

Each NTCIP Component shall comply with NTCIP 1101 and 2301 and shall meet the requirements for Conformance Level 1 (NOTE - See Amendment to standard).

Each NTCIP Component shall support SNMP traps. An NTCIP Component may support additional Application Profiles at the manufacturer's option. Responses shall use the same Application Profile used by the request. Each NTCIP Component shall support the receipt of Application data packets at any time allowed by the subject standards.

Information Level

Each NTCIP Component shall provide Full, Standardized Object Range Support of all objects required by these procurement specifications unless otherwise indicated below. The maximum Response Time for any object or group of objects shall be 200 milliseconds.

The DMS shall support all mandatory objects of all mandatory Conformance Groups as defined in NTCIP 1201 and NTCIP 1203. Table 2 indicates the modified object requirements for these mandatory objects.

Table 2: Modified Object Ranges for Mandatory Objects

Object	Reference	Project Requirement
ModuleTableEntry	NTCIP 1201 Clause 2.2.3	Shall contain at least one row with moduleType equal to 3 (software). The moduleMake shall specify the name of the manufacturer, the

		moduleModel shall specify the manufacturer's name of the component and the modelVersion shall indicate the model version number of the component.
MaxGroupAddresses	NTCIP 1201 Clause 2.7.1	Shall be at least 1
CommunityNamesMax	NTCIP 1201 Clause 2.8.2	Shall be at least 3
DmsNumPermanentMsg	NTCIP 1203 Clause 2.6.1.1.1.1	Shall be at least 1*
DmsMaxChangeableMsg	NTCIP 1203 Clause 2.6.1.1.1.3	Shall be at least 21
DmsFreeChangeableMemory	NTCIP 1203 Clause 2.6.1.1.1.4	Shall be at least 20 when no messages are stored.
DmsMessageMultiString	NTCIP 1203 Clause 2.6.1.1.1.8.3	The DMS shall support any valid MULTI string containing any subset of those MULTI tags listed in Table 4
DmsControlMode	NTCIP 1203 Clause 2.7.1.1.1.1	Shall support at least the following modes: Local External central CentralOverride

* The Permanent Messages shall display the content shown in Table 3.

The sign shall blank if a command to display a message contains an invalid Message CRC value for the desired message.

Table 3: Content of Permanent Messages

Perm. Msg. Num.	Description
1	Permanent Message #1 shall blank the display (i.e., consist of and empty MULTI string). It shall have a run-time priority of one (1).

Table 4: Required MULTI Tags

Code	Feature
fl	field 1 - time (12hr)
f2	field 2 - time (24hr)
f8	field 8 – day of month
f9	field 9 – month
f10	field 10 - 2 digit year
f11	field 11 - 4 digit year
fl (and /fl)	flashing text on a line by line basis with flash rates controllable in 0.5 second increments.
fo	Font
jl2	Justification – line – left
jl3	Justification – line – center
jl4	Justification – line – right
jl5	Justification – line – full
jp2	Justification – page – top
jp3	Justification – page – middle
jp4	Justification – page – bottom
Mv	moving text
Nl	new line
Np	new page, up to 2 instances in a message (i.e., up to 3 pages/frames in a message counting first page)
Pt	page times controllable in 0.5 second increments.

The NTCIP Component shall also implement all mandatory and optional objects of the following optional conformance groups with FSORS.

Test Heading

Time Management, as defined in NTCIP 1201

Timebase Event Schedule, as defined in NTCIP 1201. The following list indicates the modified object requirements for this conformance group.

Table 5: Modified Object Ranges for the Timebase Event Schedule Conformance Group

Object	Reference	Project Requirement
MaxTimeBaseScheduleEntries	NTCIP 1201 Clause 2.4.3.1	Shall be at least 28
maxDayPlans	NTCIP 1201 Clause 2.4.4.1	Shall be at least 14
maxDayPlanEvents	NTCIP 1201 Clause 2.4.4.2	Shall be at least 10

Report, as defined in NTCIP 1201. The following list indicates the modified object requirements for this conformance group.

Table 6: Modified Object Ranges for the Report Conformance Group

Object	Reference	Project Requirement
maxEventLogConfigs	NTCIP 1201 Clause 2.5.1	Shall be at least 50
eventConfigurationMode	NTCIP 1201 Clause 2.4.3.1	The NTCIP Component shall support the following Event Configuration Modes: onChange greaterThanValue smallerThanValue
MaxEventLogSize	NTCIP 1201 Clause 2.5.3	Shall be at least 200
MaxEventClasses	NTCIP 1201 Clause 2.5.5	Shall be at least 16

PMPP

Font Configuration, as defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

Table 7: Modified Object Ranges for the Font Configuration Conformance Group

Object	Reference	Project Requirement
NumFonts	NTCIP 1203 Clause 2.4.1.1.1.1	Shall be at least 4*
MaxFontCharacters	NTCIP 1203 Clause 2.4.1.1.1.3	Shall be at least 127**

*Upon delivery, the first font shall be a standard 457 mm (18") font. The second font shall be a double-stroke 457 mm (18") font. The third font shall be a 711 mm (28") font. The fourth font shall be empty.

**Upon delivery, the first three font sets shall be configured in accordance with the ASCII character set for the following characters:

- "A" thru "Z"- All upper case letters.
- "0" thru "9"- All decimal digits.
- Space (i.e., ASCII code 0x20).
- Punctuation marks shown in brackets [. , ! ? - ' ' " " / ( )]
- Special characters shown in brackets [# & * +< >]

DMS Configuration, as defined in NTCIP 1203.
MULTI Configuration, as defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

Table 8: Modified Object Ranges for the MULTI Configuration Conformance Group

Object	Reference	Project Requirement
DefaultBackgroundColor	NTCIP 1203 Clause 2.5.1.1.1.1	The DMS shall support the following background colors: black
DefaultForegroundColor	NTCIP 1203 Clause 2.5.1.1.1.2	The DMS shall support the following foreground colors: amber
DefaultJustificationLine	NTCIP 1203 Clause 2.5.1.1.1.6	The DMS shall support the following forms of line justification: left

		center right full
defaultJustificationPage	NTCIP 1203 Clause 2.5.1.1.1.7	The DMS shall support the following forms of page justification: top middle bottom
defaultPageOnTime	NTCIP 1203 Clause 2.5.1.1.1.8	The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds
defaultPageOffTime	NTCIP 1203 Clause 2.5.1.1.1.9	The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds
defaultCharacterSet	NTCIP 1203 Clause 2.5.1.1.1.10	The DMS shall support the following character sets: eightBit

Default Message Control, as defined in NTCIP 1203
Pixel Service Control, as defined in NTCIP 1203
MULTI Error Control, as defined in NTCIP 1203
Illumination/Brightness Control, as defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

Table 9: Modified Object Ranges for the Illumination/Brightness Control Conformance Group

Object	Reference	Project Requirement
dmsIllumControl	NTCIP 1203 Clause 2.8.1.1.1.1	The DMS shall support the following illumination control modes: photocell timer manual
dmsIllumNumBrightLevels	NTCIP 1203 Clause 2.8.1.1.1.4	Shall be at least 16

Auxiliary I/O
Scheduling, as defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

Table 10: Modified Object Ranges for the Scheduling Conformance Group

Object	Reference	Project Requirement
NumActionTableEntries	NTCIP 1203 Clause 2.9.1.1.1.1	Shall be at least 21

Sign Status, as defined in NTCIP 1203
Status Error, as defined in NTCIP 1203
Pixel Error Status, as defined in NTCIP 1203
Fan Error Status, as defined in NTCIP 1203
Power Status, as defined in NTCIP 1203
Temperature Status, as defined in NTCIP 1203
Install necessary hardware for the support of items q, r, and s above.

Table 11: Some Optional Object Requirements

Object	Reference	Project Requirement
DefaultFlashOn	NTCIP 1203 Clause 2.5.1.1.1.3	The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds
DefaultFlashOff	NTCIP 1203 Clause 2.5.1.1.1.4	The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds
DmsMultiOtherErrorDescription	NTCIP 1203 Clause 2.7.1.1.1.20	If the vendor implements any vendor-specific MULTI tags, the DMS shall provide meaningful error messages within this object whenever one of these tags generates an error.

Documentation

Software shall be supplied with full documentation, including a CD-ROM containing ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format:

- The relevant version of each official standard MIB Module referenced by the device functionality.
- If the device does not support the full range of any given object within a Standard MIB Module, a manufacturer specific version of the official Standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro. The filename of this file shall be identical to the standard MIB Module, except that it will have the extension ".man".
- A MIB Module in ASN.1 format containing any and all manufacturer-specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.
- A MIB containing any other objects supported by the device.

The manufacturer shall allow the use of any and all of this documentation by any party authorized by the Procuring Agency for systems integration purposes at any time initially or in the future, regardless of what parties are involved in the systems integration effort.

B. NTCIP Acceptance Testing

The NTCIP requirements outlined above shall be tested thoroughly by one of the following firms:

Trevilon Corp. 12827 Tewksbury Drive Oak Hill, VA 20171 Phone: (703) 390 -1053	Battelle 505 King Avenue Columbus, Ohio 43201 Phone: (614) 424-6424	PB Farradyne 3200 Tower Oaks Boulevard Rockville, MD 20852 Phone: (301) 468 – 5568

The Contractor shall submit to the Engineer for approval a portfolio of the selected firm. This shall include the name, address, and a history of the selected firm in performing NTCIP testing along with references. The Contractor shall also provide a contact person's name and phone number. The Contractor shall submit detailed NTCIP testing plans and procedures including a list of hardware and software to the Engineer for review and approval forty (40) days in advance of a scheduled testing date. These test documents shall be developed by the selected firm based on the NTCIP requirements of these Project Special Provisions. The acceptance test will use the NTCIP Exerciser, and/or other authorized testing tools and will follow the guidelines established in the ENTERPRISE Test Procedures. The test shall be conducted by the firm in North Carolina on the installed system at the presence of the Engineer. The results of the test shall be documented and certified by the firm and submitted by the Contractor to the Engineer for review and approval. In case of failures, the Contractor shall remedy the problem and the Firm retest in North Carolina. This process will continue until all failures are resolved. The Department reserves the right to enhance these tests as deemed appropriate to ensure device compliance.

C. NTCIP Submittal

Project-specific NTCIP manual shall be included in the list of deliverables that thoroughly documents the details associated with the various NTCIP options and features in the system.

D. Operational Field Test (On-Site Commissioning)

Conduct an Operational Field Test of each DMS system installed on the project to exercise the normal operational functions of the installed operational field equipment. The Operational Field Test will consist of the following tests as a minimum:

D.1 Physical Examination

Test per section "Physical Examination" above.

D.2 Continuity Tests

Test per section "Continuity Tests" above.

D.3 Functional Tests

Perform the following functional tests:

- NTCIP exerciser/other testing on the assembled DMS system.
- Start-up and operation of the DMS locally using a laptop computer.
- Use automatic (photo-electric sensor controlled), DMS Control Software to switch between "dim", "normal", and "bright" light levels.
- Operation of the DMS with all display elements flashing continuously for 10 minutes at the maximum flash rate.
- Exercise the DMS by displaying static messages, flashing messages, and alternating static and flashing message sequences.
- Automatic polling of the DMS by the Control Software at various intervals and verification of data received by Control Software from DMS.
- Downloading and editing messages using Control Software.
- Execute status request on the DMS controller.
- Normal operations during uploading and downloading.
- Display two-phase flashing message sequence of 45 characters.
- Selection of messages from the sign controller's local control panel.
- Test sequence activation at chosen intervals.
- Display and verification of all stored messages.
- Resumption of standard operation upon interruption of electrical power.
- Demonstration of the Failure Detection and Response functions.
- Demonstrate proper operation of the Failure Log.
- Set controller clock using the Control Software.
- Execute system shutdown using first the Control Software and local control panel.

- Detection of power failure in the DMS enclosure and reporting of such failure to the Control Software.

Approval of Operational Field Test results does not relieve the Contractor to conform to the specifications in these Project Special Provisions. If a system does not pass its test, either document a correction or substitute a new unit as approved by the Engineer. Re-test the system until it passes all requirements.

16.4. 30-Day Burn-in Period

At the conclusion of successful Field Operational Test, the system will enter a 30-day burn-in period. The burn-in period is part of the project completion time or any intermediate contract time that requires early deployment of the DMS systems.

During this period, the system will be operated normally and tested on a daily basis. If the system fails because of any Contractor-supplied component(s), the particular component(s) shall be corrected or substituted with other component(s) upon approval from the Engineer, and the tests shall be repeated/restarted. If a component has been modified as a result of the system test failure, a report shall be prepared and delivered to the Engineer prior to retest.

16.5. CONSTRUCTION METHODS

Conduct and provide test for approval by the Engineer. The Engineer or a designated representative reserves the right to witness all tests.

16.6. 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 for "Dynamic Message Sign "DMS - __" and will be full compensation for all work listed above.

17. DYNAMIC MESSAGE SIGN ASSEMBLY

17.1. DESCRIPTION

This section includes all design, fabrication, furnishing, and erection of each Dynamic Message Sign (DMS) assembly; maintenance walkway for access to the DMS inspection door; and attachment of the DMS enclosure to the structure in accordance with the requirements of the plans and the provisions of this specification. Fabricate the supporting DMS assembly from tubular steel.

For overhead DMS installations, the DMS assembly shall be full span (minimum of two vertical supports) with a boxed truss.

The DMS assembly shall be of the type shown in the ITS and Signing Plans.

Design the DMS assembly including footings and submit shop drawings for approval.

Where the Standard Specifications or plans require the design of a sign assembly, including footings, submit design computations and shop drawings to the Engineer for acceptance. A Professional Engineer that is registered in the state of North Carolina will prepare such computations and drawings. These must bear his signature, seal, and date of acceptance.

The provisions of Section 900 apply to all work covered by this section.

Design, furnish and install two (2) new DMS assemblies as shown on the ITS and Signing Plans.

17.2. MATERIAL

Use materials that meet the requirements of Division 10 of the Standard Specifications shown below:

Structural steel	Section 1072 and 1096
Class A concrete	Section 1000
Steel bar reinforcement	Section 1070
Anchor bolts	Article 1072-6
Joint sealer	Article 1028-2
Zinc-rich paint	Article 1080-9
High strength bolts, nuts, and washers	Sub-article 1094-1 (A)

17.3. CONSTRUCTION METHODS

A. General

Fabricate the DMS assembly in accordance with the details shown in the approved shop drawings and the requirements of these specifications.

Do not weld, cut, or drill in any manner in the field unless approved by the Engineer.

Drill bolt holes and slots to finished size or you may punch them to finished size, provided the diameter of the punched holes is at least twice the thickness of the metal being punched. Do not flame cut bolt holes and slots.

Use two coats of a zinc-rich paint to touch up minor scars on all galvanized materials.

372

B. Shop Drawing

Submit to the Engineer for approval a complete design for each DMS assembly, including footings, sign assembly hardware, brackets for supporting the signs and the maintenance walkway. Base the design on the line drawings and wind speed shown in the plans and in accordance with the "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals".

The manufacturer of the DMS assembly must coordinate with the manufacturer of the DMS to ensure that the sign and the sign structure are totally compatible, operational, and functional as a working unit.

To ensure the correct attachment of the DMS enclosure, submit plans and designs for both the DMS system and the DMS assembly to the Engineer for approval and acceptance. Resolve discrepancies and conflicts arising from non-compatibility of either the assembly or the DMS enclosure through coordination between the structure designers and the sign designers.

Submit seven copies of completely detailed shop drawings and one copy of the design computations for the DMS assembly to the Structures Engineer for approval prior to fabrication. Show in the shop drawings complete design and fabrication details including foundations, provisions for attaching DMS and walkway to supporting structures, applicable material specifications, and any other information necessary for procuring and replacing any part of the complete Dynamic message sign assembly.

The Engineer is responsible for evaluation, approval, and final acceptance of all DMS System, software, and testing submittals.

Allow a minimum of 50 days for shop drawing approval after the Engineer receives them. If revised drawings are necessary, allow appropriate additional time for review and approval of final shop drawings.

Approval of shop drawings by the Engineer will not relieve the Contractor of his responsibility for the correctness of drawings, or for the fit of all shop and field connections and anchors.

C. Design and Fabrication

C.1 Dynamic Message Sign Assembly

Fabricate the DMS assembly in accordance with the details shown in the approved shop drawings and with the requirements of these Project Special Provisions.

DMS assembly dimensions shown in the plans were estimated from available project data for bid purposes. The Engineer will determine the actual dimensions from field measurements and DMS enclosure dimensions provided by the enclosure fabricator and will furnish revised plans. You may use a truss design for horizontal components of the supporting structures for the DMS enclosure. Provide permanent camber in addition to dead load camber in accordance with the "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals". Indicate on the shop drawings the amount of camber provided and the method used in the fabrication of the assembly to obtain the camber.

Attach the DMS assembly to concrete foundations by the use of galvanized anchor bolts. Furnish anchor bolts with galvanized nuts, flat washers and lock washers. Provide anchor bolts that have a right angle bend or anchor plate with a nut at the end you embed in concrete.

Fabricate the attachment assembly for mounting signs in a manner that will ensure easy removal of the signs for repair.

C.2 Maintenance Walkway

Provide a maintenance walkway, a minimum of 914mm (36") wide and 1219mm (48") long with an open skid-resistant surface and safety railings on the DMS assembly for access to the DMS inspection door unless specifically stated otherwise in the plans. The length of the walkway must be four feet or equal to the width of the DMS inspection door plus 457 mm (1.5 ft), whichever is greater. Position the walkway so that there is no opening greater than 254 mm (10") that is unprotected. Provide walkways with fixed safety railings along both sides from the beginning of the walkway to the inspection door. When not in use, the safety railing may remain in a permanent upright position.

Connect the walkway sections rigidly where sections join to avoid an uneven walking surface. Attach the walkway directly to the walkway brackets.

Install a 100 mm x 100mm (4"x 4") safety angle parallel to and along both sides of the walkway and extend it the entire length of the walkway. Design the safety angle to withstand loading equivalent to the walkway.

Provide a walkway in which the open ends have a galvanized steel coil safety chain attached on one end near the top of the safety railing, and on the other end to the walkway hanger, or other fixed member of the structure.

C.3 Footings for Dynamic Message Sign Assembly

Design footings for the combined effects of dead and wind loads; use either spread type or pole type as specified in the project plans. Design spread footings for a maximum soil bearing of 145 KPa (3 ksf) unless otherwise allowed by the Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals. If, in the judgment of the Engineer, the soil in a given footing excavation is not adequate for 145 KPa (3 ksf) bearing pressure, or any other bearing pressure noted on approved footing drawings, the Contractor may be required to change his footing design to meet actual soil conditions at no cost to the Department.

Perform all excavation and backfill necessary for footing construction to the elevations and dimensions shown in the plans or as directed by the Engineer.

Thoroughly compact all backfill in 150 mm (6") layers. Remove all unneeded excavated material from the site.

Construct footing excavations for DMS assemblies that conform to the applicable provisions of Section 410 of the Standard Specifications. Make sure the sides of the excavation for pole type footings conform as nearly as practicable to the required dimensions. Place concrete for pole-type footings against undisturbed soil unless otherwise permitted by the Engineer. If, in the judgment of the Engineer, significant discontinuities in the required configuration of the excavation for pole-type footings are created by the removal of boulders or as a result of other causes, backfill the excavation and compact as provided for in Section 410. Re-excavate the footings to the proper dimensions. The Engineer must approve shoring prior to use, if used to stabilize the sides of excavation for pole-type foundations.

Construct footings for DMS assembly in accordance with Section 825. Construct all footings of Class A concrete. Where rectangular forms are used, use forms with a chamfer strip at all corners for at least that distance protruding above ground level. Use a chamfer which measures 25mm (1") along the diagonal face. Securely brace anchor bolts positioned in the form, and hold them in proper position and alignment. Provide a rubbed finish on concrete surfaces exposed above finished ground in accordance with Sub-article 825-6(D). Do not erect DMS assembly on footings until the concrete has reached a minimum compressive strength of 20.64 Mpa (3000 psi). Determine concrete compressive strength by non-destructive test methods, or by compressive strength tests made in accordance with AASHTO 2001, 4th edition. Furnish equipment used for non-destructive tests and obtain Engineer approval.

D. Location

The Engineer will establish the location of the DMS assembly longitudinally.

17.4. METHOD OF MEASUREMENT

The work covered by this section includes all design, fabrication, construction, transportation, and attachment of the complete dynamic message sign assembly, supporting structure, hardware, maintenance walkway, footings, direct tension indicators specified in the section titled "DMS Direct Tension Indicators", preparing and furnishing shop drawings, additional documentation, incidentals, and all other equipment and features necessary to furnish the system described above.

17.5. BASIS OF PAYMENT

The Dynamic Message Sign Assembly, measured as provided above, will be paid for at the contract lump sum price per assembly for "Dynamic Message Sign Assembly "DMS-__".

Payment will be made under:

Dynamic Message Sign Assembly "DMS-1" ..... Lump Sum

Dynamic Message Sign Assembly "DMS-2" ..... Lump Sum

18. DMS DIRECT TENSION INDICATORS

18.1. GENERAL

Use direct tension indicators on all ASTM A325 high strength bolt connections in overhead and cantilever sign structures.

Provide direct tension indicators that conform to these Project Special Provisions, the requirements of ASTM F959 and the manufacturer's recommendations.

18.2. MATERIAL REQUIREMENTS

Use direct tension indicators whose material, manufacturing process, performance requirements, workmanship and certification requirements conform to the requirements of ASTM F959.

For Type 3 high strength bolts, use direct tension indicators mechanically galvanized to ASTM B695 Class 50, then with 1 mil of baked epoxy applied.

For plain Type 1 high-strength bolts, use direct tension indicators that are plain or mechanically galvanized to ASTM B695 Class 50.

For galvanized Type 1 high strength bolts, use direct tension indicators that are mechanically galvanized to ASTM B695 Class 50 only.

18.3. TEST DOCUMENTS

Furnish the Engineer with a copy of the manufacturer's test report for each lot of direct tension indicators used in the project. The manufacturer must perform these tests according to the requirements of ASTM F959. Include in each test report the lot number of the indicators, manufacturer's name, tension load when indicators were tested, gap clearance, nominal size, coating thickness, date tested, and name and location of the company that performed the tests.

Furnish the Engineer with a copy of the manufacturer's instructions for installing the direct tension indicators before installation begins along with at least 1 metal feeler gauge for each 50 direct tension indicators shipped.

Use only direct tension indicators whose container lot numbers match the lot numbers on the test documents.

18.4. REQUIRED TEST SAMPLES

Furnish the Engineer with three samples of load indicating washers from each lot number, size and type for departmental tests along with two of the metal feeler gages required for performing the tests.

18.5. CONSTRUCTION METHODS

A. Installation

Install the direct tension indicators in strict compliance with the manufacturer's written instructions.

Install the direct tension indicator under the bolt head normally. If it is necessary to install the direct tension indicator under the nut, or if the bolt head must be turned, install additional hardened washers in accordance with the manufacturer's instructions.

Have a tension-indicating device on the project for determining the tension imposed on a fastener when the protrusions on direct tension indicator have been properly compressed.

Test three samples from each lot of direct tension indicators in the presence of the Engineer. Achieve a minimum bolt tension 5 percent greater than that required by Table 440-1 in Article 440-10 of the Standard Specifications. Do not substitute direct tension indicators for the hardened steel washers required with short slotted or oversized holes, but you may use them in conjunction with them.

Initially install the direct tension indicators to a snug tight condition as specified in Section 440-10 Paragraph (C) (3) of the Standard Specifications. After the initial tightening, fully tighten the fasteners, as recommended by the manufacturer of the direct tension indicators, beginning at the most rigid part of the joint and continuing toward its free edges.

Use a wrench to tighten fasteners containing direct tension indicators of the type and capacity recommended by the manufacturer and which is clean and lubricated. Use an air supply and hoses that are in good condition and provide air pressure of at least 690 KPa (100 psi) at the wrench.

Perform any heating of structural steel required for corrections in the vicinity of fasteners before direct tension indicators are installed.

B. Inspection

The Engineer will inspect for correct tightening of bolts by inserting a 0.125 mm (0.005") thickness feeler gauge into the openings between adjacent flattened protrusions of the direct tension indicator. The tension is correct when the number of spaces the gage can not enter is equal to or greater than the value shown in the table below.

Number of Spaces in Washer	Number of Spaces Gage is Refused
4	2
5	3
6	3
7	4

The gage must not be able to enter any spaces when the direct tension indicator is used under the turned element.

Do not tighten bolts to a no visible gap condition. Replace bolts that have a direct tension indicator with no visible gap and tighten the bolts with a direct tension indicator.

The Engineer will inspect at least 10 percent, but no less than 2, of the bolts in each connection, using the metal feeler gages provided by the Contractor.

Ensure that the part of the fastener being restrained from turning does not rotate during the tightening process, thereby abrading away a portion of the direct tension indicator protrusions.

Ensure that none of the direct tension indicator protrusions are accidentally partially flattened before installing in the structural steel joints.

Do not reuse direct tension indicators. If it becomes necessary to loosen a bolt previously tensioned, discard and replace the direct tension indicator.

18.6. 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 for "Dynamic Message Sign Assembly "DMS-__" and will be full compensation for all work listed above.