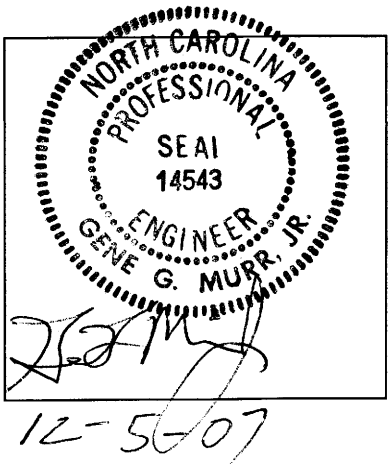

Project Special Provisions

Intelligent Transportation Systems

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Contents

1. 2006 STANDARD SPECIFICATIONS FOR ROADS & STRUCTURES

The 2006 Standard Specifications are revised as follows:

1.1 GENERAL REQUIREMENTS (1098-1)

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

In the second paragraph, add "Use 200 amp meter base for underground electrical service".

1.2 WOOD POLES (1098-6)

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

1.3 UNDERGROUND CONDUIT-CONSTRUCTION METHODS (1715-3)

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

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

2. GENERAL REQUIREMENTS

2.1 DESCRIPTION

A. General

Conform to these Project Special Provisions, Project Plans, and the *2006 Standard Specifications for Roads and Structures* (also referred to hereinafter as the "Standard Specifications"). The current edition of these specifications and publications in effect on the date of advertisement will apply.

Install state-furnished Dynamic Message Signs (DMS) on new Contractor furnished DMS support assemblies. Furnish and install new CCTV cameras, microwave vehicle detectors (MVD), metal camera poles with lowering systems, and all other related equipment and equipment cabinets. Furnish and install 72-count single-mode fiber optic cable and termination equipment at locations shown in the plans. Furnish and install communications equipment for all devices and integrate with the Metrolina Regional Traffic Management Center (MRTMC). Test all devices locally and remotely. Perform all work according to these project special provision and plans. Install devices at locations shown on the plans and route fiber optic cable according to the routing plans. Provide all parts and labor necessary to complete the work and meet all requirements of these project special provisions.

Provide real world coordinates for all field devices installed under this project. Provide the coordinates in feet units using the North Carolina State Plane coordinate system (1983 North American Datum also known as NAD '83). Furnish coordinates that do not deviate more than 1.7 feet (½ meter) in the horizontal plane and 3.3 feet (1 meter) in the vertical plane. Global positioning system (GPS) equipment able to obtain the coordinate data within these tolerances may be used. Submit cut sheets on the GPS unit proposed to collect the data for approval by the Engineer. For equipment cabinets, obtain and provide the location of the cabinet.

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

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

B. Domestic Steel and Iron Products

See section 106-1 (B) of the Standard Specifications.

2.2 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.

3. Electrical And Phone Service

3.1 Description

Install new electrical services and phone services at the locations shown in the plans. Comply with the National Electric Code (NEC), the National Electrical Safety Code (NESC), the Standard Specifications, the Project Special Provisions and all local ordinances. Coordinate all work involving electrical and phone service with the utility company and the Engineer.

Modify the existing electrical services at the locations shown on the project plans to provide power to the new device.

Coordinate with the Engineer, phone company, and the electrical utility company immediately upon determining the final equipment locations to avoid project delays. Obtaining new electrical and phone services should be given the highest priority.

Coordinate with the Engineer, the phone and electrical utility companies to ascertain the practicality of installing new services at each location before performing any work.

3.2 Material

Construct electrical and phone service in accordance with the Standard Specifications. For locations shown on the plans requiring new electrical service, provide a service that includes a new external service disconnect (breaker box) and a meter base. Route the electrical services and phone cables separately.

Provide an external electrical service disconnect in all locations shown on the Plans. Provide a service disconnect with a double pole 50 ampere circuit breaker with a minimum of 10,000 RMS symmetrical amperes short circuit rating in a lockable NEMA 3R enclosure. Provide a ground bus

and neutral bus with a minimum of four terminals and a minimum wire capacity of number 14 through number 4.

Furnish insulated copper electrical service cable in accordance with the NEC, local codes, and the Standard Specifications. Determine the gauge of electrical service cables in accordance with the distance, voltage and amperage of the service load.

3.3 CONSTRUCTION METHODS

A. New Electrical Service

At locations where new electrical service is to be installed, furnish and install electrical service as called for in the plans. After installation of the meter base, the utility company will install a new meter and make any necessary connections to the power lines. Ground the new electrical service in accordance with the Standard Specifications and the Standard Drawings.

B. Modify Existing Electrical Service

At the location shown on the project plans, modify the existing electrical service to meet the load demand of the existing and new equipment. Install a dedicated circuit in the circuit breaker box for the equipment and route the conductors through a conduit system to the equipment cabinet.

C. Phone Service

At locations where new phone service is required, coordinate with the local phone company, provide all required equipment, hardware, wires, cable, and conduits for successful delivery, installation, connection, and activation of the service. Connect the phone service grounding conductor to the main electrical service grounding conductor.

3.4 METHOD OF MEASUREMENT

New electrical services will be measured by the number of complete functional electrical service locations furnished, installed and accepted. Riser assemblies, wood poles, wood posts, meter bases, service disconnects, breakers, conduits, service hookup and acquisition costs, electrical service conductors, ground rod, ground wire and any remaining hardware to connect power to the equipment cabinets will be considered incidental to new electrical service.

Modified electrical service will be measured by the number of complete functional modified electrical service locations furnished, installed and accepted. Service entrance hardware, conductors, breakers, conduit, riser assemblies, and all other material and labor required to provide power to the equipment cabinets will be considered incidental to modified electrical service.

New phone service will be measured by the number of complete functional phone service locations furnished, installed and accepted. Riser assemblies, posts, conduit runs to the cabinet, service hookup and acquisition costs, conductors, ground wire and any remaining hardware to connect the phone service to the cabinet will be considered incidental to new phone service.

3.5 BASIS OF PAYMENT

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

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

The quantity of phone services, 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**

Modified Electrical Service ..... **Each**

New Phone Service ..... **Each**

4. CONDUIT AND JUNCTION BOXES

4.1 DESCRIPTION

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

Furnish and install tracer wire at locations shown in the Plans and in accordance with these Project Special Provisions.

Furnish and install oversized heavy-duty junction boxes at locations shown in the Plans and in accordance with these Project Special Provisions.

4.2 MATERIALS

Comply with the Standard Specifications:

Page 10-270, Article 1098-4, "Conduit"
Page 10-271, Article 1098-4 (C), "Tracer Wire"
Page 10-271, Article 1098-5, "Junction Boxes"

4.3 CONSTRUCTION METHODS

Install HDPE conduit and oversized heavy-duty junction boxes as noted in the Plans. Comply with the Standard Specifications:

Page 17-9, Section 1715, "Underground Conduit"
Page 17-10, Section 1715-3A (2), "Tracer Wire"
Page 17-15, Section 1716, "Junction Boxes"

4.4 METHOD OF MEASUREMENT

Actual length of conduit furnished, installed and accepted.

Actual length of tracer wire furnished, installed and accepted.

Actual number of oversized heavy-duty junction boxes furnished, installed and accepted.

No separate measurement will be made for, seeding, mulching, excavation of rock, conduit duct plugs, mechanical sealing devices, graded stone, paving materials, nuts and bolts or any other hardware or materials required for installation of Underground Conduit, Tracer Wire, and Oversized Heavy-duty Junction Boxes as these will be considered incidental to the items listed above.

4.5 BASIS OF PAYMENT

Conduit will be paid for per linear foot based on installation method, quantity, size and type.

Tracer Wire will be paid for per linear foot.

The quantity of oversized heavy-duty junction boxes will be paid for at the contract unit price each for "Junction Box (oversized heavy duty)".

Payment will be made under:

Directional Drill Conduit (2)(2.00")..... Linear Feet

Directional Drill Conduit (3)(2.00")..... Linear Feet

Tracer Wire..... Linear Feet

Junction Box (oversized heavy-duty) ..... Each

5. FIBER OPTIC CABLE

5.1 DESCRIPTION

Furnish and install a 72-fiber, single mode fiber optic (SMFO) cable in accordance with the plans and these Project Special Provisions. Install the SMFO cable from MRTMC to I-85 and along I-85 to Mallard Creek Church Road. The SMFO installation will utilize existing aerial and underground facilities. Splice the new 72-fiber SMFO cable to existing fibers at Mallard Creek Church Road and Harris Boulevard as shown in the Plans.

Terminate all fibers (active and dark) in the new 72-fiber SMFO cable at MRTMC in a new wall-mounted interconnect center. The wall mounted interconnect center consists of fusion splices, splice trays and patch panels.

Furnish and install 12-fiber, single mode fiber optic (SMFO) drop cables in accordance with the Plans and these Project Special Provisions.

Install fiber optic interconnect centers at the new CCTV, MVD, and DMS sites noted on the Plans.

Furnish and install fiber optic splice enclosures in accordance with the Plans and these Project Special Provisions. Install fiber optic splice enclosures in existing or new junction boxes as shown in the Plans. Splice the SMFO drop cable to the existing SMFO cable in accordance with the Plans.

Modify existing fiber optic splice enclosures in accordance with the Plans and these Project Special Provisions. Refer to manufacturer's recommendations for opening, modifying and re-sealing the existing fiber optic splice enclosures.

5.2 MATERIALS

Comply with the Standard Specifications:

Page 10-274, Article 1098-10 (A), "SMFO Communications Cable"

Page 10-275, Article 1098-10 (B), "Drop Cable" - In the first paragraph, replace the last sentence with "Furnish drop cable assemblies containing a minimum of twelve individual fibers." In the third paragraph, replace the first sentence with "On one end of cable assemblies, furnish twelve ST-PC connectors for termination on connector panel in equipment cabinet."

Page 10-276, Article 1098-11 (A), "Interconnect Center"

Page 10-276, Article 1098-11 (B), "Splice Enclosure"

5.3 CONSTRUCTION METHODS

Install SMFO cable along aerial and underground routes as noted on the project Plans.

Comply with the Standard Specifications:

Page 17-21, Section 1730, "Fiber Optic Cable"
Page 17-23, Section 1731, "Fiber Optic Splice Centers"

Install fiber optic interconnect centers at the new CCTV, MVD, and DMS locations as shown on the Plans.

Terminate the new fiber optic cable in a new wall mounted interconnect center installed in the MRTMC Communications Room as shown on the plans and directed by the Engineer.

Modify existing fiber optic interconnect center as shown in the Plans.

Install fiber optic splice enclosures in existing or new junction boxes as shown in the Plans. Splice the SMFO drop cable to the existing SMFO cable in accordance with the Plans.

Modify existing fiber optic splice enclosures as shown in the Plans.

5.4 METHOD OF MEASUREMENT

Actual length of 72 fiber SMFO cable furnished, installed and accepted.

Actual length of 12 fiber, SMFO drop cable furnished, installed and accepted.

Actual number of interconnect centers furnished, installed and accepted.

Actual number of wall mounted interconnect centers furnished, installed and accepted.

Actual number of modified interconnect centers accepted.

Actual number of splice enclosures furnished, installed and accepted.

Actual number of modified splice enclosures accepted.

No separate measurement will be made for splicing, terminating, testing fiber optic cable, communications cable identification markers, or fiber optic cable storage racks as these will be considered incidental to the installation of fiber optic cables and fiber optic drop cables.

5.5 Basis of Payment

The length of 72-Fiber SMFO cable, measured as provided above, will be paid for at the contract unit price per linear foot for "Communications Cable (72-fiber)."

The length of 12-Fiber drop cable, measured as provided above, will be paid for at the contract unit price per linear foot for "Drop Cable."

The number of interconnect centers, measured as provided above, will be paid for at the contract unit price each for "Interconnect Center."

The number of wall mounted interconnect centers, measured as provided above, will be paid for at the contract unit price each for "Wall Mounted Interconnect Center."

The number of modified interconnect centers, measured as provided above, will be paid for at the contract unit price each for "Modify Interconnect Center."

The number of splice enclosures, measured as provided above, will be paid for at the contract unit price each for "Splice Enclosure."

The number of splice enclosures, measured as provided above, will be paid for at the contract unit price each for "Modify Splice Enclosure."

Payment will be made under:

Communications Cable (72-fiber) ..... **Linear Feet**

Drop Cable ..... **Linear Feet**

Interconnect Center ..... **Each**

Wall Mounted Interconnect Center ..... **Each**

Modify Interconnect Center ..... **Each**

Splice Enclosure ..... **Each**

Modify Splice Enclosure ..... **Each**

6. FIBER OPTIC TRANSCEIVERS

6.1 DESCRIPTION

Furnish and install fiber optic video transmitters (w/data) at sites shown in the Plans. The fiber optic video transmitters will transmit CCTV video and receive/transmit PTZ data over a single fiber.

Furnish and install fiber optic video receivers (w/data) at the MRTMC. The fiber optic video receivers will receive CCTV video and transmit/receive PTZ data over a single fiber.

Install fiber optic data transceivers at sites shown in the plans. The fiber optic data transceivers will transmit and receive DMS data.

6.2 MATERIALS

A. Fiber Optic Video Transmitters (w/ data)

Furnish and install fiber optic video transmitters (w/ data) at CCTV locations shown in the plans. Ensure that the transmitters are compatible with the CCTV equipment specified for use on this project. Furnish shelf mounted video transmitters. The fiber optic video transmitters (w/ data) must meet the following minimum functional requirements:

- Video — 10-bit digitally encoded video transmission
- Input — 1 volt pk-pk (75 ohms)
- Connector — BNC (gold plated center pin)
- Bandwidth — 5Hz – 10MHz
- Diff. Gain — < 2%
- Diff. Phase — < 1%
- Signal / Noise — >67dB @ maximum optical loss budget
- Frame Rate — Broadcast quality (30fps)
- Data Connector — Terminal Block with Screw Clamps or DB-9
- Data Interface — RS-232, RS-422 / RS-485
- Data Format — NRZ, RZI, Manchester, Bi-phase
- Data Rate — 512 kbps
- Bit Error Rate — < 1 in 10^{-9} @ maximum optical loss budget
- Operating Mode — Simplex or Full Duplex
- Optical Connector — ST
- Wavelength — 1310 / 1550 nm, single mode
- Optical Budget — 23 dB
- Max Distance — 43 miles
- Operating Temp — -40 to +74 degrees Celsius
- Humidity — 0-95% (non-condensing)
- Certifications, Compliance and Compatibility
  - RS-250C Medium Haul Transmission
  - NTSC / PAL / SECAM / Full Color
  - UL

- CE
- FCC Part 15

B. Fiber Optic Video Receivers (w/ data)

Furnish and install fiber optic video receivers (w/ data) at the MRTMC. Furnish and install a video receiver rack in an existing equipment rack at the MRTMC. Coordinate with the Engineer to determine installation location. Furnish receivers from the same manufacturer as the transmitters. The fiber optic video receivers (w/ data) must meet the following minimum functional requirements:

• Video	10-bit digitally encoded video transmission
• Output	1 volt pk-pk (75 ohms)
• Connector	BNC (gold plated center pin)
• Bandwidth	5Hz – 10MHz
• Diff. Gain	< 2%
• Diff. Phase	< 1%
• Signal / Noise	>67dB @ maximum optical loss budget
• Frame Rate	Broadcast quality (30fps)
• Data Connector	Terminal Block with Screw Clamps or DB-9
• Data Interface	RS-232, RS-422 / RS-485
• Data Format	NRZ, RZI, Manchester, Bi-phase
• Data Rate	512 kbps
• Bit Error Rate	< 1 in 10^{-9} @ maximum optical loss budget
• Operating Mode	Simplex or Full Duplex
• Optical Connector	ST
• Wavelength	1310 / 1550 nm, single mode
• Optical Budget	23 dB
• Max Distance	43 miles
• Operating Temp	-40 to +74 degrees Celsius
• Humidity	0-95% (non-condensing)

- Certifications, Compliance and Compatibility
  - RS-250C Medium Haul Transmission
  - NTSC / PAL / SECAM / Full Color
  - UL
  - CE
  - FCC Part 15

6.3 CONSTRUCTION METHODS

A. Installation of Field Equipment

Furnish and install a fiber optic video transmitter (w/ data) at each CCTV field location as shown in the plans. Connect the optical port of each transceiver to a new or existing 12-fiber drop cable as shown in the splice details. Use ST connectors for fiber. Connect the video and data ports of each transceiver to the CCTV unit in accordance with CCTV manufacturer's recommendations. Furnish

and install fiber optic video receiver (w/data) in TRTMC as approved by the Engineer. Integrate the receivers with the video distribution, display, and control equipment in MRTMC.

6.4 Method of Measurement

Actual number of fiber optic video transmitters with data (field) furnished, installed and accepted.

Actual number of fiber optic video receivers with data (MRTMC) furnished, installed and accepted.

No separate measurement will be made for fiber optic jumpers, coaxial cables, communication cables, electrical cables, R3 chassis rack unit, power supplies, mounting hardware, nuts, bolts, brackets, connectors or surge suppression as these will be considered incidental to the transceiver pay items listed above.

6.5 Basis of Payment

The quantity of fiber optic video transmitters (w/ data), measured as provided above, will be paid for at the contract unit price each for "Fiber Optic Video Transmitter w/ Data (Field)."

The quantity of fiber optic video receivers (w/ data), measured as provided above, will be paid for at the contract unit price each for "Fiber Optic Video Receiver w/ Data (MRTMC)."

Payment will be made under:

Fiber Optic Video Transmitter w/ Data (Field)..... Each

Fiber Optic Video Receiver w/ Data (MRTMC)..... Each

7. CCTV Field Equipment

7.1 Description

Furnish and install CCTV field equipment described in this Section. Furnish equipment that is compatible, interoperable, and completely interchangeable with existing Pelco Spectra IV high-performance dome equipment currently in use by NCDOT in this Region. Ensure that the equipment is fully compatible with all features of the existing video matrix switch at the MRTMC and the *VideoPro* video management software.

7.2 Material

A. General

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

- One Pelco Spectra Series IV Dome CCTV or approved equivalent that contains in a single enclosed unit the following functionality and accessories:

1. CCTV color digital signal processing camera unit with zoom lens, filter, control circuit, and accessories
2. Motorized pan, tilt, and zoom
3. Pole-mount camera attachment assembly
4. All necessary cable, connectors and incidental hardware to make a complete and operable system

- A lightning arrestor installed in-line between the CCTV camera and the equipment cabinet components.
- A NEMA Type 4 enclosure constructed of aluminum with a clear acrylic dome or approved equal Camera Unit housing.

B. Camera and Lens

1. Cameras

Furnish new charged-coupled device (CCD) color cameras. Furnish cameras with automatic gain control (AGC) for clear images in varying light levels. The camera must 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 with manual override
- 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 must 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

2. Zoom Lens

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

- Focal length: 0.16" – 3.45", 35X optical zoom, and 12X electronic zoom
- Preset positioning: 64 Presets

The lens must be capable of both automatic and remote manual control iris and focus override operation. The lens must 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 must be provided to protect the motors from overrunning in extreme positions. The operating voltages of the lens must 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 IV high performance integrated dome system or approved equal. Equip each housing with mounting assembly for attachment to the CCTV camera pole. The enclosures must be equipped with a sunshield and be fabricated from corrosion resistant aluminum and finished in a neutral color of weather resistant enamel. The enclosure must meet or exceed NEMA 4X ratings. The viewing area of the enclosure must be tempered glass.

D. Pan and Tilt Unit

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

Provide each new camera unit with a control receiver/driver that is integral to the CCTV dome assembly. The control receiver/driver will 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 must 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 must accept status information from the pan/tilt unit and motorized lens for preset positioning of those components. The control receiver/driver will relay pan, tilt, zoom, and focus positions from the field to the remote camera control unit. The control receiver/driver must 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 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 attachments that allow 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 a CCTV Camera Attachment Assembly that is able to withstand wind loading at the maximum wind speed and gust factor called for in these Special Provisions and can support a minimum camera unit dead load of 45 pounds (20.4 kg).

G. Surge Suppression

Protect all equipment at the top of the pole grounded metal oxide varistors connecting each power conductor to ground.

Protect coaxial cable from each camera by a Vicon V15LP surge protector or approved equivalent at each end of the cable.

7.3 CONSTRUCTION METHODS

A. General

Mount CCTV camera units at a height sufficient to adequately see traffic in all directions and as approved by the Engineer. The minimum attachment height is 50 feet above ground level.

Mount the CCTV camera units such that a minimum 5 feet of clearance is maintained between the camera and the top of the pole.

Install CCTV assemblies at the locations shown on the Plans.

Mount CCTV cameras on the side of poles nearest intended field of view. Avoid occluding the view with the pole. Obtain approval of camera orientation from the Engineer.

Integrate CCTV camera unit with fiber optic video transceiver, equipment cabinet, and the MRTMC CCTV equipment. CCTV cameras are connected to MRTMC in a point-to-point configuration.

B. Electrical and Mechanical Requirements

Ground all equipment as called for in the Standard Specifications, these 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.

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

7.4 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, surge protectors, or any other equipment or labor required installing the CCTV assembly and integrating it with the fiber optic communications cable.

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.

7.5 Basis of Payment

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

Payment will be made under:

CCTV Assembly ..... Each

8. Microwave Vehicle Detector Field Equipment

8.1 Description

Furnish and install non-intrusive microwave or radar vehicle detectors (MVD) in accordance with the Plans and these Project Special Provisions. Provide MVD units with the capability to interface with a fiber optic network by using RS-232 lead-in cable that integrates with a Ethernet switch with integrated serial ports and media converter. The MVD devices will collect traffic data such as traffic volume, vehicle speed, average speed, lane occupancy, vehicle classification and presence. The MVD devices must be fully compatible with the *EIS WATER* software currently in use by the NCDOT.

Furnish new equipment and component parts, of the latest design and manufacture, and in operable condition at the time of delivery and installation. No part or attachment can be substituted or applied contrary to the manufacturer's recommendations and standard practices.

Provide equipment design that prevents reversed assembly or improper installation of connectors, fasteners, etc. Design each item of equipment to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.

8.2 Materials

A. Microwave Vehicle Detector (MVD)

For compatibility with existing equipment and software in the Region, furnish EIS RTMS X3, or approved equivalent. Furnish MVDs with all necessary hardware, mounting brackets and cabling to provide a complete, integrated and fully functional system. The MVD must meet the following minimum functional requirements:

• Measured Quantities	Volume, speed, occupancy, classification
• Detection Zone	8 traffic lanes (minimum)
• Detection Range	6 to 250 feet
• Zone Resolution	1 foot
• Communications	RS-232 / RS-485
• Configuration	Automatic
• Management	Supports local and remote management

- Operating Temperature -40°C to 75°C

Furnish MVD lead-in cable in accordance with the MVD manufacturer's recommendations.

B. Lead-In Cable

Furnish detector lead-in cable that meets the following:

- Complies with IMSA 20-2 or REA PE-22
- 20-24 gauge, shielded copper cable
- conductors with different colors of insulation

C. Field Ethernet Switch

Furnish and install an ethernet switch with a minimum of two RS-232 serial ports and one 10/100MB RJ-45 and two 100BASE-FX fiber optic ports with ST connectors. For compatibility with the existing equipment in the Region, furnish ethernet switches that are RuggedCom model RS910 or an approved equivalent with the following features:

Serial Ports

- Fully compliant EIA/TIA RS485, RS422, RS232 serial ports (software selectable) - DB9, RJ45, Phoenix style connectors
- Transmit serial data over an IP network
- Support for Modbus TCP, DNP 3, TIN serial protocols
- Baud rates up to 230 kbps
- Point-to-point and multi-point modes
- Convert Modbus RTU to Modbus TCP
- Supports multiple Modbus masters

Ethernet Ports

- Integrated Ethernet Switch with 3 ports
- High performance and throughput Ethernet switching
- Fully IEEE 802.3, IEEE 802.3u, IEEE 802.3x compliance
- Non-blocking, store and forward switching
- 10/100BaseTX, 10BaseFL, 100BaseFX options

Environmental Requirement

- Immunity to EMI and heavy electrical surges
  - IEEE 1613 (electric utility substations)
  - IEC 61850-3 (electric utility substations)
  - IEEE 61800-3 (variable speed drive systems)
  - IEC 61000-6-2 (generic industrial)
  - NEMA TS-2 (traffic control equipment)
- Fully independent 2kV (RMS) isolated serial ports
- -40°C to +85°C operating temperature (no fans)
- 18 AWG galvanized steel enclosure

Power Supply

- Fully integrated power supplies (no external adaptors)
- Low voltage ranges: 24VDC(9-36VDC), 48VDC (36-59VDC), Universal high-voltage range: 88-300VDC or 85-264VAC
- CSA/UL 60950 safety approved to +85°C

Operating System Features

- Simple plug and play operation - automatic learning, negotiation, and crossover detection
- Integrated Cyber Security features
- Fast network fault recovery (<5ms)
- Quality of Service (802.1p) for real-time traffic
- VLAN (802.1q) and GVRP support
- Port Rate Limiting and Broadcast Storm Limiting
- Port configuration, status, statistics, mirroring, security

Management Tools

- Web-based, Telnet, CLI management interfaces
- SNMP v1/v2/v3
- Remote Monitoring (RMON)
- Rich set of diagnostics with logging and alarms

8.3 CONSTRUCTION METHODS

A. Microwave Vehicle Detector

Mounted the MVDs in a side-fired configuration on the CCTV metal poles at the specified locations, using the manufacturer supplied mounting brackets. Attach with stainless steel bands.

Install the MVDs at a minimum height of 17 feet above the road surface so that the masking of vehicles is minimized and that all detection zones are contained within the specified elevation angle as suggested by the manufacturer. In locations where two detector units are mounted on the same CCTV camera pole, one detector unit will monitor traffic on the northbound I-85 and the other unit will monitor traffic on the southbound I-85. A manufacturer's representative should determine the height of each detector unit to ensure best performance.

Set up each MVD detection zone using configuration software and a Notebook PC.

B. Field Ethernet Switch

Install a switch in each CCTV equipment cabinet. Connect the RS-232 lead-in cable to the serial port of the switch and connect the fiber optic cable to the fiber ports in drop-n-repeat configuration. Interconnect the MVDs to MRTMC in a ring configuration. Install one Ethernet switch at the MRTMC. Ensure the Ethernet switches installed in the field and in the MRTMC communicate reliably without loss of data over SMFO cable up to 15 miles. Provide attenuator as needed for shorter distances.

8.4 METHOD OF MEASUREMENT

Actual number of microwave vehicle detector assemblies furnished, installed, integrated, and accepted. No separate payment will be made for power supplies, attachment assemblies, configuration, grounding equipment, surge protectors, cabling, lead-in cable, connectors, conduit,

noise filters, meter bases, excavations or any other equipment or labor required to install the MVD unit and integrate with the communications system.

Actual number of field ethernet switches furnished, installed, integrated, and accepted. No separate payment will be made for power supplies, attachment assemblies, configuration, grounding equipment, surge protectors, cabling, connectors, noise filters, or any other equipment or labor required to install the field ethernet switches and integrate into the system.

8.5 Basis of Payment

The quantity of microwave vehicle detector units, measured as provided above, will be paid for at the contract unit price each for "MVD Assembly".

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

MVD Assembly ..... Each

Field Ethernet Switch ..... Each

9. CCTV / MVD Metal Poles

9.1 Description

Furnish and install metal poles with grounding systems and all necessary hardware in accordance with the Plans and these Project Special Provisions. Comply with the provisions of Section 1700.

At locations shown in the Plans, furnish and install metal poles to support closed circuit television (CCTV) cameras with lowering systems and microwave vehicle detector (MVD) units.

Furnish CCTV metal poles with a minimum height of 50 feet. Attach equipment cabinets to the metal poles as called for in the Plans.

9.2 Materials

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

Furnish and install a concrete foundation for each pole that is in accordance with the Plans and Specifications. Comply with the Standard Specifications.

Furnish poles and foundations that meet or exceed the following functional requirements with all CCTV & MVD units, power meters, service disconnects, and all equipment cabinets attached and all risers, condulets, and weatherhead accessories in place:

- Maximum deflection at top of pole (in 30 mph, non-gusting wind): two inches
- Ultimate load: 90 mph wind with a 30% gust factor

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

Prepare a design for each pole foundation and submit to the Engineer for review. The top of the drilled shaft foundation must be flush with finished grade. Unstable soil may require a deeper foundation. Concrete for the foundation must be 3000 psi minimum. A registered professional engineer must prepare and seal the foundation design that meets all NCDOT requirements. Perform soil tests for each CCTV metal pole foundation location in accordance with Section 11.4.B of the "Project Special Provisions for Signals and Intelligent Transportation Systems." The Project Special Provisions for Signals and Intelligent Transportation Systems can be found at the following link:

http://www.ncdot.org/doh/preconstruct/traffic/ITSS/ws/PSP.doc

Furnish poles with a ½ inch x 36 inch air terminals in accordance with the CCTV Metal Pole Grounding Details.

A. CCTV Lowering System

Provide a CCTV camera lowering system as an integral part of the CCTV metal pole. The lowering system will consist of a support arm, camera connection box, and all necessary cabling and wiring for installation.

Provide a portable CCTV lowering device to operate the lowering system. Provide the lowering device with a variable speed, heavy-duty reversible motor as recommended by the CCTV lowering system steel pole manufacturer. Provide a lowering device that is capable of both manual and motor driven operation. Equip the lowering device with a positive breaking mechanism to secure the cable during raising/lowering operations to prevent freewheeling. All lowering equipment, lowering device, pulleys, cables, etc. must be made of durable, corrosion resistant materials, powder coated, galvanized, or otherwise protected from the environment by industry-accepted coatings to withstand exposure to corrosive environment.

9.3 CONSTRUCTION METHODS

Determine and provide to pole fabricator the effective projected area of all items to be attached to each pole at each pole location.

Obtain approval from the Engineer for final field locations of the CCTV metal poles before developing shop drawings and installing the poles. Obtain shop drawings, signed and sealed by a North Carolina registered professional engineer, for each pole location (each combination of pole height and equipment mix) and submit to the Engineer for approval. When approved, submit to pole fabricator. Perform soil tests for each CCTV metal pole foundation location in accordance with Section 11.4.B of the "Project Special Provisions for Signals and Intelligent Transportation Systems." The Project Special Provisions for Signals and Intelligent Transportation Systems can be found at the following link:

http://www.ncdot.org/doh/preconstruct/traffic/ITSS/ws/PSP.doc

Ground metal poles in accordance with NCDOT Typical Grounding Details. Bond all CCTV and MVD housings and mounting brackets to pole.

9.4 Method of Measurement

Actual number of 50-ft. CCTV metal poles furnished and installed. Payment for this item includes field locating the pole, geotechnical sampling and analysis of soil at pole locations, development of shop drawings, wind surface area calculations, equipment dead loads, grounding system, design and fabrication of the pole, design and fabrication of the pole foundation, and delivery and storage of poles.

Actual number of CCTV camera lowering systems furnished and installed. Payment for this item includes development of shop drawings, mounting hardware, all cables, connectors, and grounding system.

Actual number of portable CCTV lowering devices furnished. Payment for this item includes development of shop drawings, mounting hardware, all cables, connectors, variable speed reversible drive motor, manually operation option, positive breaking mechanism.

9.5 Basis of Payment

The quantity of 50 ft. CCTV Metal Poles, measured as provided above, will be paid for at the contract unit price each for "CCTV Metal Pole".

The quantity of CCTV camera lowering systems, measured as provided above, will be paid for at the contract unit price each for "CCTV Camera Lowering System".

The quantity of portable CCTV lowering devices, measured as provided above, will be paid for at the contract unit price each for "Portable CCTV Lowering Device".

Payment will be made under:

CCTV Metal Pole..... Each

CCTV Camera Lowering System ..... Each

Portable CCTV Lowering Device ..... Each

10. Field Equipment Cabinet

10.1 Description

Furnish 336 stretch cabinets to house CCTV and MVD control and transmission equipment and fiber optic interconnect centers for terminating, splicing, and cross-connecting fiber optic cables. The 336 stretch field cabinet must consist of a cabinet housing, 19-inch EIA mounting cage, and power distribution assembly (PDA #3 as described in the CALTRANS TSCES).

The cabinet housing must 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. Do not equip the CCTV cabinet housings with a police panel.

The cabinet cage must 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 CCTV, MVD, and communications devices as needed to accommodate the number of devices in the cabinet.

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

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

Obtain the Engineer's approval of all CCTV cabinets prior to furnishing for use on this project.

10.2 MATERIALS

A. Shelf Drawer

Provide a pull out, hinged-top drawer, having sliding tracks, with lockout and quick disconnect feature in the equipment cabinet. Furnish a pullout drawer that extends a minimum of 14 inches that is capable of being lifted to gain access to the interior of the drawer. Minimum interior dimensions of the drawer are to be 1 inch high, 13 inches deep, and 16 inches wide. Provide drawers capable of supporting a 40-pound device or component when fully extended.

B. Cabinet Light

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

C. Surge Protection for System Equipment

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

1. Main AC Power Input

Furnish and install each 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 must be capable of reducing the effect of lightning 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 must rise in 8 microseconds and fall in 20 microseconds to ½ the peak: 20000 Amperes.
- The protector must be provided with the following terminals:

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

- The Main AC line in and the Equipment Line out terminals must be separated by a 200 Microhenry (minimum) inductor rated to handle 10 AMP AC Service.
- The first stage clamp must be between Main Line and Ground terminals.
- The second stage clamp must be between Equipment Line Out and Equipment Neutral.
- The protector for the first and second stage clamp must have an MOV or similar solid state device rated at 20 KA and must be of a completely solid state design (i.e., no gas discharge tubes allowed).
- The Main Neutral and Equipment Neutral Out must be connected together internally and must 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.

2. Ground Bus

Provide a neutral bus that is not connected to the earth ground bus or the logic ground bus 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.

10.3 CONSTRUCTION METHODS

For each field cabinet installation use stainless steel banding or other methods approved by the Engineer to fasten cabinet to pole.

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

10.4 METHOD OF MEASUREMENT

Actual number of field equipment cabinets furnished, installed and accepted. No separate measurement will be made for cabling, connectors, cabinet attachment assemblies, conduit, condulets, grounding equipment, surge protectors, power supplies, or any other equipment or labor required to install the field equipment cabinet and integrate it with the CCTV, MVD and communications equipment.

10.5 BASIS OF PAYMENT

The quantity of field equipment cabinets, measured as provided above, will be paid for at the contract unit price each for "Field Equipment Cabinet."

Payment will be made under:

Field Equipment Cabinet ..... Each

11. CENTRAL SYSTEM EQUIPMENT

11.1 DESCRIPTION

Install new hardware, integrate with existing hardware and perform modifications at the MRTMC. Furnish and install SMFO jumper cables and flexible duct between the equipment room and the communications room. Label jumpers as directed by the Engineer.

Upgrades to the MRTMC system to be performed with this project include modifications to the existing system database, and installation of new hardware. Database upgrades will include updating the system to monitor and control the additional ITS field devices and incorporating the new lanes (on a link by link basis, where a link is the section of roadway between two MVD units). Software upgrades necessary include using the Sherrill-Lupinski Graphical Modeling System (SL-GMS) graphics tool to update the system map to depict the correct number of lanes, the new devices installed, and the expanded coverage area.

An agenda of work items and a projected time frame must be submitted to the Engineer for approval.

A. Hardware Modifications

1. Video Distribution Amplifiers

Furnish and install a new 16 ports, rack mounted video distribution amplifier (VDA) in MRTMC for the new CCTV cameras. For compatibility with the existing equipment in the Region, furnish a Pelco CM9760-MDA or an approved equivalent.

2. Terminal Server Expansion

Integrate Department furnished 16-port terminal servers into the racks in the MRTMC. The terminal servers furnished are DECSERVE716 with flash cards. Integrate the terminal servers into the MRTMC central hardware communications system. Connections to the new Department furnished terminal servers are shown in the Plans.

Install the Department furnished terminal servers at the same time the new field hardware is installed.

3. Central Ethernet Switch:

Furnish and install ethernet switches to communicate with MVDs and DMS. This switch will be the same made and model installed in the field for the MVDs and DMS. The switch must communicate with field devices reliably and without loss of data up to 15 miles in distance.

4. Video Switch Modifications

Modify the existing Pelco video switch to incorporate the new CCTV units installed as part of this project. These modifications should not require the installation of new I/O cards in the switch. Assign the CCTV units to the appropriate inputs on the switch in the same manner as the existing CCTV units and as approved by the Engineer.

B. Central Site Software Modifications

1. Update System Overview Map

Use the existing SL-GMS graphics package to modify the existing system map. Modifications to the existing map will include extending the map to include the limits of this project, assigning roadway lanes on a link (between MVD devices), and adding new ITS field devices/elements (MVD, CCTV, and DMSs). Incorporate the MVD devices into the system overview map such that the links are color coded and automatically update (in the same fashion as the existing map) to indicate the speeds between the links. All new ITS device icons on the map (CCTV, MVD, DMS, lanes, etc.) must maintain the same level of functionality as the existing map. Information obtained by clicking on the icons and lanes should be the same as is available on the existing map. The SL-GMS graphics package uses a hardware dongle for licensing purposes. To upgrade the system map, the Contractor will have to make the required modifications at the MRTMC or procure (at their own expense) a dongle to allow them to perform modifications at their facility. If the contractor elects to make modifications to the map at the MRTMC, these modifications must be made offline, in the back room of the MRTMC and uploaded during off-hours with the approval of the Engineer.

2. Modify Central CCTV Software

Modify existing video matrix switch and configure existing CCTV database at MRTMC to incorporate mapping of new inputs from new CCTV cameras. Modify CCTV central software at MRTMC to display and facilitate mapping of new CCTV cameras.

3. Modifying the System Database to Accommodate New Field Devices

Configure and modify the system database to incorporate all new devices installed with this project to make the devices fully functional components of the MRTMC system.

Configure field devices using external software or the device keypad according to the manufacturer's instructions. Configure the devices using addressing and communication parameters compatible with the configuration of the central system.

The EasyStreets© database maintenance utility provides a user interface for adding new devices to the system database. The MRTMC System User's Guide provides instruction in the use of the EasyStreets© database maintenance utilities. In addition to the list of equipment defined within the system, the database includes lane designations, segments, and incident parameters associated with the field devices. The contractor will be required to update the database for all of these devices (with the exception of incident parameters, which will be installed by the NCDOT at a later date).

The delivery documents associated with each system build contain updated information on database contents. The contractor will be required to assure new device parameters do not conflict with any existing database parameters as defined in the most recent delivery documents.

The MRTMC system utilizes SL-GMS as a graphics engine. SL-GMS provides utility programs for updating and maintaining graphic displays. The SL-GMS utilities required to maintain the map are located on the development computer. The contractor will be required to update the system map to include the new devices and lanes.

11.2 METHOD OF MEASUREMENT

Actual number of video distribution amplifiers furnished, installed, integrated, and accepted.

Actual number of Department furnished terminal servers installed, integrated, and accepted.

Actual number of Central Ethernet switches furnished, installed, and integrated.

Lump sum for the video switch modifications.

Lump sum for the central site software modifications. This work includes an update of the system overview map and modification to the system database to accommodate new field devices.

No separate measurement will be made for jumpers and flexible duct between the equipment and communications rooms. Additionally, no separate payment will be made for cabling, connectors, attachment assemblies, grounding equipment, surge protectors, power supplies, or any other equipment or labor required to install and integrate the components in the MRTMC facility.

11.3 BASIS OF PAYMENT

The quantity of video distribution amplifiers, measured as provided above, will be paid for at the contract unit price each for "Video Distribution Amplifier."

The quantity of Department furnished terminal servers integrated, measured as provided above, will be paid for at the contract unit price each for "Integrate Terminal Server."

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

Video switch modifications will be paid for at the lump sum price for "Video Switch Modifications."

Central site software modifications will be paid for at the lump sum price for "MRTMC Software Modifications."

Payment will be made under:

Video Distribution Amplifiers ..... **Each**

Integrate Terminal Server ..... **Each**

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

Video Switch Modifications ..... **Lump Sum**

MRTMC Software Modifications ..... **Lump Sum**

12. DYNAMIC MESSAGE SIGN (DMS) SYSTEM INSTALLATION

12.1 DESCRIPTION

Transport the State furnished DMS from the Metrolina Regional Transportation Management Center (MRTMC) located at 2327 Tipton Drive, Charlotte, NC 28206 to the location shown on the project Plans. Mount the DMS and its new equipment cabinet to a new support assembly. Install power, communications equipment, and cabling as shown on the project plans. Interconnect the DMS with the MRTMC and provide full command and control of the DMS from MRTMC.

Reference Information for the State furnished DMS:

- Manufactured by Mark IV industries,
- Display area consists of 3 lines of 15 characters.
- Character height is 18",
- Walk-in enclosure type,
- Enclosure Dimensions: 25'-3 1/4" wide, 9'-11 5/8" high, 3'-2" deep at the bottom and 3'-9 9/16" deep at the top,
- Weight: 4000lbs
- See DMS drawings included in the Plans for further information.

12.2 MATERIAL

A. 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.

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.

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.

B. 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.

C. DMS Controller and Cabinet

Install state-furnished DMS controller and other equipment in new pole mounted cabinet. Installation of new equipment and wiring within the cabinet must comply with the following:

1. Wiring

The requirements stated herein apply 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 6" maximum to prevent separation of the individual conductors.

Label all conductors individually, clearly, and uniquely. Connect all terminal conductors to terminal strips at right angles. Remove excess conductors before termination. Mold the conductor in such a fashion as to retain its relative position to the terminal strip if removed from the strip. Install all connectors, devices and conductors in accordance with manufacturer's guidelines. Comply with the latest NEC guideline in effect during installation. No conductor or conductor bundle may hang loose or create a snag hazard. Protect all conductors from damage. All solder joints should be completed using industry accepted practices and not fail due to vibration or movement. All welds must be in a manner that will not fail due to vibration. Protect all lamps and control boards from damage.

Insulate all conductors and live terminals so they are not hazardous to maintenance personnel. Route and bundle all wiring containing AC line voltage 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 one complete set 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.

2. 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.

3. 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 2".

Provide power line surge protectors that 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)

4. 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" 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.

5. 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

6. Lightning Arrester

Protect the system with a UL-approved lightning arrester installed at the main service disconnect that meets 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.

7. 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. The 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 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.

12.3 CONSTRUCTION METHODS

A. Description

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. The Contractor is responsible for 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 locations. Mark the proposed location of electrical service locations, pole foundations, 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. Conduit

Install the conduit system in accordance with section 1715 of Standard Specification and 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 4 feet for conduit 1.5" and larger, or 6 feet for conduit 1.25" and smaller. Place fasteners no more than 3 feet 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.

Do not exceed the appropriate fill ratio on all cable installed in conduit as specified in the NEC.

D. 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 3" (75mm) of sand or earth back-fill free of rocks and debris. Compact backfill in 6" (150 mm) layers. Do not splice underground circuits unless specifically noted in the plans.

E. 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 (with approved sealing devices/method) all unused conduits 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.

F. 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 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" minimum diameter, 10 feet 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.

G. 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.

12.4 METHOD OF MEASUREMENT

Each DMS System installation consists of transporting the state-furnished DMS to the location shown on the plans, mounting the DMS to a supporting assembly, furnishing and installing a new pole-mounted cabinet, strapping hardware, UPS, conduit and conduit bodies, wires and cables, connectors, circuit protection equipment, tools, materials, all related testing, cost of labor, incidentals, and all other equipment necessary to install a DMS system as detailed in the previous pages.

12.5 BASIS OF PAYMENT

The quantities of each DMS System installation as measured will be paid for at the contract lump sum price for "DMS - __ Installation".

Payment will be made under:

DMS – __ Installation".....Lump Sum

13. DMS TESTING REQUIREMENTS

13.1 DESCRIPTION

Test the DMS system using "before" and "after" functional tests. The purpose of the "before" installation tests is to document that the DMS is functioning properly and all equipment operates correctly. The purpose of "after" installation tests is to ensure the DMS system has not sustained any damage during transportation, installation, and power up. Perform the before and after tests per test procedure found in Section 19.

A. Operational Field Tests

Conduct an Operational Field Test of each DMS system before and after installation. The Operational Field Test will consist of the following tests as a minimum:

1. Physical Examination

Check the DMS enclosures to ensure there are no damages to the metal enclosure, front panel, access doors, locks and etc.

2. Functional Tests

Perform the following functional tests:

- 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.

- Operate 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.
- Select messages from the sign controller's local control panel.
- Display and verification of all stored messages.
- Resume standard operation upon interruption of electrical power.
- Demonstrate the Failure Detection and Response functions.
- Set controller clock using 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 component supplied by the Contractor on this project 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.

If a component supplied by the Department on this project does not pass the "before" test, notify the Engineer.

If a component supplied by the Department on this project passes the 'before" tests but fails the "after" tests, either document a correction or substitute a new unit as approved by the Engineer. Re-test the system until it passes all requirements.

13.2 CONSTRUCTION METHOD

Conduct tests according to the provided test procedures found in Section 19 and provide the results for approval by the Engineer. The Engineer or a designated representative reserves the right to witness all tests.

13.3 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 "DMS - __ Installation" and will be full compensation for all work listed above.

14. DYNAMIC MESSAGE SIGN ASSEMBLY

14.1 DESCRIPTION

This section includes all design, fabrication, furnishing, and erection of the Dynamic Message Sign (DMS) assembly; access platform to the DMS inspection door; and attachment of the DMS enclosure to the structure in accordance with the requirements of the Project Plans and the provisions of this specification. Fabricate the supporting DMS assembly from tubular steel. Provide pedestal type DMS assemblies as shown on the Project Plans.

Reference Information for the State furnished DMS:

- Manufactured by Mark IV industries,
- Display area consists of 3 lines of 15 characters.
- Character height is 18",
- Walk-in enclosure type,
- Enclosure Dimensions: 25'-3 1/4" wide, 9'-11 5/8" high, 3'-2" deep at the bottom and 3'-9 9/16" deep at the top,
- Weight: 4000lbs
- See DMS drawings included in the Plans for further information.

Provide a minimum of twenty-five feet (25') clearance from the high point of the road to the bottom of the DMS enclosure. **The DMS assembly must allow for field adjustment (horizontal & vertical tilting) of the DMS enclosure to ensure optimum legibility from all travel lanes.**

Design the DMS assembly including footings and submit shop drawings for approval.

Where the Standard Specifications or plans require the design of a DMS assembly, including footings, submit design computations and shop drawings prepared and sealed by a Professional Engineer (registered in the state of North Carolina) to the Engineer for acceptance.

The provisions of Section 900 apply to all work covered by this section.

14.2 MATERIAL

Use materials that meet the following requirements of the NCDOT Standard Specifications:

Structural Steel	Section 1072
Overhead Structures	Section 1096
Signing Materials	Section 1092
Organic-Zinc Repair Paint	Article 1080-9
Reinforcing Steel	Sub-article 1070
Direct Tension Indicators	Sections 440 and 1072

14.3 CONSTRUCTION METHOD

A. General

Fabricate the DMS assembly in accordance with the details shown in the approved shop drawings and the requirements of these specifications.

No welding, cutting, or drilling in any manner will be permitted in the field, unless approved by the Engineer.

Drill bolt holes and slots to finished size. Holes may also be punched to finished size, provided the diameter of the punched holes is at least twice the thickness of the metal being punched. Flame cutting of bolt holes and slots will not be permitted.

Use two coats of a zinc-rich paint to touch up minor scars on all galvanized materials.

B. Shop Drawing

Submit to the Engineer for approval a complete design for the DMS assembly, including footings, DMS assembly hardware, brackets for supporting the DMS and the access platform. Base the design on the line drawings and correct wind speed in accordance with the "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals".

The manufacturer of the DMS assembly must ensure that design of the assembly is totally compatible with the existing DMS for mounting and attachment.

Submit six copies of completely detailed shop drawings and one copy of the design computations for the DMS assembly to the Engineer for approval prior to fabrication. Show in the shop drawings complete design and fabrication details including foundations, provisions for attaching DMS and access platform to supporting structures, applicable material specifications, and any other information necessary for procuring and replacing any part of the complete Dynamic message sign assembly.

Allow a minimum of thirty (30) working 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

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 Project Plans were estimated from available project data for bid purposes. Determine the actual dimensions from field measurements and DMS enclosure dimensions and furnish revised plans. Attach the DMS assembly to the concrete foundation by the use of galvanized anchor bolts. Furnish anchor bolts with galvanized nuts, flat washers and lock washers. Provide anchor bolts that have an anchor plate with a nut at the end embed in concrete.

Fabricate the attachment assembly for mounting DMS in a manner that will ensure easy removal of the DMS.

2. Access Platform

Provide an access platform, a minimum of three feet wide with an open skid-resistant surface and safety railing, on the DMS assembly for access to the DMS inspection door unless specifically stated otherwise in the Project Plans. Provide platforms with fixed safety railings along both sides from the beginning of the platform to the inspection door.

Connect the platform sections rigidly where sections join to avoid an uneven walking surface.

Install a 4"x 4" safety angle parallel to and along both sides of the platform and extend it the entire length of the platform. Design the safety angle to withstand the equivalent load imposed on the platform.

3. DMS Access Ladder

Provide a fixed ladder, of the same material as the assembly, leading to the access platform. Equip the ladder with a security cover to prohibit access by unauthorized persons. The ladder should start from three feet above finished ground and end at the access platform. Design the ladder as a permanent part of the DMS assembly and include complete design details in the DMS assembly shop drawings. The fixed ladder must meet OSHA requirements as well as state and local codes.

4. Footings for Dynamic Message Sign Assembly

Design the footings for 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 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 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 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 of the Standard Specifications. 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 that measures 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 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.

14.4 Method of Measurement

The Dynamic Message Sign Assembly includes all design, fabrication, construction, transportation, and attachment of the complete dynamic message sign assembly, supporting structure, hardware, access platform, direct tension indicators, preparing and furnishing shop

drawings, additional documentation, incidentals, and all other equipment and features necessary to furnish the system described above.

The DMS Access Ladder includes design, fabrication, transportation, and attachment to the DMS assembly.

14.5 Basis of Payment

The Dynamic Message Sign Assembly, measured as provided above, will be paid for at the contract lump sum price per assembly.

The DMS Access Ladder, measured as provided above, will be paid for at the contract lump sum price per DMS Access Ladder.

Payment will be made under:

Dynamic Message Sign Assembly "DMS-__" .....Lump Sum

DMS-__ Access Ladder.....Lump Sum

15. DMS Foundation

15.1 Description

The work covered by this provision consists of the design and construction of sign foundations in accordance with the submitted approved plans and this provision. Design and construct either spread footing type foundations and/or drilled pier type foundations for each sign unless otherwise directed by the Engineer.

15.2 Material

Portland Cement Concrete Production and Delivery .....Section 1000
Reinforcing Steel .....Section 1070
Anchor Bolts .....Article 1072-6
Structural Steel and Overhead Sign Structures .....Section 1072 and 1096

15.3 Construction Methods

A. General

A North Carolina Licensed Professional Engineer must seal all design calculations, drawings and recommendations. Design foundations for the effects of dead, wind and ice loads in accordance with the wind zone load shown on the plans and Section 3 of the 2001, 4th edition AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals (including interims). Use either spread footing or drilled pier foundations. In some instances, conflicts with drainage structures may dictate a certain type of foundation. Spread footings or dual drilled pier foundations are required for full span overhead signs (no single drilled pier foundations). When designing dual drilled pier foundations, a rectangular grade beam with a moment of inertia approximately equal to either of the drilled piers is required to connect the pier tops.

Provide reinforced concrete design in accordance with either Section 13.7.2 or 13.6.2 (whichever is applicable), allowable stress design method, of the 2001, 4th edition AASHTO Standard

Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals (including interims).

Consider sloping ground in the design, if applicable. Do not exceed an allowable bearing pressure of 3 ksf for spread footings. For drilled pier foundations, do not exceed an allowable lateral soil pressure of 4 ksf for AASHTO Group II Loading. Use the following default soil parameters and groundwater elevation for foundation design in the absence of a site-specific subsurface investigation in accordance with this provision.

Total Unit Weight = 120 pcf
Friction Angle = 30 degrees
Cohesion = 0 psf

Assume the groundwater elevation is at a depth of 7 feet below the ground surface. If the groundwater is encountered at a depth shallower than 7 feet, the DMS foundation must be redesigned based upon the actual field conditions. The default soil parameters and allowable pressures do not apply to very soft or loose soil, muck (generally, SPT blow counts per foot less than 4), weathered rock or hard rock (generally, SPT refusal). If soft or loose soil, muck, weathered rock or hard rock conditions are present, a site-specific subsurface investigation and foundation design is required in accordance with this provision.

Design spread footings in accordance with Sections 4.4.1 through 4.4.10, allowable stress design method, of the AASHTO Standard Specifications for Highway Bridges (including interims). Restrict uplift due to the eccentricity of the loading to one corner of the footing and the tension area may not exceed 25% of the total bearing area of the spread footing.

Design drilled piers in accordance with Sections 4.6.1 through 4.6.5, allowable stress design method, of the AASHTO Standard Specifications for Highway Bridges (including interim's). If drilled piers are designed for skin friction only, increase the required length of each drilled pier a minimum of 6 inches to allow for sediment. If drilled piers are designed for end bearing, no additional length is required; however, the drilled piers will be subject to the cleanliness requirements in Section B under "Drilled Pier Construction:" below. Clearly state on the plans whether end bearing was accounted for in the foundation design.

Calculate expected vertical, lateral and torsional movements for single drilled pier foundations. Provide drilled pier foundations that result in a horizontal lateral movement of less than 1 inch at the top of the pier and a horizontal rotational movement of less than 1 inch at the edge of the pier. Also, use a factor of safety of 2.0 for lateral and torsion failure. Preliminary design methods described in Section 13.6.1.1 of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals (including interims) may be used to incorporate a factor of safety in foundation design for lateral failure. Wings are required to increase torsion resistance for cantilever signs supported by a single drilled pier.

If a site-specific subsurface investigation is performed, use only an NCDOT Highway Design Branch Pre-Qualified Geotechnical Engineering Firm to provide a site specific foundation design.

B. Subsurface Investigation

If the default soil parameters or allowable pressures referenced above are not applicable for a given DMS foundation site, the Engineer may require a site-specific subsurface investigation. If the Engineer requires a site-specific subsurface investigation, the Department will perform the borings

and provide the data to the Contractor. The subsurface investigation will be provided within two weeks of being notified by the Contractor that the site is at rough grade and accessible to a drill rig.

The Contractor may elect to conduct a site specific subsurface investigation at each proposed sign foundation location in accordance with the requirements listed below, in lieu of using the default soil parameters and allowable pressures referenced above. If the Contractor elects to conduct a site-specific subsurface investigation, the costs of the investigation will be considered incidental to the " Footing" pay item.

Perform a boring at each sign foundation location and provide boring data on an NCDOT Standard Boring Log form. Download this form from the NCDOT site at http://www.ncdot.org/doh/preconstruct/highway/geotech/contractserv/investigation/Documents/BoringLogs.zip. A licensed geologist or a professional engineer registered in the State of North Carolina and employed by an NCDOT Highway Design Branch pre-qualified Geotechnical Engineering Firm must seal each boring log. Use only an NCDOT Highway Design Branch pre-qualified Geotechnical Engineering Firm to conduct the subsurface investigation. Perform the investigation only after rough grade (within 3 feet of final grade) is achieved. Locate each boring within 3 feet of the center of the sign foundation. Drill the boring to a minimum depth of 10 feet below the required spread footing bearing or drilled pier tip elevation, whichever is deeper. Conduct Standard Penetrating Tests at 1 ft, 2.5 ft, 5 ft, 7.5 ft, 10 ft, and every 5-ft after 10 ft below the rough grade in accordance with ASTM D-1586. A boring may be terminated above the minimum depth required (10 ft below the foundation elevation) if one of the following conditions occur: (a) a total of 100 blows have been applied in any 2 consecutive 6-in.intervals; (b) a total of 50 blows have been applied with less than 3-in. penetration.

C. Foundation Construction

Excavate footings for sign structures in accordance with the applicable provisions of Section 410 of the 2006 Standard Specifications. Construct footings for sign structures in accordance with Section 825 of the 2006 Standard Specifications. Construct all footings with Class A concrete. Where rectangular forms are used, use forms that have a chamfer strip at all corners for at least that distance protruding above finished ground. Use chamfers, which measure one-inch along the diagonal face.

Securely brace anchor bolts positioned in the form and hold in proper position and alignment. Provide a rubbed finish on concrete surfaces to be exposed above finished ground in accordance with Section 825-6 (D) of the 2006 Standard Specifications. Do not erect sign structures on foundations until the concrete has reached a minimum compressive strength of 3000 psi. Determine concrete compressive strength by nondestructive test methods or compressive strength tests made in accordance with AASHTO T22 and T23. Furnish equipment used for nondestructive tests and obtain Engineer's approval before performing the tests.

D. 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 hard rock, weathered rock or removal of boulders and debris may be required.

Dispose of drilling spoils as directed by the Engineer and in accordance with Section 802 of the 2006 Standard Specifications. Drilling spoils consist of all material excavated including water or slurry removed from the excavation either by pumping or with augers.

Construct drilled piers within the tolerances specified herein. If tolerances are exceeded, provide additional construction as approved by the Engineer to bring the piers within the tolerances specified. Construct drilled piers such that the axis at the top of the piers is no more than 3 inches in any direction from the specified position. Build drilled piers within 1% of the plumb deviation for the total length of the piers. When a grade beam is not required at the top of a pier, locate the top of pier elevation between 18 inches above and 6 inches above the finished grade elevation. Form the top of the pier such that the concrete is smooth and level.

If unstable, caving or sloughing soils are anticipated or encountered, stabilize drilled pier excavations with steel casing and/or polymer slurry. Steel casing may be either the sectional type or one continuous corrugated or non-corrugated piece. All steel casings should 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 inch. . Extract all temporary casings during concrete placement in accordance with this provision unless the Contractor chooses to leave the casing in place in accordance with the requirements below.

Any steel casing left in place will be considered permanent casing. 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 with a minimum diameter of 12 inches smaller than the specified size of the pier in order to facilitate permanent casing installation provided the sides of the excavation do not slough during drilling such that the hole diameter becomes larger than the inside diameter of the casing. Permanent steel casings are only allowed for full span overhead signs as approved by the Engineer and prohibited for cantilever overhead signs. No additional compensation will be paid for permanent casing. If the Contractor chooses to use permanent steel casing, include all casing costs in the "Overhead Footing" pay item.

If the Contractor elects to use polymer slurry to stabilize the excavation, use one of the 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 might not be appropriate for a given site. Polymer slurry should not be used for excavations in very soft or loose soils. If the excavation can not be stabilized with polymer slurry, the Engineer may require a site-specific subsurface investigation (if not done during design) and the use of steel casing. No additional time or compensation will be provided if both steel casing and polymer slurry are required to stabilize the excavation.

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 time or compensation will be provided for substituting a larger diameter drilled pier in order to construct a drilled pier cast against undisturbed soil.

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 time or compensation.

2. Bottom Cleanliness

After drilled pier excavations are complete and immediately before concrete placement, demonstrate acceptable bottom cleanliness of the drilled pier excavation to the Engineer for

approval if the plans indicate end bearing was used in the design. Provide any equipment, personnel and assistance required for the Engineer to inspect the drilled pier excavation. The pier excavation bottom is considered clean if no portion of the bottom area has more than 3 inches of sediment as determined by the Engineer.

3. 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 and the concrete is not required.

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

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

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

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

4. Concrete

Begin concrete placement immediately after inserting reinforcing steel into the drilled pier excavation.

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 2006 Standard Specifications.

Designate the concrete as Drilled Pier Concrete with a minimum compressive strength of 4500 psi at 28 days. The Contractor may use a high early strength mix design as approved by the Engineer. Make certain the cementitious material content complies with one of the following options:

- Provide a minimum cement content of 640 lbs/yd^3 and a maximum cement content of 800 lbs/yd^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 of fly ash per LB of cement removed.

- If Type IP blended cement is used, use a minimum of 665 lbs/yd^3 Type IP blended cement and a maximum of 833 lbs/yd^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 for dry placement of concrete or 7 and 9 inches for wet placement of concrete.

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

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

b. Concrete Placement

Place concrete such that the drilled pier is a monolithic structure. Temporary casing may be completely removed and concrete placement may be temporarily suspended when the concrete level is within 42 to 48 inches of the ground elevation to allow for placement of anchor bolts and construction of grade beam or wings. 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 de-water any drilled pier excavations unless the Engineer approves the de-watering and the excavation is entirely cased down to tip. Do not begin to remove the temporary casing until the level of concrete within the casing is in excess of 10 feet above the bottom of the casing being removed. Maintain the concrete level at least 10 feet above the bottom of casing throughout the entire casing extraction operation except when concrete is near the top of the drilled pier elevation. Maintain a sufficient head of concrete above the bottom of casing to overcome outside soil and water pressure. As the temporary casing is withdrawn, exercise care in maintaining an adequate level of concrete within the casing so that fluid trapped behind the casing is displaced upward and discharged at the ground surface without contaminating or displacing the drilled pier concrete. Exerting downward pressure, hammering or vibrating the temporary casing is permitted to facilitate extraction.

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

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

- Dry Placement: Before placing concrete, make certain the drilled pier excavation is dry so the flow of concrete completely around the reinforcing steel can be certified by visual inspection. Place the concrete by free fall with a central drop method where the concrete is chuted directly down the center of the excavation.
- Wet Placement: Maintain a static water or slurry level in the excavation before placing concrete. Place concrete with a tremie or a pump in accordance with the applicable parts of Sections 420-4 and 420-5 of the 2006 Standard Specifications. Use a tremie tube or pump pipe made of steel with watertight joints. Passing concrete through a hopper at the tube end or through side openings as the tremie is retrieved during concrete placement is permitted. Use a discharge control to prevent concrete contamination when the tremie tube or pump pipe is initially placed in the excavation. Extend the tremie tube or pump pipe into the concrete a minimum of 5 feet at all times except when the concrete is initially introduced into the pier excavation. If the tremie tube or pump pipe pulls out of the concrete for any reason after the initial concrete is placed, restart concrete placement with a steel capped tremie tube or pump pipe.

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

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

c. Concrete Placement Time:

Place concrete within the time frames specified in Table 1000-2 of the 2006 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.

E. Scheduling and Restrictions:

If caving or sloughing occurs, no additional compensation will be provided for additional concrete to fill the resulting voids.

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, do not install adjacent piles and do not allow any heavy construction equipment loads or "excessive" vibrations to occur at any point within a 20 foot 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. Propose

remedial measures for any defective drilled piers and obtain approval of all proposals from the Engineer before implementation. No additional time or compensation will be provided for losses or damage due to remedial work or any investigation of drilled piers found defective or not in accordance with this provision or the plans.

15.4 COMPENSATION

The work covered by this section to be paid for will be the actual number of cubic yards of concrete, which has been incorporated into the completed and accepted footing. Computing the number of cubic yards (cubic meter) of concrete will be done from the dimensions shown in the plans or from revised dimensions authorized by the Engineer, calculated to the nearest 0.01 of a cubic yard. Anchor bolts and structural steel cages are considered incidental to the DMS Footing.

Payment will be made under:

DMS Footing.....Cubic Yard

16. DMS DIRECT TENSION INDICATORS

16.1 GENERAL

Use direct tension indicators on all ASTM A325 high strength bolt connections in the sign structures.

Provide direct tension indicators that conform to these Project Special Provisions, the requirements of ASTM F959 and the manufacturer's recommendations.

16.2 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.

16.3 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.

16.4 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.

16.5 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 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 0.005" 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.

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 Assembly "DMS-__" and will be full compensation for all work listed above.

17. SYSTEM SUPPORT EQUIPMENT

17.1 DESCRIPTION

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

17.2 MATERIALS

A. General

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

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

B. Fiber Optic System Support

Furnish transceivers identical to the type installed in the equipment cabinets to be used for emergency restoration of the system and the fiber-optic communications system. Furnish transceivers in the quantities and types listed below.

- One (1) Video Optical Transmitters with Data (VOT-D)
- One (1) Video Optical Receivers with Data (VOR-D)
- One (1) field Ethernet Switches for the MVD system

C. CCTV System Support

Furnish one (1) complete CCTV cameras (include: PTZ, camera, lens, and camera housing) as defined in these Project Special Provisions that are identical to the type installed in this project to be used for emergency restoration of the system.

D. MVD System Support

Furnish one (1) complete MVD detectors as defined in these Project Special Provisions and that are identical to the type installed in this project to be used for emergency restoration of the system.

17.3 METHOD OF MEASUREMENT

Actual number of VOT-D units furnished and accepted.

Actual number of VOR-D units furnished and accepted.

Actual number of field Ethernet Switches for the MVD system furnished and accepted.

Actual number of CCTV cameras furnished and accepted.

Actual number of MVD detectors furnished and accepted.

17.4 BASIS OF PAYMENT

The quantity of VOT-D units, measured as provided above, will be paid for at the contract unit price each for "Furnish Only VOT-D."

The quantity of VOR-D units, measured as provided above, will be paid for at the contract unit price each for "Furnish Only VOR-D."

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

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

The quantity of MVD assemblies, measured as provided above, will be paid for at the contract unit price each for "Furnish Only MVD Detector."

Payment will be made under:

Furnish Only VOT-D ..... Each

Furnish Only VOR-D ..... Each

Furnish Only Field Ethernet Switch ..... **Each**

Furnish Only CCTV Camera ..... **Each**

Furnish Only MVD Detector ..... **Each**

18. TESTING AND DOCUMENTATION

18.1 DESCRIPTION

Testing requirements described in this section do not supersede any of the testing requirements described in any other section of these Project Special Provisions. Perform testing on all major hardware and support software components supplied for use on this project. These include:

- CCTV Field Equipment
- MVD Field Equipment
- DMS Field Equipment
- Node and Hub Equipment
- Fiber Optic Communications System

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

A. Test Plan

Submit a detailed test plan to the Engineer for approval at least 45 working days prior to initiation of any testing. Identify all required testing levels for the specific equipment provided. Identify the test organization including the roles and responsibilities of the quality assurance organization. For each piece of equipment that requires testing, the test plan should at a minimum, delineate the following:

- Submittal schedule of test procedures
- Start time of each level of testing
- Test duration including any re-tests that are required or anticipated
- Submittal of the completed and signed off test report

Develop a critical path method (CPM) chart to track the sequence and completion of test plans for each level of testing, including periodic revisions.

Notify the Engineer of the proposed date, time and location of all testing 45 working days in advance of the test being performed. The Contractor is required all tests and may be observed by the Engineer. The Engineer may perform additional testing at any time during the project. A flow chart of the required testing levels is included in the Appendix for reference.

B. Test Procedures

Prepare and submit test procedures Unit Tests and System Acceptance Tests (SATs) to be performed. Provide test procedures for review and approval by the Engineer before any tests are

conducted. The review period will not exceed 40 working days from receipt of the test procedures. The test procedures will include the following:

- Step-by-step outline of the test sequence to be followed, showing a test of every function of the equipment of system to be tested.
- Description of the operation, output, pass/fail criteria, test results, and criteria for re-test.
- Cross reference of test procedures to these Special Provisions.
- Estimate of the test duration and proposed test schedule.
- Data form to be used to record all data and quantitative results obtained by the test.
- Failure analysis and corrective action plan for failed equipment.
- Description of special equipment, setup, manpower, or conditions required for the test.
- Log make, model, serial number, and calibration expiration date of test equipment.

Test each device and subsystem in accordance with the testing plan and procedures developed by the Contractor and approved by the Engineer. Include tests of the individual components as well as a test of the overall subsystem. Test each subsystem from the field cabinet, and from a workstation in the MRTMC.

C. Unit Tests

After field equipment is installed and the Engineer has approved the Unit Test plan, conduct Unit Tests. At a minimum, the Unit Tests must exercise all the non-network functional requirements of the equipment being installed and demonstrate compliance with these Special Provisions. Furnish all necessary test equipment and the means to operate it at the field site.

1. Corrective action

Summarize failed equipment and corrective actions taken in a report and present to the Engineer for approval. If the corrective action requires redesign of a failed device, provide the serial number tracking documentation to prove that all units have been successfully retrofitted. Conduct (at no additional costs) re-testing to ensure the adequacy of the corrective action. Provide results of the Unit Tests to the Engineer for approval.

D. System Acceptance Testing (SAT)

Perform the SATs after the installation and integration of all field devices installed under this project and the integration of equipment in the MRTMC and the CDOT TOC. Perform SATs in accordance with the SAT manual developed for the original MRTMC system. The Engineer will provide a copy of the original MRTMC SAT upon request.

Repair the system and rerun the affected portions of the SAT to the Engineer's satisfaction when failures occur during testing. Perform the SATs successfully prior to interim and final acceptance of the system. The Department must be present during the SAT. The Department will rerun the SAT during the warranty period.

Include and demonstrate the following:

- Operation of all field equipment (new and modified) from the MRTMC
- All features of the existing CCTV central software operate properly with all field equipment installed under this project and the existing functionality is preserved.(existing, modified, or newly installed)
- Verification of the reception of video at the signal to noise ratio called for in the VOTR-D specification contained in these Project Special Provisions

- Complete incorporation of each new MVD unit into the central software database and GUI map and their proper operation in accord with the MRTMC freeway, traveler information, and incident management systems.
- Standard hardware tests with regards to diagnostic routines

The Engineer or his representative must witness all tests. If system performance tests fail because of any component(s) in the system, the particular component(s) must be corrected or substituted with new component(s) and the tests repeated. If a component has been modified as results of the system performance test failure prepare a report and delivered to the Engineer prior to re-testing. The Contractor is totally responsible for documenting the results of the test and furnishing the documented test results to the Engineer.

18.2 MATERIALS

A. Sample and Material Testing

Materials to be used in this system will be subject to inspections and evaluations by the Engineer or their designated representative. Upon request by the Engineer, without charge, provide the following equipment for his review, inspection, and evaluation:

- Fiber optic communications transceivers
- Equipment cabinets
- CCTV equipment
- MVD equipment
- Ethernet switches

Provide the Engineer with a minimum of thirty (30) days to complete his evaluation. No equipment submitted for inspection may be shipped or installed until the Engineer has sent a formal written notice of "Conditional Acceptance". Receiving a "Conditional Acceptance" notification does not in any way relieve the Contractor of his responsibility to meet all of the requirements of these Project Special Provisions. Make the equipment available for inspection at the MRTMC office located at:

North Carolina Department of Transportation
Regional Transportation Management Center
2327 Tipton Drive
Charlotte, NC

The Contractor is responsible for all charges involved with the shipping and handling of the equipment. The Engineer may inspect, sample or test materials at the source of supply or other locations, but such inspection, sampling, or testing will not be undertaken until the Engineer is assured by the Contractor of the cooperation and assistance of both the Contractor and the supplier of the material.

It is understood that such inspection and tests, if made at any point other than the point of incorporation of work, in no way will be considered as a guarantee of acceptance of such material. Inspections and testing performed by the Engineer for the purpose of providing a conditional acceptance does not in any way relieve the Contractor or his suppliers of the responsibility for supplying equipment that meet the requirements of these Project Special Provisions.

B. CCTV Field Equipment Testing

All CCTV camera equipment and materials furnished will be subject to monitoring and testing to determine conformance with all applicable requirements and to ensure proper operation of the CCTV camera assemblies. Supply all required test equipment not provided under this contract. No separate payment will be made for the monitoring and testing equipment used during testing.

Provide forms to be used for documenting test results as an integral part of the testing procedures. These forms must specify the acceptable results of the CCTV camera assemblies' tests, and be submitted for review and approval by the Engineer. As a minimum, provide testing procedures including the necessary documentation and satisfy the testing requirements for the CCTV camera assembly components discussed below.

1. Local Camera Assembly Tests

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

- Verification of installation of specified cables and connections between the camera unit (with combined pan, tilt, and zoom unit and control receiver driver) and the local cabinet.
- Local operation of all CCTV equipment, exercising the pan, tilt, zoom, focus, iris opening, and power on/off functions while observing the video picture on a portable monitor
- Preset test to ensure camera consistently goes to the proper preset position.

Whenever any unit of equipment fails to pass the assembly tests, correct the deficiencies, either by repair or replacement (at no additional costs to the Department), as required to comply with the testing requirements. Upon notification that the deficiencies have been corrected, the equipment will be re-tested. All camera assembly testing and re-testing will be performed in the presence of the Engineer or his designated representative. All equipment required to conduct the tests will be incidental and not paid for separately.

C. MVD Field Equipment Testing

All radar vehicle detector (MVD) equipment and materials will be subject to monitoring and testing to determine conformance with all applicable requirements and to ensure proper operation of the MVD assemblies. Supply all required test equipment not provided under this contract. No separate payment will be made for the monitoring and testing equipment used during testing, or for the documentation of test results.

Provide forms to be used for documenting test results as an integral part of the testing procedures. These forms must specify the acceptable results of the MVD assemblies' tests, and be submitted for review and approval by the Engineer. As a minimum, provide testing procedures including the necessary documentation and satisfy the testing requirements for the MVD assembly components discussed below.

1. Local MVD Assembly Tests

Each MVD assembly furnished and installed will be subject to the following tests:

- Verification of installation (cables and connections) between the MVD unit and the cabinet.

- Verification of detector zone setup and detector zone response including estimated speed, volume, long vehicle detection, and occupancy.

Whenever any unit of equipment fails to pass the assembly tests, correct the deficiencies, either by repair or replacement (at no additional costs to the Department), as required to comply with the testing requirements. Upon notification that the deficiencies have been corrected, the equipment will be re-tested. All MVD assembly testing and re-testing will be performed in the presence of the Engineer or his designated representative. All equipment required to conduct the tests will be incidental and not paid for separately.

D. Fiber Optic Transceivers Transmission Equipment Testing

1. General

Provide forms to be used for documenting test results as an integral part of the testing procedures submitted to the Department. Specify the acceptable results of the video and data transmission components, and submit for review and approval by the Engineer.

2. Shop Testing

Set up testing apparatus in shop to determine the functional operation of the fiber optic transceivers. The purpose of the shop tests is to identify non-operating or deficiently operating equipment prior to its installation in the field.

Determine that clear and acceptable, static free video images are being transmitted and received by the fiber optic transmission equipment. Determine that all of the CCTV control functions described in these Project Special Provisions can be accomplished via the fiber optic transmission equipment. All equipment required to conduct the tests is incidental and not paid for separately.

E. 60-Day Observation Period

Upon completion of all project work, the successful completion of the component tests and the System Acceptance Test, and the correction of all deficiencies, including minor construction items, a 60-day observation period will commence. This observation period consists of 60 days of continuos operation of the new field equipment with the central equipment without any failure. The 60-Day Observation Period will be warranted by the payment and performance bond. The purpose of this observation period is to ensure that all components of the system function in accordance with the Plans and these Special Project Provisions over an extended length of time.

Complete all documentation prior to the end of the 60-Day Observation Period. The 60-Day Observation Period will not be considered part of the contract time.

Respond to failures that occur during the 60-Day Observation Period within twenty-four (24) hours. Correct said failures within forty-eight (48) hours. Failures that affect any of the major system components defined below for more than forty-eight (48) hours will suspend the timing of the 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. System or components failures that necessitate a redesign of any component and failures in any of the major system components exceeding a total of three (3) occurrences, will terminate the 60-Day Observation Period and cause the 60-Day Observation Period to be restarted from zero when the redesigned components have been installed and/or the failures corrected. The major system components are:

- Fiber optic communications network

- CCTV field hardware
- MVD field hardware

18.3 DOCUMENTATION

A. General

Supply equipment with operations and maintenance manuals that comply with applicable Bellcore/Telcordia specifications. Supply manuals on all new equipment that include information on installation, theory of operations, troubleshooting, part replacement, and parts identification. Schematics, block diagrams, and spare parts list will conform to delivered equipment.

- As-Installed Engineering Drawings
- Installation plan test plan, test procedures and test report
- Equipment layout
- Spare parts analysis and "As Supplied" inventory list
- Status Report (monthly)
- Modifications of splice details or diagrams
- All database and software changes.

B. Specific Documentation

The Engineer upon request will provide the existing system schematic connection diagrams. Notify the Engineer 45 days prior to changing to the system documentation.

Supply a systems-level manual that provides an overview of the system, its operation, its interconnects and troubleshooting procedures. This manual will be an update to the existing System User's Manual to include the new equipment installed as part of this project. Test equipment used in system-level test should be provided in a table format. Provide a detailed system operations and maintenance plan. Provide six (6) copies of this manual.

Provide manuals associated with the operational understanding, interconnect, and maintenance of subsystems. Apply Bellcore/Telcordia documentation requirements to contents and format. Provide six (6) copies of each manual.

Provide detailed manuals related to functional electronic units. Provide six (6) copies of each commercial manual for each functional type of equipment (by identical part number) installed on the project.

C. Installation and Interconnect Drawings

Provide all engineering drawings associated with equipment installation and interconnection in both hard copy form and electronic format. Clearly indicate on drawings

- Equipment cabinet designations
- Equipment cabinet interconnections
- Interconnection location
- Interconnection number (terminal, jack, connector pin, etc)
- Cable/wire/fiber assignments

D. Delivery of Documentation

Provide all documentation to the Engineer for review. The Engineer may "Reject" the submittal if not in compliance with these specifications. For standard product documentation, provide examples for the Engineer's review prior to construction. All documentation must represent as-installed equipment and interconnects. Final Acceptance will not be considered until all documentation has been delivered and conditionally accepted.

18.4 METHOD OF MEASUREMENT

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

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

19. DMS TEST PROCEDURE

DMS Before and After Installation Tests
Physical Inspection: Check for damages and note.

	Before Installation	After Installation
Enclosure Shell		
Paint		
Front Panel		
Door and Lock		
Hinges		
Gaskets		
Mounting Hardware		
Display Elements		
Wiring and Conduits		
Fans and Heaters		
Electrical System		
Photocell Assembly		
Maintenance Lighting		
Receptacles and Switches		
Others		

Functional Test: Use a generator or other source of power to turn on the Display for the before installation tests.

	Before Installation	After Installation
Test Circuit Breakers		
Test the Lights		
Test the Receptacles		
Test the Fans		
Test the Heaters		
Test the Controller		
Test and verify local/remote switch		
Run Diagnostics and record results		
Run Pixel Test and record results		
Run messages from controller memory		
Connect a Laptop to Local Port		
Connect to sign using DMS software		
Run messages from laptop		
Run Flashing messages		
Run Diagnostics and record results		
Run Pixel Test and record results		
Test automatic dimming circuitry		
Test controller clock		