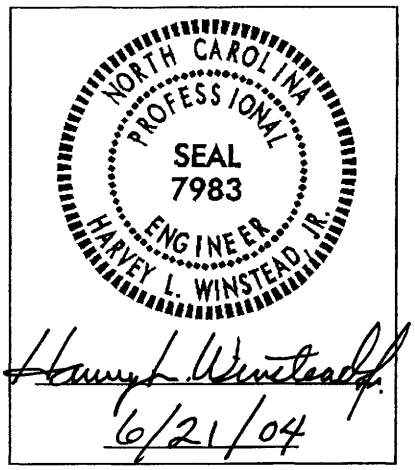

Project Special Provisions

(Version 02.13)

Traffic Management Systems

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21-Jun-04

Contents

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

The 2002 Standard Specifications are revised as follows:

1.1 General Requirements (1098-1)

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

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

1.2 Wood Poles (1098-6)

Page 10-228, Article 1098-6

Replace the entire article with the following:

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

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

1.3 Metal Poles (1098-15)

Page 10-236, Subarticle 1098-15(A)

In paragraph 1, sentence 2, delete the phrase "(AASHTO Specifications) in effect on the date of advertisement" and insert the words "Fourth Edition, 2001, including the latest interim specifications."

Page 10-238, Subarticle 1098-15(B)

In paragraph 1 (partial), sentence 2, delete the phrase "6 x 6 x 3/4 inches (150 x 150 x 18 mm)" and insert the words "circular anchor bolt lock."

In the first full paragraph, add the following sentence:

Where splicing is necessary, use butt splice and heat shrink tubing.

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

The 2002 Standard Specifications are revised as follows:

2.1 General Requirements (1700)

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

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

2.2 Underground Conduit (1715)

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

Add the following paragraph:

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

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

Delete the first paragraph.

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

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

2.3 Wood Poles (1720)

Page 17-10, Article 1720-3

Replace the fourth paragraph with the following paragraph:

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

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

2.4 Structure Design of Signal Supports (1744)

Page 17-26-28, Subarticle 1744-2(A)

In paragraph 2, sentence 2, delete the phrase "(AASHTO specifications) in effect on the date of advertisement" and insert the words "Fourth Edition, 2001, including the latest interim specifications." Revise "with a 1.3 gust factor" to "with a minimum 1.14 gust factor."

Add the following paragraph after paragraph 2:

"Use the following in design, which is taken from The Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 4th Edition, 2001:

- The wind pressure map that is developed from the 3-second gust speeds, as provided in Article 3.8, shall be used.
- Signal support structures shall include natural wind gust loading and truck-induced gust loading in the fatigue design, as provided for in Article 11.7.3 and 11.7.4, respectively. Designs need not consider periodic galloping forces.
- The natural wind gust speed in North Carolina is assumed to be 11.2 mph.
- The fatigue importance category used in the design, for each type of structure, as provided for in Article 11.6, Fatigue Importance Factors, shall be Category II unless otherwise shown on the contract plans.
- Deflection induced by truck gust, as provided in Article 11.8, at the free end of single-arm sign supports and all traffic signal arms, shall be limited to 8 inches (200 mm) vertically, when the equivalent static design wind effect from truck-induced gusts are applied to the structure.
- Conform to article 10.4.2 of the 2001 AASHTO Specification

The maximum allowable vertical deflection at the tip of the mast arm due to the combined deflection of the pole and the arm shall not exceed 3.0% of the total mast arm length under maximum dead loading conditions.

For span wire mounted signal support structures, wind loads shall be applied as shown in Figure 3-5 of the AASHTO Specification. For Group III loading, where ice is present, half wind shall also be applied to the span wire cable bundle diameter shown above as well as to the increased diameter of the cable bundle due to the presence of ice around the full perimeter of the cable bundle."

"Use the following in design, which modifies The Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 4th Edition, 2001":

Revise Article 11.7.4, Truck-Induced Gust, Equation 11-6 to read as follows:

$$P_{TG} = 900 C_d I_F \quad \text{(Pa)}$$

$$P_{TG} = 18.8 C_d I_F \quad \text{(psf)}$$

Revise the third sentence of Article 11.7.4, Truck-Induced Gust, to read as follows:

"The pressure range shall be applied along any 12 feet (3.7 m) length to create the maximum stress range, excluding any portion of the structure not located directly above a traffic lane."

In Article 11.7.4, Truck-Induced Gust, after the first paragraph, add a paragraph to read as follows:

"The magnitude of applied pressure range may be varied depending on the height of the horizontal support and the attachments above the traffic lane. Full pressure shall

be applied for heights up to and including 19.7 ft (6 m), and then the pressure may be linearly reduced for heights above 19.7 ft (6 m) to a value of zero at 32.8 ft (10 m)."

Revise the third paragraph of the Commentary to Article 11.7.4, Truck-Induced Gust, to remove the following two sentences in their entirety:

"To improve fuel economy ... created by the trailer. It has been proposed ... (Desantis and Haig, 1996)."

Revise the fourth paragraph of the Commentary to Article 11.7.4, Truck-Induced Gust, to read as follows:

"The design pressure calculated from Equation 11-6 is based on a truck speed of 65 mph (30 m/s). For structures installed at locations where the posted speed limit is much less than 65 mph (30 m/s), the design pressure may be recalculated based on this lower truck speed. The following may be used:

$P_{TG} = 900C_d(V/30\ m/s)^2 I_F$ (Pa) Eq. C 11-6

$P_{TG} = 18.8C_d(V/65\ mph)^2 I_F$ (psf)

Where V is the truck speed in m/s (mph), V may be taken as either the posted speed limit or the design speed (if known), whichever is higher."

Revise the Commentary to Article 11.7.4, Truck-Induced Gust, to remove in their entirety, the fifth and seventh paragraphs, which deal with the application length, and variability of truck gust pressure range.

Page 17-29, Subarticle 1744-2(B)

In the third paragraph, second sentence, revise the phrase "3 percent" to "2.5 percent."

In the fourth paragraph, following the first sentence, add the following:

"The base plate thickness for all uprights and poles shall be no less than that determined by the following criteria and design:

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

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

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

P = anchoring force of each anchor bolt

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

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

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

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

P = anchoring force of each anchor bolt

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

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

The thickness of base plate of Case 2 shall not be less than that calculated based on formula for Case 1."

Page 17-30, Subarticle 1744-2(C)

Delete paragraphs 1 and 2.

3. GENERAL REQUIREMENTS

3.1 DESCRIPTION

A. General

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

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

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

The limits of the R-0513 project for the work described herein is as follows:

- I-95 from just north of the Highway Patrol Station near the intersection of Dawn Drive and Nelson Way to 1,441 feet (439.1 meters) south of Mile Marker 10.
- New US 74 from Station 86+00 to approximately 2 miles (3.22 Km) east of NC 41.

This project is in Metric units.

Furnish, install, test, integrate and make fully operational Closed Circuit TV (CCTV) cameras and Internet connections in order to display video over the Internet to the Division 6 office in Fayetteville, the Triangle Regional Traffic Management Center (TRTMC) in Raleigh, and the Emergency Information Center (EIC) in Raleigh. Furnish, install and fully integrate software to allow control and viewing of the cameras by operators in the Division 6 office, the TRTMC, and the EIC. Furnish, install, test, integrate and make fully operational Dynamic Message Signs (DMS) and dial-up telephone circuits in order to monitor and control messages from the Division 6 office in Fayetteville, the TRTMC, and the EIC. Furnish, install and fully integrate software to allow monitoring and control of the DMSs by operators in the Division 6 office, the TRTMC, and the EIC.

Furnish, install, test, integrate and make fully operational two (2) new CCTV cameras as listed below:

- Two (2) CCTV cameras at the interchange of I-95 and new US 74.

Furnish, install, test, integrate and make fully operational two (2) High Speed Internet connections at the following locations:

- Interchange of I-95 and US 74
- Division 6 office in Fayetteville, NC.

Furnish, install, test, integrate and make fully operational four (4) new DMSs as listed below:

- One (1) new DMS for southbound traffic and one (1) new overhead DMS assembly spanning all northbound and southbound lanes at I-95 just north of the Highway Patrol Station near the intersection of Dawn Drive and Nelson Way.

- One (1) new DMS for westbound traffic and one (1) new overhead DMS assembly spanning the westbound lanes at US 74 approximately 2 miles (3.17 Km) east of NC 41.
- One (1) new DMS for eastbound lanes and one (1) new overhead DMS assembly spanning the eastbound lanes on new US 74 at Station 86+00.
- One (1) new DMS to replace an existing DMS for northbound traffic on an existing overhead DMS assembly on I-95 1,441 feet (439.1 meters) in advance of Mile Marker 10.

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

Provide real world coordinates for all field devices (including but not limited to controller cabinets, closed circuit television cameras, dynamic message signs, and oversized junction boxes) installed and/or modified under this project. Provide the coordinates in feet units using the North Carolina State Plane coordinate system (1983 North American Datum also known as NAD '83). Furnish coordinates that do not deviate more than 1.7 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

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

All steel and iron products furnished as "domestic products" shall be melted, cast, formed, shaped, drawn, extruded, forged, fabricated, produced, or otherwise processed and manufactured in the United States. Raw materials including pig iron and processed pelletized and reduced iron ore

used in manufacturing "domestic" steel products may be imported; however, all manufacturing processes to produce the products, including coatings, must occur in the United States.

Before each steel or iron product is incorporated into this project or included for partial payment on a monthly estimate, the Contractor shall furnish the Resident Engineer a notarized certification certifying that the product conforms to the above requirements of this Special Provision. The Resident Engineer will forward a copy of each certification to the Materials and Tests Unit.

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

3.2 TRAFFIC CONTROL

The two DMSs on I-95 shall be installed and made operational during the early phases of the project construction to be used for traffic advisories during the remaining construction phases. Refer the Traffic Control section of the project plans for more detailed information on the precise schedule for installation of the two I-95 DMSs.

3.3 BASIS OF PAYMENT

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

4. ELECTRICAL SERVICE

4.1 DESCRIPTION

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

4.2 MATERIAL

Construct electrical service installations in accordance with the Standard Specifications. For locations shown on the Plans requiring new electrical service, provide a service that includes a new external service disconnect (breaker box) and a meter base. Electrical service cable shall run separately to each of the cabinets in 1" (25 mm) rigid metallic conduit (RMC).

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

For base mounted cabinets, mount the service on an existing nearby pole as indicated in the Plans, and extend the service cables into the cabinet through a new 1" (25 mm) RMC.

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

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

4.3 CONSTRUCTION METHODS

A. Electrical Service

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

B. External Electrical Service Disconnect

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

4.4 METHOD OF MEASUREMENT

New electrical service will be measured by the number of complete functional electrical service locations furnished, installed and tested. Riser assemblies (1-inch [25 mm]), meter bases, service disconnects, electric service cable, acquisition of service fees, ground rod, ground wire and any remaining hardware and conduit to connect the electrical service to the cabinet will be considered incidental to new service.

4.5 BASIS OF PAYMENT

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

Payment will be made under:

New Electrical Service ..... Each

5. DIRECTIONAL DRILLING

5.1 DESCRIPTION

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

5.2 MATERIAL

A. General:

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

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

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

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

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

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

Dependent upon the number of conduits required, furnish conduits in black, orange, blue and white colors. Provide conduits that are factory extruded with the appropriate colors.

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

B. Polyethylene Conduit:

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

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

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

5.3 CONSTRUCTION METHODS

A. Pre-Approvals and Minimum Depth Requirements:

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

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

Man-made Structure	Minimum Clearance Requirement
Bridge foundation	5' (1.5 m) horizontal & 4' (1.2 m) vertical (clearances greater than minimum horizontal should continue to use the 4V:5H ratio, i.e., 10' (3 m) horizontal should be no deeper than 8' (2.4 m)
Drainage pipes less than 60"	1' (0.3 m) above or below [while maintaining a minimum depth of 30" (760 mm) below grade]
Drainage pipes greater than 60"	1' (0.3 m) above or 4' (1.2 m) below [while maintaining a minimum depth of 30" (760 mm) below grade]
Box Culverts	1' (0.3 m) above or 4' (1.2 m) below [while maintaining a minimum depth of 30" (760 mm) below grade]
Slope protection	2' (0.6 m) below
Slope protection foundation footing	5' (1.5 m) below

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

Provide a means of collecting and containing drilling fluid/slurry that returns to the surface such as a slurry pit. Provide measures to prevent drilling fluids from entering drainage ditches and storm sewer systems. Prevent drilling fluid/slurry from accumulating on or flowing onto sidewalks, other

pedestrian walkways, driveways or streets. Immediately remove any drilling fluids/slurry that is accidentally spilled.

B. Directional Drill Operations:

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

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

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

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

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

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

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

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

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

C. Drilling Fluids:

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

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

D. Splicing of the Conduit:

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

E. Duct Plugs and Mechanical Sealing Devices:

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

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

F. Plan of Record Drawings:

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

5.4 METHOD OF MEASUREMENT

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

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

5.5 BASIS OF PAYMENT

The quantity of directional drilled polyethylene conduit(s), measured as provided above, will be paid for at the contract unit price per linear foot (meter) as "Directional Drill Polyethylene Conduit(s), (size)(quantity of conduits) and (size)(quantity of conduits)."

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

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

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

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

Payment will be made under:

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

6. UNDERGROUND POLYETHYLENE CONDUIT

6.1 DESCRIPTION

Furnish and install underground polyethylene conduit systems with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

6.2 MATERIAL

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

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

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

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

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

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

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

Dependent upon the number of conduits required, furnish conduits in black, orange, blue and white colors. Provide conduits that are factory extruded with the appropriate colors.

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

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

Furnish mechanical sealing devices that provide a watertight barrier between the conduit and communications cable. Furnish mechanical sealing devices sized in accordance with the conduit

furnished and with appropriately sized penetration holes for the communications cable. Provide mechanical sealing devices that are removable.

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

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

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

6.3 CONSTRUCTION METHODS

A. General:

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

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

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

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

B. Underground Polyethylene Conduit Installation in Trench:

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

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

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

Use one common trench with approved conduit spacers to bind the individual conduits together at no more than every 50 feet (15 meters). Install the non-detectable marker tape approximately 15 inches (380 mm) below the finished grade.

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

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

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

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

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

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

C. Underground Polyethylene Conduit Installation by Plowing:

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

Use equipment that is of a sufficient size and horsepower to accommodate the chute plowing of up to four (4) reels of conduit to the depth called for in these Project Special Provisions. Do not exceed reel dimensions, burial depths, and weight limits called for by the equipment manufacturer. Follow all procedures required or recommended by the equipment manufacturer.

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

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

D. Splicing of Underground Polyethylene Conduits:

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

E. Plan of Record Drawings:

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

6.4 METHOD OF MEASUREMENT

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

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

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

6.5 BASIS OF PAYMENT

The quantity of HDPE conduit installed underground, measured as provided above, will be paid for at the contract unit price per linear foot (meter) as "Underground polyethylene conduit(s), (size)(quantity of conduits) and (size)(quantity of conduits)."

As examples, an installation of a single 2" HDPE conduit would be paid as:

Underground Polyethylene Conduit(s), (2")(1).....Linear Foot (Meter)

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

Underground Polyethylene Conduit(s), (1.25")(3)&(2")(2).....Linear Foot (Meter)

Payment will be made under:

Underground Polyethylene Conduit(s), (Size)(Qty)&(Size)(Qty)..... Linear Foot (Meter)

7. VIDEO EQUIPMENT

7.1 DESCRIPTION

Furnish and install video equipment described in this Section. Furnish equipment that is compatible, interoperable, and completely interchangeable with existing Pelco Spectra II/Spectra III high-performance dome equipment currently in use by NCDOT that terminate in the TRTMC. The unit shall be fully compatible with all features of the existing matrix switcher at the TRTMC and the CCTV control software, unless otherwise approved by the Engineer.

Furnish and install video equipment necessary to control and monitor the CCTV assemblies installed at locations shown in the Plans. The video equipment shall include (but not be limited to) CCTV Cameras, a Video Multiplexer, Protocol Converters, Video Encoders, Video Decoders, and Monitors.

Furnish and install the video equipment and software necessary to allow users at the Division 6 offices in Fayetteville, NC to control and view the video from the CCTV cameras located in the field. Provide control and viewing of the cameras and video multiplexer over the Internet from the Division 6 offices, the TRTMC, and the EIC.

Install and integrate one new video monitor at the Division 6 offices in Fayetteville, NC.

7.2 MATERIAL

A. CCTV Camera Assembly:

1. General

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

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

2. Cameras

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

- Video signal format: NTSC composite color video output, 1 volt peak to peak
- Automatic Gain Control (AGC): 0-20 dB, peak-average adjustable
- Automatic focus: Automatic with manual override
- White balance: Automatic through the lens and manual adjustable from remote controller.
- Electronic-Shutter: dip-switch selectable electronic shutter with speed range from 1/60 of a second (off) to 1/30,000th of a second
- Overexposure protection: The camera shall have built-in circuitry or a protection device to prevent any damage to the camera when pointed at strong light sources, including the sun
- Sensitivity: 1.5 lux at 90% scene reflectance
- Signal to noise ratio: Greater than 48-dB
- Video output connection: 1-volt peak to peak, 75 ohms terminated, BNC connector
- Power: 24 VAC or less

3. Zoom lens

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

Focal length: 0.16" – 3.45", 22X optical zoom, 12X electronic zoom

Preset positioning: 64 Presets

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

4. Camera Housing

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

5. Pan and Tilt Unit

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

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

6. Control Receiver/Driver

Each new camera unit shall contain a control receiver/driver that is integral to the CCTV dome assembly. The control receiver/driver shall receive serial asynchronous data initiated from a camera control unit, decode the command data, perform error checking, and drive the pan/tilt unit, camera controls, and motorized lens. As a minimum, the control receiver/drivers shall provide the following functions:

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

In addition, each control receiver/driver shall accept status information from pan/tilt unit and motorized lens for preset positioning of those components. The control receiver/driver shall relay pan, tilt, zoom, and focus positions from the field to remote camera control units. The control receiver/driver shall accept "go to" 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.

7. CCTV Camera Attachment to Pole

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

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

Furnish CCTV camera attachment assembly that is able to withstand wind loading at the maximum wind speed and gust factor called for in these Project Special Provisions and can support a minimum camera unit dead load of 45 pounds (20.4 kg).

8. Surge Suppression

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

Coaxial cable from each camera shall be protected by a surge protector equal to Vicon V15LP, at each end of the cable.

B. CCTV Camera Metal Pole:

Furnish hot-dipped galvanized steel poles to mount CCTV units and equipment cabinets that meet or exceed the requirements of article 1098-15 and Section 1744 of the Standard Specifications, unless otherwise noted in the Plans or these Project Special Provisions. The revision of Section 1744 of the Standard Specifications is included in Section 2 of these Project Special Provisions.

Furnish and install a concrete foundation for each pole that is in accordance with the Plans and Specifications. Comply with Section 1742 of the Standard Specifications.

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

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

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

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

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

Furnish poles with 5/8-inch x 36-inch (16 mm x 610 mm) minimum air terminal. Bond a 3" x 0.016" (76 mm x 0.4 mm) copper strap inch between the air terminal and pole. Exothermically weld the a copper strap to the air terminal. At the base of the pole, furnish a 1.5" x 0.08" (38 mm x 2 mm) flat braided tinned copper strap between the pole and the ground rod. Exothermically weld the braided copper strap to the ground rod. Attach the braided copper strap to the pole base with a tinned copper ring terminal and self-tapping stainless steel screw. Refer to Details for Grounding Metal CCTV Pole in the Plans.

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

C. Video Multiplexer:

Furnish and install a video multiplexer with the following features:

- Minimum of 4 NTSC inputs
- Minimum of 1 NTSC output
- Minimum output formats:
  - full screen for each input individually
  - quad view with 4 inputs shown in the quadrants of a full screen

- RS-422 remote control
- Title generator providing up to 8 characters for each channel
- Built in Real Time Clock
- Dimensions:
  - Height: ≤ 1.75" (1U)
  - Width: Fits in normal 19" rack
  - Depth: < 11"
- Power Requirements: ≤ 10 W at 12 VDC (± 10%)

D. Protocol Converter:

Furnish and install a Protocol Converter to convert serial RS-232 data to RS-422 data and vice versa. Furnish the protocol converter to have the following features:

- Baud rate: up to 115K baud
- Drive: Up to 32 RS-422 receivers
- Compliance: CE, FCC Class A
- Power: 9 - 24 V ac/dc @170 mA nominal. Wall-plug adapters are acceptable.
- Connections: Equipment side: RS-232: DB9F
  RS-422: #16 screw terminals
  Line side: RS-422: #16 screw terminals
- Indicators: Power
  Line side: transmit and receive
  Equipment side: transmit and receive

E. Video Encoder:

Furnish and install Video Encoders as shown on the Plans.

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

The video encoder shall be installed with the following features:

- One (1) NTSC video input
- One (1) 10/100 Base-T Ethernet LAN (TCP/IP)
- Two (2) RS-232 ports
- Operate from 120 VAC (use of a transformer providing a lower voltage is permissible)

The unit shall be easy to install and configure. It shall allow for password protection and shall be capable of upgrading the software via downloads. The unit shall be equipped with high performance image capture and compression.

The unit shall be capable of full multiplexer control and shall be capable of providing control to multiple Pan/Tilt/Zoom cameras.

For compatibility with the TRTMC, furnish a Protronix Pro-VX2 video encoder, or an approved equivalent.

F. Video Decoder:

Furnish and install Video Decoders as shown on the Plans.

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

The video decoder shall be installed with the following features:

- One (1) 10/100 Base-T Ethernet LAN (TCP/IP)
- One (1) NTSC video output
- Two (2) RS-232 ports
- Operate from 120 VAC (use of a transformer providing a lower voltage is permissible)

The unit shall be easy to install and configure. It shall allow for password protection for dial–in access and shall be capable of upgrading the software via downloads. The unit shall be equipped with high performance image decompression.

For compatibility with the TRTMC, furnish a Protronix Pro-VX2-R video decoder, or an approved equivalent.

G. Monitor:

Furnish all color video monitors from the same manufacturer.

Furnish and install video monitors at the Division 6 offices with the following features:

- Video Performance: 500 horizontal lines
- Tuner: 181 channels, cable ready
- Audio: two (2) internal speakers with Hi-Fi stereo, 40 watt music output
- The screen shall measure a minimum of 21" diagonally
- Remote functions: wireless, multi-function remote with on-screen programming

Provide monitors that operate on 120 VAC (±10%) at 60 Hz. Provide monitors that operate in a +32° F to +132° F (0° C to 56° C) environment at 20 to 80 percent relative humidity.

H. PTZ Control Panel:

Furnish and install a desktop camera PTZ Control panel compatible with installed CCTV camera assemblies and with the following operating features:

- 10-digit keypad for video switching (camera and monitors), with a 3-digit LED display
- Operating mode
- Pan/tilt position control using a joystick

- Focus: near/far
- Zoom: in/out
- Iris: open/close
- Auto iris override
- Preset selection

The control panel shall interface with a serial communications port installed in the workstation.

7.3 CONSTRUCTION METHODS

A. Electrical and Mechanical Requirements

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

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

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

B. CCTV Camera

Install CCTV assemblies at the locations shown on the Plans. Mount CCTV camera on side of pole nearest intended field of view and avoid occluding the view with the pole. Mount CCTV camera units at a height sufficient to adequately see traffic in all direction and as approved by the Engineer. The minimum height shall be 33 feet (10 meters) above ground level and the maximum height shall be 50 feet (15 meters) above ground level. Electrically bond each camera and pan/tilt/zoom mechanism and its housing to the CCTV camera attachment assembly using a number 6 AWG braided copper conductor. Integrate CCTV camera unit with wireless transmission equipment, equipment cabinet, and equipment cabinet power supply.

C. CCTV Camera Metal Pole

Obtain approval from the Engineer for final field locations of the CCTV metal poles before developing shop drawings and installing the poles. Obtain shop drawings, signed and sealed by a North Carolina registered engineer, for each pole location (each combination of pole height and equipment mix) and submit to Engineer for approval. When approved, submit to pole manufacturer. Determine and provide to pole manufacturer the effective projected area of all items to be attached to each pole at each pole location.

If required by the manufacturer, provide soil core sample test results and/or soil classification results performed by a geotechnical laboratory approved by the Engineer.

Install steel pole in accordance with the plans and specifications. Comply with Section 1740 and Section 1742 of Standard Specifications.

D. Video Multiplexer

Install and integrate the Video Multiplexer with the Video Encoder and the Video/PTZ Receivers as shown in the Plans. Provide all necessary hardware and cables.

E. Protocol Converted

Install and integrate the Protocol Converter with the Video Encoder, Video Multiplexer and the Video/PTZ Receiver as shown in the Plans. Provide all necessary hardware and cables.

F. Video Encoder

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

G. Video Decoder

Install the Video Decoders and integrate them to the Ethernet switch and the monitor. Provide all necessary hardware and cables.

H. Monitor

The Engineer will determine which room/office in the Division 6 office will contain the monitor and associated equipment. The Engineer will determine the equipment layout in the appropriate room/office.

Mount the monitor at the Division 6 offices using a triple action yoke mounting bracket that rotates 360° in the horizontal plane. The bracket shall provide ±45° tilt angle. The monitor mounting brackets shall be either ceiling or wall mounted as directed by the Engineer. Insure that monitors are installed securely and in a fashion that allows for their removal for maintenance and access to monitor display controls. Connect, configure, and fully integrate new monitors with video decoders.

I. PTZ Control Panel

Furnish and install a PTZ Control panel at the Division 6 offices. Connect the control panel to the workstation. Furnish any additional hardware (serial boards, cables, etc.) necessary to connect the control panel to the workstations.

7.4 METHOD OF MEASUREMENT

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

Actual number of CCTV metal poles and foundations furnished and installed. Payment for this item shall include field location of the pole placement position; geotechnical sampling and analysis of soil at pole locations; development of shop drawings with equipment attachment points, surface area, and equipment dead loads; design and fabrication of the pole foundation and delivery and storage of poles. No separate payment will be made for design of metal pole or foundation.

Actual number of video multiplexers furnished, installed, integrated, and accepted. No separate measurement will be made for cabling, connectors, conduit, surge protectors, or any other equipment

or labor required to install the video multiplexer and integrate it with the other video equipment. No separate measurement will be made for integration of the video multiplexer with the Video Software.

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

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

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

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

New color video monitor shall be paid for at the unit bid price per each under the item "Monitor." No separate payment will be made for cables, mounting, mounting brackets and hardware, integration, or other accessories required for a complete installation of the CCTV monitors as they are considered incidental to the CCTV monitor.

Actual number of PTZ control panels furnished, installed, and accepted.

7.5 BASIS OF PAYMENT

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

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

The quantity of video multiplexers as provided above will be paid for at the contract unit price each for "Video Multiplexer".

The quantity of protocol converters as provided above will be paid for at the contract unit price each for "Protocol Converter".

The quantity of video encoders as provided above will be paid for at the contract unit price each for "Video Encoder".

The quantity of video decoders as provided above will be paid for at the contract unit price each for "Video Decoder".

The quantity of monitors as provided above will be paid for at the contract unit price each for "Monitor".

The quantity of PTZ control panels, measured as provided above, will be paid for at the contract unit price each for "PTZ Control Panel".

Payment will be made under:

CCTV Camera Assembly ..... **Each**

CCTV Metal Pole ..... **Each**

Video Multiplexer ..... **Each**

Protocol Converter ..... **Each**

Video Encoder ..... **Each**

Video Decoder ..... **Each**

Monitor ..... **Each**

PTZ Control Panel ..... **Each**

8. WIRELESS EQUIPMENT

8.1 DESCRIPTION

Furnish and install 2.4 GHz wireless video/PTZ system (transmitters and receivers) at locations shown on the Plans. The transmitter and receiver pair provides a bi-directional communication channel between two line-of-sight points using unlicensed, spread-spectrum frequencies. The transmitter/receiver pair has a minimum of 11 frequency channels that are selectable on both the transmitter and receiver. The system has the capacity to transmit at least one NTSC video channel to the Video Multiplexer and one PTZ channel to the appropriate CCTV in order to display and control a CCTV at a remote site.

Integrate the Video/PTZ transmitter with the CCTV dome cameras as described in these Special Provisions. Integrate the transmitter with the receiver for end-to-end video transmission. Integrate the receivers with the Video Multiplexer as described in these Special Provisions.

8.2 MATERIAL

A. Video/PTZ System:

Furnish unlicensed 2.4 GHz spread spectrum transmitter and receiver with appropriate antennas (SmartSight S1000, or approved equivalent). The Video/PTZ System shall meet the following minimum requirements:

Frequency range of 2.4000 to 2.4835 GHz.

Provide at least 11 user-selectable channels.

Support point-to-point operation.

Transmitter has a minimum of one (1) input supporting NTSC signal input.

Receiver has a minimum of one (1) output supporting NTSC signal output.

Frame rates generated and programmable from 1 – 30 frames/sec.

Both transmitter and receiver shall possess an internal watchdog timer.

Both transmitter and receiver firmware shall be upgradeable and configurable via a terminal emulation program driven by the manufacturer's software.

Video and PTZ data shall be transmitted over the same wireless frequency channel.

The Video/PTZ System shall support an error correction algorithm for a high quality video picture.

Support RS232, RS485, and RS422 protocols.

Supports data rates up to 230 kbps

Operate from –22° F to +122° F (-30° C to 50° C) at 0 to 95% relative humidity.

No more than 3.8"H x 3.9"W x 9"D (97 mm x 99 mm x 229 mm) and weigh less than four (4) pounds.

The PTZ Data Transmitter operates from 115VAC +/- 10% input power that is stepped-down to the appropriate voltage by a contractor/vendor-supplied power adapter.

The Video/PTZ System shall be supplied with all necessary cables and connectors including power supplies and adapters to provide a complete working system. Power will be supplied from a terminal block inside the equipment cabinet called for in these Project Special Provisions at the base of the camera pole.

A lightning arrestor shall be furnished and installed in-line between each antenna and the appropriate transmitter or receiver in the equipment cabinet. Lightning arrestor shall be approved by the Engineer.

B. NTSC Coaxial Cable:

NTSC coaxial cable shall be plenum-rated RG 59/U cable. The cable shall meet the video transmitter and receiver manufacturer's specifications and installation requirements.

8.3 CONSTRUCTION METHODS

A. Video/PTZ System

Furnish, install, and integrate wireless Video/PTZ System Transmitter and Receiver Assemblies as shown in the Plans. Install the wireless video transmitters, receivers, and antennas in the approximate locations shown in the Plans. Conduct a radio spectrum survey to determine the exact locations of the equipment by establishing the signal levels present at each location. Final locations will be determined with the Engineer. Perform antenna alignment in accordance with the manufacturer's installation requirements. Ground mounting plates, brackets, and extension arms with a minimum of an 8 AWG copper wire. Mount transmit and receive antennas and orient to provide proper line-of-sight between each camera and its receiver.

Integrate the serial port from the Video Multiplexer with the appropriate Video/PTZ receiver. At CCTVs, integrate serial ports from the transmitters and Video Multiplexer with the cameras.

Integrate the video transmitter into the video system by connecting the NTSC output of the CCTV to the NTSC input of the video transmitter.

Integrate the video receiver into the video system by connecting the NTSC output of the receiver to the NTSC input of the video transmitter or the Video Multiplexer, as appropriate for the particular location shown in the Plans.

Set-up and configure each wireless video transmitter/receiver pair using channel separations as recommended by the manufacturer for adjacent camera locations. Test the performance of the received video signal at the receiver video output port. The received video signal from each wireless video receiver location shall provide a minimum of 42dB signal to noise ratio (SNR) prior to being accepted. Develop testing forms and procedures to be approved by the Engineer that uses the video waveform test equipment in the section titled "System Support Equipment" of these Project Special Provisions to measure the received video signal of an installed wireless video transmit-receive pair.

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

8.4 METHOD OF MEASUREMENT

Actual number of 2.4 GHz Wireless Video/PTZ Systems (including antennas) furnished, installed, integrated, and accepted. This price and payment will be full compensation for installation

of the transmitter and receiver pair with their antennas, integration between transmitter and receiver, integration with the CCTV dome camera, and integration with the Video Multiplexer. All power supplies, power cords, adapters, connectors, cables and installation materials necessary to complete this work shall be incidental to the cost. Final payment will be made when work is accepted by the Engineer.

8.5 BASIS OF PAYMENT

The quantity of video/PTZ systems as provided above will be paid for at the contract unit price each for "Wireless Video/PTZ System".

Payment will be made under:

Wireless Video / PTZ System.....Each

9. HIGH SPEED INTERNET SERVICE

9.1 DESCRIPTION

Install High Speed Internet service at locations as shown in the Plans. The service on the Plans may be from any set of carriers (cable TV, phone, etc.) as long as the download speed at each site is a minimum of 1.5 Mbits/sec with a minimum upload speed of 256 kbits/sec. The carrier shall provide equipment to convert their Internet technology (DSL, cable, etc.) to an Ethernet 10/100BaseT interface.

Install High Speed Internet service at Division 6 office by connecting to the state's T1 line already present at the facility. Contact the NCDOT Division 6, Assistant Division Traffic Engineer at (910) 486-1452 prior to commencing any work at the Division 6 offices.

9.2 MATERIAL

Furnish and install an Ethernet Switch at the location shown in the Plans. The Ethernet Switch shall have twenty-four (24) auto negotiating 10/100 Base-T ports. In addition, the switch shall have two (2) auto negotiating 10/100/1000 Base-T ports. The unit shall be stackable and shall allow up to four (4) switches to be stacked together. The switch shall have a RS232 port as a console port.

Minimum performance of the switch shall be as follows:

- 8.8 Gbps switching capacity.
- 6.6 million packets per second.
- Wirespeed performance.
- 8,000 MAC addresses supported.

The unit's height shall be 1U (1.75") or less. The width of the unit shall permit it to be placed in a standard 19" rack. Depth shall be 10.8" or less. The weight of the unit shall be 5.3 pounds (2.4 Kg) or less. Power inputs shall accept input voltages between 90 and 240 VAC, with a maximum current of 2.3 A. Maximum heat dissipation shall be 40 W or less.

Furnish a 3 Com SuperStack 3 Switch with model number 3C16988A, or an approved current equivalent.

9.3 CONSTRUCTION METHODS

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

Install, configure, and integrate the Ethernet Switch to provide LAN communication (as shown in the Block Diagram of the Plans) between the Internet service, the video decoders, and the workstation.

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

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

9.4 METHOD OF MEASUREMENT

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

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

9.5 BASIS OF PAYMENT

The quantity of High Speed Internet Access points as provided above will be paid for at the contract unit price each for "High Speed Internet Access".

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

Payment will be made under:

High Speed Internet Access.....Each

Ethernet Switch.....Each

10. SYSTEM COMPUTER INTEGRATION

10.1 DESCRIPTION

Install and integrate workstation with software and all necessary hardware in accordance with the Plans and Project Special Provisions. Comply with the provisions of Section 1700 of the Standard Specifications.

The Department will furnish all system computer equipment.

It will be the Contractor's responsibility to request any equipment procured by the Department 60 days prior to when it is needed. It will also be the responsibility of the Contractor to ensure that all system computer equipment and software is integrated and functions to the requirements of these Project Special Provisions.

The Contractor will furnish and install any additional software and system computer equipment not furnished by the Department in order to successfully integrate the system computer equipment.

10.2 MATERIAL

The following equipment will be supplied by the Department:

- HP Compaq D530 CMT Model P2.66/40bc/256E/4, P4, 2.66Ghz, 533Mhz FSB, 40GB HD, 256 MB DDR333 (2x128), 48xCD, Intel Extreme Graphics2, PCI Audio, XP PRO - PN: DG061A#ABA
- P930 19" Professional Series Monitor (Carbon - Silver) - PN: P9009D#ABA
- Laptop Computer
- Printer
- Connecting Cables and Surge Protection Strips

10.3 CONSTRUCTION METHODS

Install workstation and all connecting cables and hardware as necessary to develop a complete and operational system. Integrate and make fully operational.

Install all connecting cables and hardware for laptop as necessary to develop a complete and operational system. Integrate and make fully operational the 56K modem with existing cellular and wired phones.

Install printer and integrate with the workstation and network.

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

10.4 METHOD OF MEASUREMENT

Lump Sum for System Computer Integration. This includes installing system computer equipment furnished by the Department and all materials, equipment, labor, tools, storage, shipping, and incidentals necessary to successfully integrate the system computer equipment.

10.5 BASIS OF PAYMENT

The quantity of system computer integration, measured as provided above, will be paid for at the contract lump sum price for "System Computer Integration".

Payment will be made under:

System Computer Integration ..... Lump Sum

11. CCTV EQUIPMENT CABINETS

11.1 DESCRIPTION

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

11.2 MATERIAL

A. General

Furnish 336S (stretch) cabinets to house CCTV control and transmission equipment. The 336S CCTV cabinet shall consist of a cabinet housing, 19-inch EIA mounting cage, and power distribution assembly (PDA #3 as described in the CALTRANS TSCES).

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

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

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

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

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

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

The Engineer shall approve all CCTV cabinets.

B. Shelf Drawer

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

C. Cabinet Light

Each cabinet shall include two (2) fluorescent lighting fixtures (one front, one back) mounted horizontally inside the top portion of the cabinet. The fixtures shall include a cool white lamp, and shall be operated by a normal power factor UL-listed ballast. A door-actuated switch shall be

installed to turn on the applicable cabinet light when the front door or back door is opened. The lights shall be mounted not to interfere with the upper door stay.

D. Surge Protection for System Equipment

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

E. Main AC Power Input

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

- Maximum AC line voltage: 140 VAC.
- Twenty pulses of peak current, each of which shall rise in 8 microseconds and fall in 20 microseconds to ½ the peak: 20000 Amperes.
- The protector shall be provided with the following terminals:
- Main Line (AC Line first stage terminal).
- Main Neutral (AC Neutral input terminal).
- Equipment Line Out (AC line second state output terminal, 19 amps).
- Equipment Neutral Out (Neutral terminal to protected equipment).
- GND (Earth connection).

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

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

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

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

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

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

Voltage shall never exceed 350 volts.

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

Continuous service current: 10 Amps at 120 VAC RMS.

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

F. Ground Bus

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

11.3 CONSTRUCTION METHODS

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

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

11.4 METHOD OF MEASUREMENT

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

11.5 BASIS OF PAYMENT

The quantity of 336 stretch cabinets, measured as provided above, will be paid for at the contract unit price each for "Equipment Cabinet (Pole Mounted)."

Payment will be made under:

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

12. ITS SYSTEM INTEGRATION

12.1 DESCRIPTION

A. General

Develop, install and integrate software onto the Division 6 workstation to allow an operator to launch DMS and Video software by clicking on icons present on a geographic information system (GIS) based map of this project.

Install, update, and integrate software onto the EIC and TRTMC workstations to allow operators to launch DMS and Video software by clicking on icons present on a geographic information system (GIS) based map of this project.

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

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

If the software provided is not a commercially available off the shelf software, obtain and provide the source code to the Department.

B. GIS Map

Furnish a GIS map of the project that is scalable from the entire project down to an individual DMS and CCTV device.

The software shall be Windows 2000 compatible.

Clicking on the DMS icons on the GIS map shall launch the DMS Software as defined in these Project Special Provisions.

Clicking on the CCTV icons on the GIS map shall launch the Video Software as defined in these Project Special Provisions.

C. Video Software

Furnish Video Software on the Workstation. The software will allow the system to display up to three (3) NCDOT camera views from this project on a standard television monitor and on the monitor at the Workstation. The two CCTVs can be displayed either individually as a full screen of a single monitor or as a 2-way group view on a single monitor. The group view shall be expandable to a 4-way group view.

The Video Software located on the workstation shall allow control of the video size. Video quality shall be selectable for each remote site to meet variations in network performance. The Video Software shall provide a drop down list labeling each CCTV camera available for viewing.

The software shall provide the following system capabilities:

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

- The software shall be Windows 2000 compatible and shall provide the following features:
- RS232 and RS485 formats
- Uniquely addressable video distribution
- Broad Band Networks
- Networkable over existing LAN
- Host and Multiple Secondary Locations
- Allows up to 99 presets per camera location.
- Allows up to 32 users to be networked and simultaneously use the system.

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

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

12.2 FUNCTIONAL REQUIREMENTS

A. GIS Map

Furnish and install a GIS map of the project area.

Add icons for all DMS and CCTV units under this project to the project GIS map in their geographically correct locations.

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

B. Video Software

Include the display and selection of the CCTV units installed under this project. These new CCTV units will use the same drag and drop and drop down list selection techniques in current use by existing Protronix software in the Region to assign the CCTVs to monitors whether the operator is in the Division 6 office, the EIC, or the TRTMC.

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

12.3 CONSTRUCTION METHODS

Install and integrate the DMS and Video software on the Workstations at the Division 6 office. Install and integrate the DMS and Video software on existing Workstations at the EIC and the TRTMC.

The NCDOT Division 6 offices are located at 558 Gillespie St., Fayetteville, NC 28301.

The EIC is located at 1 S. Wilmington Street, Raleigh, NC 27611.

The TRTMC is located at 101 Roscoe Trail, Raleigh, NC 27607.

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

12.4 METHOD OF MEASUREMENT

Lump sum for ITS System Integration. This shall include the development, furnishing, installation, testing, and all materials, equipment, labor, tools, storage, shipping, and incidentals necessary to successfully provide the GIS map, DMS, and Video, software. Partial payment for this item will be made as follows: 50% of the lump sum price upon completion of the software and 50% of the lump sum price upon successful completion of the Observation Period.

12.5 BASIS OF PAYMENT

The integration of the DMS and Video software into a system shall be paid for at the lump sum price for "ITS System Integration".

Payment will be made under:

ITS System Integration..... Lump Sum

13. TESTING

13.1 DESCRIPTION

This section covers the testing requirements of the DMS field components, video field components, wireless systems, workstation, and software. Testing requirements described in this section do not supersede any of the testing requirements described in any other section of these Project Special Provisions. Refer to Section "DMS Testing Requirements" of these Project Special Provisions for extended DMS testing requirements.

Perform testing on all major hardware and software components supplied for use on this project. These include:

- DMS Field Equipment
- CCTV Field Equipment
- Wireless Video/PTZ System
- Division 6 Office Hardware
- GIS Map Software
- DMS Software
- Video Software

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

13.2 MATERIAL

Perform operation and performance testing on each piece of major equipment and each major software component prior to installing it on this project.

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

The Engineer reserves the right to an on-site inspection at the manufacturing facility or at the Contractor's shop to witness any operation and performance testing or inspect any equipment hardware. The Engineer will be responsible for any charges associated with his/her travel expenses.

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

13.3 DMS - NTCIP TESTING

The Contractor shall use the services of one of the following firms to perform DMS NTCIP compliance tests outlined in these Project Special Provisions. **No exception shall be allowed**.

Trevilon Corp.
12827 Tewksbury Drive
Oak Hill, VA 20171
Phone: (703) 390 -1053

Battelle
505 King Avenue
Columbus, Ohio 43201
Phone: (614) 424-6424

PB Farradyne
3200 Tower Oaks Boulevard
Rockville, MD 20852
Phone: (301) 468 – 5568

A. CCTV Field Equipment Testing

1. General

All CCTV camera equipment and materials furnished by the Contractor will be subject to monitoring and testing to determine conformance with all applicable requirements and to ensure proper operation of the CCTV camera assemblies. The Contractor will 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, but shall be included in the amount bid for other pay items.

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

2. Shop Testing

Set up testing apparatus in shop to determine the functional operation of the CCTV units. The purpose of the shop test will be to identify non-operating or deficiently operating equipment prior to its installation in the field.

3. Field Camera Assembly Tests

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

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

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

B. Wireless Video/PTZ 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. These forms shall specify the acceptable results of the video and data transmission components, and shall be submitted for review and approval by the Engineer.

2. Shop Testing

Set up testing apparatus in shop to determine the functional operation of the Video/PTZ system. The purpose of the shop test will be to identify non-operating or deficiently operating equipment prior to its installation in the field.

3. Field Testing

In the field, once the CCTV assemblies and wireless transmission equipment have been installed to form a complete and operational CCTV transmission installation, test the wireless video transmission and data transmission control channels. Use the CCTV test monitor and the laptop computer at their respective ends to test the in field functionality of the wireless video and data transmission assemblies.

Determine that clear and acceptable, static free video images are being transmitted and received by the wireless video transmission equipment. Determine that all of the CCTV control functions described under "CCTV Field Equipment Testing" can be accomplished via the wireless data channel.

Using the Handheld Scope/Meter, the Waveform Monitor/Vector Scope, and the video signal generator from the video signal test kit called for in the section "System Support Equipment" of these Project Special Provisions, verify that the video signal on the receive end of the wireless video pair has the minimum signal-to-noise ratio of 42dB.

Perform and document any other field tests recommended by the manufacturer.

C. GIS Map

Upon completion of software installation and integration, the vendor shall perform a software Operational Test. This test shall be designed to insure that all field device icons are able to launch their native software application from each workstation in the Division 6 office, the TRTMC, and the EIC that has a version of the GIS Map software.

Develop a testing protocol that is approved by the Engineer and performs tests on the GIS Map Software that determines if all the requirements listed in section "ITS System Integration" of these Project Special Provisions are satisfied.

D. Video Software

Upon installation and integration of video equipment and video software, perform a software Operational Test of the Video software at the Division 6 office. This test shall be designed to insure communications between the Video software and each CCTV assembly via the Internet. In addition to being able to control which CCTV is displayed on which monitor, the Operational Test should also test the Video Multiplexer, and the Pan/Tilt/Zoom functions of each CCTV.

Develop testing protocol that is approved by the Engineer. Perform tests on the Video software to determine that all requirements listed in these Project Special Provisions are satisfied.

E. System Test

After delivery, installation, and integration of new field equipment and communications network, as required in these Project Special Provision, including all documentation, the Contractor shall perform detailed tests on each system component and shall demonstrate to the Engineer's satisfaction that each equipment item and software program is operating correctly, and is in conformance with the requirements of these Project Special Provisions.

The System Test requires verification of complete operation of all field locations utilizing the dial up telephone connections, wireless networks and the Internet connections. The test shall include the demonstration of the following:

- Complete operation of all field equipment from the Division 6 office.
- All local area network software and hardware operate properly.
- Complete control and viewing of each DMS location from the Division 6 office using the software integrated into the GIS map software while utilizing the dial up telephone connections.
- Complete control and viewing of each CCTV location from the Division 6 office using the Video software integrated into the GIS map software while utilizing the wireless networks and the Internet connections.
- All features of the Video software operate properly with all field equipment.
- Verification of the reception of video at the signal to noise ratio called for in these Project Special Provisions.
- Standard hardware tests with regards to diagnostic routines

The testing shall be executed on the basis of the approved test plan only. The Engineer or his representative shall witness all tests.

If system performance tests fail because of any component(s) in the system, the particular component(s) shall be corrected or substituted with new component(s) and the tests shall be repeated.

If a component has been modified as a result of the system performance test failure, a report shall be prepared by the Contractor and delivered to the Engineer prior to re-testing.

The Contractor shall be totally responsible for documenting the results of the test and furnishing the documented test results to the Engineer.

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

F. 90-Day Observation Period

Upon completion of all project work, the successful completion of the component tests and the System Test, and the correction of all deficiencies, including minor construction items, a 90-day Observation Period shall commence. This observation shall consist of a 90-day period of normal operations of the new field equipment in operation with the existing central equipment without any failure. The 90-day Observation Period shall be warranted by the payment and performance bond. The purpose of this period is to ensure that all components of the system function in accordance with the Plans and these Special Project Provisions over an extended length of time.

All training shall have been completed at least thirty (30) calendar days prior to the start of the 90-Day Observation Period.

Respond to system or component failures (or reported failures) that occur during the 90-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 shall suspend the timing of the 90-day Observation Period beginning at the time when the failure occurred. After the cause of such failures has been corrected, timing of the 90-day Observation Period shall resume. System or components failures that necessitate a redesign of any component and failures in any of the major system components exceeding a total of three (3) occurrences, shall terminate the 90-day Observation Period and shall cause the 90-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:

- DMS field hardware
- Wireless Video/PTZ system
- CCTV field hardware
- Video Encoder
- Video Decoder
- Video multiplexer
- Ethernet switch
- Workstation with PTZ control panel
- Monitor
- GIS Map Software
- Video Software

13.4 CONSTRUCTION METHODS

Provide test procedures for approval by the Engineer.

After delivery and installation of the hardware and software, perform detailed tests on each system component. Upon the successful completion of all component tests, the system test procedures may commence. Execution of these test procedures will demonstrate that all equipment is fully integrated, operational, and properly controlling the DMSs and CCTVs.

13.5 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.

13.6 BASIS OF PAYMENT

None specified.

14. DYNAMIC MESSAGE SIGN (DMS) SYSTEM

14.1 DESCRIPTION

To ensure compatibility with existing DMS equipment deployed in the Region, furnish NTCIP compliant DMS(s) that are Daktronics model number VF-1000-27X90-18-A or approved equivalent. Add and configure the new DMSs into the system using the existing control software. Demonstrate that all functions and features of the existing control software are fully operational on the new DMSs. Do not make any hardware or software changes or modifications to the existing DMS system. The Contractor will be responsible for all damages that may be inflicted on the new or existing system as a result of the integration process.

Furnish, install, test, integrate and make fully operational four (4) new DMSs as listed below:

- One (1) new DMS for southbound traffic and one (1) new overhead DMS assembly spanning all northbound and southbound lanes at I-95 just north of the Highway Patrol Station near the intersection of Dawn Drive and Nelson Way.
- One (1) new DMS for westbound traffic and one (1) new overhead DMS assembly spanning the westbound lanes at US 74 approximately 2 miles (3.22 Km) east of NC 41.
- One (1) new DMS for eastbound lanes and one (1) new overhead DMS assembly spanning the eastbound lanes on new US 74 at Station 86+00.
- One (1) new DMS to replace an existing DMS for northbound traffic on an existing overhead DMS assembly on I-95 1,441 feet (439.1 meters) in advance of Mile Marker 10.

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

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

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

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

These Project Special Provisions reference the following:

- Latest edition of National Transportation Communications for ITS Protocol (NTCIP) Joint Standards Committee Recommended Standards applicable to DMS system and requirements of these Project Special Provisions,

- AASHTO 2001, 4th edition and 2002 Interim *to Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals.*

14.2 MATERIALS

A. Environmental Requirements

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

Design the DMS, controller, cabinet, and accessories for a nominal performance through an ambient temperature range of -30° F to 165° F (-34° C to 74° C) with up to 95% relative humidity. Add fans and / or heaters and thermostats to the DMS enclosure to meet the operating requirements above. Add a thermostatically controlled fan and thermostat to the cabinet as described in the subsection titled "DMS Interior Environment Control." Provide equipment that does not suffer any damage when temporarily operating at 10°F (5°C) above or below the ambient temperature above. Design the system so that interior condensation does not occur and result in reduced visibility or legibility of the DMS elements.

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

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

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

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

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

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

B. LED Dynamic Message Sign (DMS)

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

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

1. DMS Enclosure

Construct the DMS with a metal walk-in enclosure excluding the face. Provide an aluminum walking platform inside the enclosure that is at least 28 inches (711 mm) wide. The width of the walking platform shall be free of obstructions to a height of 7 feet (2 m). Construct the enclosure of welded aluminum type 6061-T6, 5052-H38, 5052-H34, or of an Engineer

approved alternate at least 1/8-inch (3.175mm) thick. Perform all welding of aluminum and aluminum alloys in accordance with the latest edition of AWS D1.2, Structural Welding Code - Aluminum. Continuously weld the seams using Gas Metal Arc Welding (GMAW).

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

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

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

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

The sign face excluding the front panel shall be covered with a flat black, UV treated, colorfast material such as 3M™ Scotchcal™ non-reflective sheeting. Prior to the application of the sheeting, all surfaces shall be prepared for application per the sheeting manufacturer's recommendation. UV-treat the border and make it colorfast. Construct the border with a minimum width of 18 inches (457mm).

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

Provide three photoelectric sensors mounted on the DMS and / or DMS support structure.

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

A shielded voice communications circuit from the DMS to the DMS controller cabinet shall be provided. A telephone jack shall be provided at an Engineer approved location in the DMS accessible from the inspection doors. A telephone headset with a boom mounted, noise canceling microphone shall be stored in the DMS in a convenient location as approved by the Engineer. The headset shall have sound dampening earphones, a 50 feet (15 m) (extended) coiled cord with strain relief terminated in a standard 310 style phone plug, and hands off operation. The circuit shall provide an audible and clear signal over the noise level of interstate traffic.

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

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

2. DMS Interior Environment Control

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

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

- Housing Cooling System – Provide the DMS housing with a cooling system which circulates outside air into the DMS housing whenever LED board temperature exceeds a user-programmable threshold. Provide this system with enough ventilation fans to exchange the internal DMS housing air volume at a minimum rate of 4 times per minute. Provide ball-bearing type fans. Mount fans in a line across the upper rear wall of the DMS housing to direct air out of the cabinet. Provide one filtered air intake port for each exhaust fan. Locate intake ports in a line across the lower rear wall of the DMS housing. Provide intake ports with a removable filter that will remove airborne particles measuring 500 microns in diameter and larger. Provide a filter that is of a size and style that is commercially readily available. Initially program the Field Controller to activate the DMS housing cooling system whenever the LED board temperature exceeds +90° F (+32° C) and to turn the cooling system off whenever LED board temperature falls below +85° F (+29° C). On the DMS housing rear exterior wall, cover all air intake and exhaust ports on their top, front, and sides by an aluminum shroud fabricated from 0.090-inch aluminum sheeting. Taper the shrouds at the top to discourage birds from nesting in them. Securely fasten shrouds to the DMS housing, and provide gaskets at the interface to prevent water from entering the DMS. Design all air filters and fans to be removable from inside the DMS housing. Provide the DMS housing cooling system with an adjustable timer that will turn fans off after the set time has expired. Provide a timer that is adjustable to at least four (4) hours, and locate it just inside the DMS housing door, within easy reach of a maintenance technician standing outside the DMS doorway.

- LED Display Cooling System – Provide the DMS with an LED display cooling system which directs air across the LED display modules whenever LED board temperature exceeds a user-programmable threshold. Direct fan-forced air vertically across the backside of the entire LED display matrix using multiple ball-bearing fans. Initially

program the Field Controller to activate the LED cooling fan system whenever LED board temperature exceeds +90° F (+32° C) and to deactivate the system whenever LED board temperature falls to +85° F (+29° C). Locate cooling fans so as not to hinder removal of LED display modules and driver boards.

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

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

3. Front Panel

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

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

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

4. Display Modules

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

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

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

- All upper case letters.
- All punctuation marks.

- All numerals 0 to 9.
- Special user-created characters.

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

5. Discrete LEDs

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

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

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

Provide discrete LEDs with a half-power viewing angle of 15 degrees. Half-powering viewing angle is defined as follows: an LED which has a center-axis luminous intensity of calculated candelas at a distance of one foot from the LED while driven at 20 mA forward current is considered to have a 15 degree half-power viewing angle if its luminous intensity is at least half the calculated candelas at a distance of one foot from the LED and at an angle of 7.5 degrees off the LED's center axis while driven with a 20 mA forward current.

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

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

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

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

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

6. LED Power Supplies

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

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

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

7. LED Pixels

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

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

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

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

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

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

8. Character Display

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

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

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

9. Display Capabilities

Design the DMS with at least the following message displays:

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

C. DMS Enclosure Structure Mounting

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

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

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

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

D. DMS / DMS Controller Interconnect

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

Ensure the controller is able to communicate with the DMS when installed at the separation distance shown on the Signing project plans.

E. DMS Controller and Cabinet

Furnish and install one DMS controller with accessories per DMS in a protective cabinet at locations approved by the Engineer.

Mount the controller cabinet on a concrete base at ground level close to and in advance of the DMS support structure. Locate the cabinet so that a person working at the cabinet can see the face of the DMS.

Provide the DMS controller as a software-oriented microprocessor and with resident software stored in non-volatile memory. The Control Software, controller and communications must comply

with the NTCIP Standards identified in these project special provisions. Provide sufficient non-volatile memory to allow storage of at least 500 multi-page messages and a test pattern program.

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

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

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

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

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

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

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

Provide a torsionally rigid door with a continuous stainless steel hinge on the side that permits complete access to the cabinet interior. Provide a gasket as a permanent and weather resistant seal at

the cabinet door and at the edges of the fan / exhaust openings. Use a non-absorbent gasket material that will maintain its resiliency after long-term exposure to the outdoor environment. Construct the doors so that they fit firmly and evenly against the gasket material when closed. Provide the cabinet door with louvered vents near the bottom, and with air filters as described in the paragraph above.

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

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

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

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

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

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

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

A shielded voice communications circuit from the DMS controller cabinet to the DMS enclosure shall be provided. A telephone jack shall be provided at a location inside the cabinet approved by the Engineer. A telephone headset shall be stored in a convenient, Engineer-approved location in the cabinet. The head-set shall have sound dampening earphones, a boom mounted, noise canceling microphone, a 10-foot(3 m) (extended) coiled cord with strain relief terminated in a standard 310 style phone plug, and hands-off operation.

Mount a bug-proof and weatherproof thermostatically controlled fan and safety shield in the top of the cabinet. Size the fan to provide at least for two air exchanges per minute. Fuse the fan at 125% of the capacity of the motor. The magnetic field of the fan motor must not affect the performance of the control equipment. Use a fan thermostat that is manually adjustable to turn on between 80°F and 160°F (26°C and 72°C) with a differential of not more than 10°F (4°C) between automatic turn-on and turn-off. Mount it in an easily accessible location, but not within 6" (150 mm) of the fan.

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

1. Wiring

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

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

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

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

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

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

Label all equipment and equipment controls clearly.

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

2. Back Panels and Terminal Blocks

Include a fully wired equipment back panel(s) mounted on the lower rear inside of the wall of each cabinet below the equipment backs and shelves. Provide a detailed layout for approval by the Engineer.

Locate terminal blocks on the back panel so they are accessible to the extent that it is not necessary to remove the electronic equipment from the cabinet to make an inspection or connection, and so they do not upset the entrance, routing, and connection of incoming field

conductors. Use two-position multiple pole barrier-type terminal blocks. Identify all terminals by permanent legends attached to the blocks. Do not allow electrically live parts to extend beyond the barriers.

3. Power Supply and Circuit Protection

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

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

4. 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.

5. 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" (50 mm).

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

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

* Capable of handling the continuous current to the equipment

6. Radio Interference Suppressor

Provide each controller cabinet with sufficient electrical and electronic noise suppression to enable all equipment in it to function properly. Provide one or more radio interference suppressors (RIS) connected between the stages of the power line surge suppressor that minimize interference generated in the cabinet in both the broadcast and the aircraft frequencies. Each RIS must provide a minimum attenuation of 50 decibels over a frequency range of 200 KHz to 75

MHz. Clearly label the suppressor(s) and size them at least at the rated current of the main circuit breaker but not less than 50 amperes.

Provide RIS that are hermetically sealed in a substantial metal case which is filled with a suitable insulating compound and have nickel-plated 10/24 brass stud terminals of sufficient external length to provide space to connect #8 AWG wires. Mount them so that the studs cannot be turned in the case. Properly insulate ungrounded terminals from each other, and maintain a surface linkage distance of not less than ¼" (6.3 mm) between any exposed current conductor and any other metallic parts. The terminals must have an insulation factor of 100-200 MΩ, dependent on external circuit conditions. Use RIS designed for 120 VAC ± 10%, 60Hz, and which meet the standards of UL and the Radio Manufacturers Association.

7. 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

8. Lightning Arrester

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

Type of design	Silicon Oxide Varistor
Voltage	120/240 Single phase, 3 wires
Maximum current	100,000 amps
Maximum energy	3000 joules per pole
Maximum number of surges	Unlimited

Response time one milliamp test	5 nanoseconds
Response time to clamp 10,000 amps	10 nanoseconds
Response time to clamp 50,000 amps	25 nanoseconds
Leak current at double the rated voltage	None
Ground Wire	Separate

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

9. Uninterruptible Power Supply (UPS)

Provide the cabinet with an industrial grade UPS unit with AC line voltage conditioning capability, operating on a 120 volts AC, 60 Hz commercial line voltage. The unit must supply continuous power to operate the equipment connected to it if the primary power fails. The UPS must detect a power failure and provide backup power within twenty (20) milliseconds. Transition to the UPS source from primary power must not cause loss of data or damage to the equipment being supplied with backup power. Provide an UPS with at least three outlets for supplying conditioned AC voltage to the DMS controller and an industrial-grade dial-up modem. Equipment connected to the UPS must operate without interruption during line voltage variations of 88 volts AC to 140 volts AC. Mount backup batteries external to the UPS on ½" (12.5 mm) thick plywood to separate them from concrete floor and aluminum cabinet structure. Provide an UPS capable of operating within an ambient temperature range from -40° F to +185° F (-40° C to +85° C) and at up to 95% humidity, non-condensing.

Provide a **Clary SP 1000U** or an approved equivalent UPS unit with a minimum rating of 1250VA, 865 Watts.

10. Communications Interface

The controller will have the following interface ports:

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

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

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

11. Telephone Modem

Modem shall be an external industrial-grade unit. The modem design must have integral transient protection and Galvanic Isolation between line, RS232/422/485 ports, and power connections. The modem must have a watchdog circuitry to continuously monitor the power

supply, internal hardware, and operational software. In the event of a hardware or software problem the modem shall automatically reset itself. The unit must meet the following minimum specifications:

Telephone Modem	
Max Data Rate	33.6 kbps (V.34)
Compatibility	V.34, V.32bis, V.32, V.22, V.22A/B, V.23, V.21, Bell212a &103
Settings	AT-Commands & Switches
Transmission	Asynchronous and Synchronous
Data Compression	V.42bis and MNP5
Error Correction	V.42, MNP2-4, and MNP10
REN	0.3 - 1.0
Line Jack	RJ11/12
Phone Jack	RJ11/12
RS 232 Port	
Max RS232 Rate	115.2 kbps
RS232 Signal Support	TXD, RXD, CTS, RTS, DCD, DTR, DSR, RI, GND
RS232 Connector	DB9 Female
Command Set	All Standard AT and S Register commands including Class 1 and Class 2 fax commands
RS422/485 Port	
RS422 Mode	4 wires full duplex
RS485 Mode	2 or 4 wires party-line operation (halfduplex)
Signal Rate	Standard Rates up to 115.2 kbps
RS422/485 distance	Up to 0.5 miles
Status LEDs	
Carrier Detect (CD)	The modem has detected a carrier on the phone line
Data Terminal Ready (TR)	The PC has established a connection to the modem and is ready
Received Data (RD)	Flashes as data is received from the phone line
Transmit Data (TD)	Flashes as data is sent out the phone line
Power	On when power is present
General Specifications	
Input power	10-60 VDC or 115 VAC

Operating Temperature	-22 °F to 158 °F (-30° C to 70° C)
Storage Temperature	-40° F to 185 °F (-40° C to 85° C)
Humidity	Up to 95%RH
Flammability	UL94V-0 MATERIAL
EMI Emissions	FCC part 15, ICES-003, EN5502
EMC Immunity	EN50082-1, IEC801-2,3,4
Electrical Safety	UL 508, CSA C22.2/14, IEC1010
Surge Withstand	IEEE-472 (ANSI C37.90)
Hazardous Locations	UL 1604, CSA C22.2/213-M1987, EN50021 (Zone 2)
PLC Discrete I/O Interface (if required by the Project Special Provisions or to implement a functional requirement)	
Trigger Input from PLC	Connects to PLC output. Starts auto dialing upon transition from OFF to ON. Modem will stay connected while input is ON
Voltage Range	9 to 30 VDC
Input Current	6.5 mA @ 24VDC
Max OFF Voltage	5VDC
On-Line Output (to PLC)	Output is ON as long as a connection exists (carrier detect)
Output Characteristics	Sourcing - Switches supply power
Max Output Current	100 mA

12. Modem Reset Device

Provide a **Teleboot BB 100** or an approved equivalent device to automatically reset/reboot a locked-up modem.

13. Telephone Line Surge and Lightning Protector

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

Technology	Solid state sidactors with fast acting fuses and resistors
Usage	Telephone Line
Ports Protected	1 (2 lines per port)
Connectors	RJ11/12
Surge Capacity	1.9 kA / line
Clamp & Rated Voltage	270 V and 200 V

Max Frequency	50 MHz
Operating Temperature	-40° F to 185 ° F (-40° C to +85° C)
Max Inline Resistance	22 Ohms
Ratings	UL 497A, IEC801-5, CCITT (ITU-T) K17

14. Local Control Panel

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

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

The LCP displays at least the following:

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

15. Controller Address

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

16. Controller Modes of Operation

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

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

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

17. Controller Functions

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

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

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

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

Include the following functions in the controller and software:

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

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

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

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

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

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

a. Error and Failure Reports:

- Power failure
- Data transmission error
- Receipt of invalid data

- Communications failure recovery
- DMS controller failure
- Power recovery
- LED and module status

b. Error and Failure Responses:

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

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

18. DMS Controller Commands

Include these commands at a minimum in the controller:

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

19. DMS Controller Memory

Design each DMS controller with its own local non-volatile memory. Use the non-volatile memory to store and reprogram at least one test pattern sequence and 500 messages containing a minimum of two pages of 45 characters per page. The Engineer will furnish the initial set of messages. Load these messages into both the Control Software library and the DMS controller's

non-volatile memory. The Control Software can upload messages into and download messages from each controller's non-volatile memory remotely.

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

F. Photo-Electric Sensors

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

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

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

G. Circuit Breakers, Panels, and Enclosures

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

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

H. Service Poles

Use service poles for this project that conform to Article 1097-7 in the Standard Specifications. Install separate conduits on the service pole for telephone and electrical service. The Engineer must approve the locations of service poles.

I. Equipment List

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

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

J. Character Set Submittal

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

K. Wiring Diagrams and Theory of Operation

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

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

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

14.3 CONSTRUCTION METHODS

A. Description

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

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

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

B. Layout

The Engineer will establish the actual location of each Dynamic Message Sign assembly. Provide the proper elevation, offset, level, and orientation of all DMS assemblies. The location of service poles and controller cabinets as well as conduit lengths as shown in the plans are

approximate based on available project data. Make actual field measurements to place conduit and equipment at the required location. Mark the proposed location of circuits and all other components for the Engineer's approval prior to installation. Submit a drawing showing all underground conduits and cables dimensioned from fixed objects or station marks.

C. Construction Submittal

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

The "as built" plans will show: the DMS, controller, and service pole locations; DMS enclosure and controller cabinet wiring layouts; and wire and conduit routing. Include detailed drawings that identify the routing of all conductors in the system by cable type, color code, and function. Clearly label all equipment in the DMS system, controller cabinet, and DMS enclosure.

D. Conduit

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

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

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

Attach the conduit system to and install along the structural components of the DMS structure assembly with beam clamps or stainless steel strapping. Install strapping according to the strapping manufacturer's recommendations. Do not use welding or drilling to fasten conduit to structural components. Space the fasteners at no more than 4 feet (1.2m) for conduit 1.5" (40 mm) and larger, or 6 feet (1.8 m) for conduit 1.25" (30 mm) and smaller. Place fasteners no more than 3 feet (900 mm) from the center of bends, fittings, boxes, switches, and devices.

Locate underground conduit as shown in the Plans in a manner consistent with these Project Special Provisions.

Where conduit is required beneath pavement, bury it at the required depth prior to laying new pavement, or bore and jack it beneath existing pavement. "Water jetting" is not an acceptable installation method. Plug any abandoned opening for bored or jacked conduit as directed by the Engineer.

Extend conduit stubs for controller cabinets at least 6 inches (150 mm) upward and at least 3 feet (900 mm) downward from the top of the foundation.

Provide caps or plugs made of the same material as the conduit on stub-outs for future use.

Clean conduit after installation by "snaking" with a mandrel of a diameter not less than 85% of the nominal diameter of the conduit. Ensure all conduit runs are free of moisture, trash, and debris before pulling cable. Seal the ends of underground conduit with temporary caps and, after installation of circuits, plug the ends as specified in these Project Special Provisions. Coat field-cut threads and other uncoated metal or damaged galvanizing with 2 coats of zinc-rich paint meeting the requirements of Article 1080-9 of the Standard Specifications. Ream the ends of rigid conduit.

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

E. Wiring Methods

Do not pull permanent wire through a conduit system until the system is complete and has been cleaned.

Color-code all conductors per the NEC (grounded neutral-WHITE, grounding-BARE or GREEN, and phase conductors RED and BLACK). Use approved marking tape, paint, sleeves or continuous colored conductors for No.8 AWG and larger. Do not mark a white conductor in a cable assembly any other color. You may strip a white, red, or black conductor at all accessible points and use it as a bare equipment-grounding conductor.

Bury underground circuits at the depth shown in the plans and surround with at least 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.

F. Equipment and Cabinet Mounting

Mount equipment securely at the locations shown in the plans, in conformance with the dimensions shown, and plumb and level. Install fasteners as recommended by the manufacturer and space them evenly. Use all mounting holes and attachment points for attaching DMS enclosures (and controller cabinets, if required) to structures.

Drill holes for expansion anchors of the size recommended by the manufacturer of the anchors and thoroughly clean them of all debris.

Provide one key-operated, pin tumbler, dead bolt padlock, with brass or bronze shackle and case, conforming to Military Specification MIL-P-17802E (Grade I, Class 2, Size 2, Style A) for each electrical panel and switch on the project. Key all padlocks alike, and provide 10 keys to the Engineer.

Provide cabinets with all mounting plates, anchor bolts, and any other necessary mounting hardware in accordance with the Signal Specifications and the project plans.

Provide Class-A concrete in conformance with Article 1000-4 of the Standard Specifications.

Seal all unused conduit installed in cabinets at both ends to prevent water and dirt from entering the conduit and cabinet.

Install a ground bushing attached inside the cabinet on all metal conduits entering the cabinet. Connect these ground bushings to the cabinet ground bus.

G. Cabinet and System Grounding

Ground the controller cabinet, DMS enclosure, DMS structure, and service entrance equipment per Sections 1098 and 1700 of the Standard Specifications, applicable addenda, typical drawings, the Plans and these Project Special Provisions. Provide grounding circuits that are permanent and electrically continuous with a current carrying capacity high enough and an impedance low enough to limit the potential above ground to a safe level.

Run the power company neutral, conduit grounds, and all equipment grounds directly and independently of the ground bus. Use ground clamps, grounding and bonding bushings, lock nuts, and grounding electrodes that comply with UL Standard Electric Grounding and Bonding Equipment. Use ground rods of 5/8" (16mm) minimum diameter, 10 feet (3 m) long, and made of copper-clad steel.

Make connections between ground electrodes and the ground wire using an exothermic welding process, cadweld or equivalent.

Ensure completed cabinet grounds have a resistance to ground of not more than 20 Ohms.

H. Work Site Clean-Up

Clean the site of all debris, excess excavation, waste packing material, wire, etc. Clean and clear the work site at the end of each workday. Do not throw waste material in storm drains or sewers.

I. Power and Telephone Service

When power and telephone service are required at a DMS location, contact the power and telephone companies, make application, and pay all costs, including the installation charge and monthly usage bills, to assure the ability to complete all work. Pay all power and telephone company charges incurred until the date of acceptance of the project by the Department. Upon acceptance of the project and upon request, the Department will reimburse the actual verified cost of power and telephone company charges, including monthly usage bills.

Provide a power service connection that is a single-phase 120/240 volt 3 wire 60 Hz alternating current supply furnished from the local electric utility to a service pole close to the controller cabinet. Provide a main disconnect switch in a lockable NEMA 3R enclosure located on the service pole. Use a main-disconnect that is 120/240V, double pole, bolt-in circuit breaker sized according to the NEC to protect the above equipment.

Install a service pole in a location approved by the Engineer and deliver power and telephone service to it. Run power and telephone service to the controller cabinet through separate conduits.

14.4 METHOD OF MEASUREMENT

Each Dynamic Message Sign System consists of LED Dynamic Message Sign, communications equipment including the spare parts, strapping hardware, controller, UPS, cabinet and base, conduit and conduit bodies, wire, connectors, circuit protection equipment, photo-electric sensors, service pole, electrical and telephone service acquisition, and related service equipment, tools, materials, all related testing, cost of labor, cost of transportation, incidentals, and all other equipment necessary to furnish and install a DMS system as detailed in the previous pages.

There will be no separate measurement of the work required to remove the existing DMS from the existing overhead DMS assembly at the "DMS-4" location and delivering the existing DMS to the Department at a location within Division 6 to be designated by the Engineer.

14.5 BASIS OF PAYMENT

The quantities of each Dynamic Message Sign System and Maintenance Training as measured will be paid for at the contract lump sum price for "Dynamic Message Sign "DMS - __"".

Payment will be made under:

Dynamic Message Sign "DMS – 1" ..... Lump Sum

Dynamic Message Sign "DMS – 2" ..... Lump Sum

Dynamic Message Sign "DMS – 3" ..... Lump Sum

Dynamic Message Sign "DMS – 4" ..... Lump Sum

15. DMS TESTING REQUIREMENTS

15.1 General Test Procedure

Test the DMS system in a series of design approved and functional tests. The results of each test must meet the specified requirements. These tests should not damage the equipment. The Engineer will reject equipment that fails to fulfill the requirements of any test. Resubmit rejected equipment after correcting non-conformities and re-testing; completely document all diagnoses and corrective actions. Modify all equipment furnished under this contract, without additional cost to the North Carolina Department of Transportation, to incorporate all design changes necessary to pass the required tests.

Provide 4 copies of all test procedures and requirements to the Engineer for review and approval at least 40 days prior to the testing start date.

Only use approved procedures for the tests. Include the following in the test procedures:

- A step-by-step outline of the test sequence, showing a test of every function of the equipment or system tested
- A description of the expected nominal operation, output, and test results, and the pass / fail criteria
- An estimate of the test duration and a proposed test schedule
- A data form to record all data and quantitative results obtained during the test.
- A description of any special equipment, setup, manpower, or conditions required by the test

Provide all necessary test equipment and technical support. Use test equipment calibrated to National Institute of Standards and Technology (NIST) standards. Provide calibration documentation upon request.

The Contractor shall notify the Engineer forty days in advance of factory tests.

Failure to conform to the requirements of any test and these specifications shall be counted as a complete failure, and the equipment shall be rejected. Rejected equipment/tests may be retested after all deviations have been corrected. After successful completion of all factory tests, the DMS for this contract will be accepted for shipment to the installation site. The Contractor shall provide the documentation to the Engineer of all test and results.

The approval of test procedures and the Engineers acceptance of DMS tests shall not relieve the Contractor of his responsibility to provide a completely acceptable operating DMS system that meets the requirements as stated herein.

Provide 4 copies of the quantitative test results and data forms containing all data taken, highlighting any non-conforming results and remedies taken, to the Engineer for approval before the next project stage is started. An authorized representative of the manufacturer must sign the test results and data forms.

15.2 Design Approval Tests

A. Procedure and Requirements

Perform the following Design Approval Tests at the manufacturer's facility on the DMS modules, controller, controller cabinet, communications, and all other associated equipment before beginning full production on the units supplied for this Contract.

PROTOTYPE – Manufacture a prototype Dynamic Message Sign and controller of the type and size described in these Project Special Provisions. Test the prototype according to the Design Approval and Operational Tests. When all corrections and changes (if any) have been made, the Department may accept the prototype DMS and controller as the physical and functional standard for the system furnished under this contract. You may use the prototype units on this project if, after inspection and rework (if necessary), they meet all physical and functional specifications. In the case of standard product line equipment, if the Contractor can provide test results certified by an independent testing facility as evidence of prior completion of successful design approval tests, then the Engineer may choose to waive these tests. If the Engineer so chooses, reduce the contract price by the amount bid for these tests.

In each Design Approval Test designated below, successfully perform the tests described in the Check Test below, under the conditions described. Apply the extreme conditions to all associated equipment unless stated otherwise in these Project Special Provisions.

Perform the following Check Tests as a minimum:

- Start-up and operate the DMS locally using the Control Software.
- Use automatic (photoelectric sensor controlled), remote control using Control Software, and local control using Control Software to switch between "dim", "normal", and "bright" light levels.
- Operate the DMS with all display elements flashing continuously for 15 minutes at the maximum flash rate.
- Exercise the DMS by displaying static messages, flashing messages, and alternating static and flashing message sequences.
- Automatically poll the DMS using Control Software at various intervals and verify data received by the Control Software from the DMS.
- Download and edit messages.
- Execute status request on the DMS controller.
- Normal operations during uploading and downloading.
- Display a two-phase flashing message sequence of 45 characters.
- Select messages from the sign controller's local control panel.
- Activate the test sequence at chosen intervals.
- Display and verify several stored messages.
- Display a 2-page diagonal test pattern with half the pixels on and half off, alternating pixels on each page. Display this pattern for 1 hour.

B. Environmental Tests

1. Temperature

a. Stabilize the equipment -10° F (–23° C). After stabilization at this temperature, perform the Check Tests without degradation or failure at both the low and high ends of the input power voltages.

b. Stabilize the equipment at 140° F (60° C) and operate it as per part a. above.

2. Humidity

a. Maintain the equipment at 140° F (60° C) with a relative humidity of 95% for 48 hours. At the conclusion of the 48 hours period, perform the Check Tests without degradation or failure at both the low and high ends of the input power voltages.

3. Primary Power Variation

a. Voltage: Operate the field equipment with the input line voltage set first at 132V and then at 108V (120V +/- 10%). Operate the equipment for at least 15 minutes at each of these voltages while successfully performing the Check Tests.

b. Frequency: Operate the field equipment with the input line frequency set first at 63 Hz and then at 57 Hz (60Hz +/- 3Hz). Operate the equipment for at least 15 minutes at each of these frequencies while successfully performing the Check Tests.

c. High Frequency: Check Test the field equipment when subjected to the high frequency and voltage transient interference specified in the Transients, Power Service section of the NEMA Standards for Traffic Control Systems while successfully performing the Check Tests.

4. Vibration and Shock:

Subject the field equipment to the vibration and shock tests described in the Vibration Test and Shock Test sections of the NEMA Standards for Traffic Control Systems. This test must not cause degradation of mechanical structure, soldered components, or plug-in components. Successfully perform the Check Tests immediately after completing the Vibration Test.

5. Water Spray Test (Controller Cabinet Only):

Perform the following water spray test on an empty controller cabinet. Spray water from a point directly overhead at an angle of 60° from the vertical axis of the cabinet. Repeat this procedure for each of eight equally spaced positions around the cabinet for a period of not less than two minutes in each position. Spray the water using a domestic type sprinkling nozzle at a rate of not less than 1 gallon (3.78 liters) per minute per 1 square foot (.09 square meters) of surface area. Then check the cabinet for leakage. Reject or repair the cabinet if there is any evidence of leakage and repeat the test.

6. LED Pixel Light Output Test:

Perform a test to confirm that the light output intensity conforms to the requirements of "LED Pixels".

15.3 Operational FACTORY Tests

Perform Operational Factory Tests on the assembled DMS system at the manufacturer's facility prior to shipping. Perform Operational Field Test on each system after it is shipped, installed, and operational.

A. Operational Factory Test

1. Physical Examination

Examine each piece of equipment to verify that the materials, design, construction, markings, and workmanship comply with the mechanical, dimensional, and assembly requirements of these Project Special Provisions.

Perform the following tests as a minimum:

- Verify that all surfaces are free of dents, scratches, weld burns, or abrasions. Round sharp edges and corners.
- Verify bend radius of cables is not excessive or could potentially cause damage.
- Verify all modules, lamps, and components are properly secured.
- Verify that there are no exposed live terminals.

2. Continuity Test

Check the wiring to assure it conforms with the requirements of the appropriate paragraphs of this Specification.

3. Functional Tests

Operate each unit of equipment in the system long enough to permit the equipment temperature to stabilize, and to check and record performance characteristics to ensure compliance with the latest edition of NTCIP Standards as required in these Project Special Provisions.

Conduct approved DMS functional tests on the equipment with the Control Software. Exercise all remote and local monitoring and control functions required by these specifications and display the return status codes from the controller for a period of 72 hours.

Include the following functional tests as a minimum:

- NTCIP exerciser/other testing on the assembled DMS system
  - Verification of all memory requirements
  - Start-up and operation of the DMS locally using the Control Software
- Use automatic (photoelectric sensor controlled), remote control using Control Software, and local control using Control Software to switch between "dim", "normal", and "bright" light levels
- Operation of the DMS with all display elements flashing continuously for one hour at the maximum flash rate
- Exercise the DMS by displaying static messages, flashing messages, and alternating static and flashing message sequences

- Automatically poll the DMS using Control Software at various intervals and verify data received by the Control Software from the DMS
- Demonstration of the writing speed to meet specified requirements.
- Downloading and editing messages
- Execute status request on the DMS controller
- Normal operations during uploading and downloading
- Display two-phase flashing message sequence of 45 characters
- Selection of messages from the sign controller's local control panel
- Test sequence activation at chosen intervals
- Display and verification of all stored messages
- Resumption of standard operation upon interruption of electrical power
- Demonstrate no loss of RAM memory during a 24 hour electrical power outage
- Demonstration of the Failure Detection and Response functions
- Demonstrate proper operation of the Failure Log
- Watchdog timer detection of microprocessor failures and the resetting of the microprocessor
- Non-volatile memory reprogramming requirements
- Set controller clock using the Control Software
- Execute system shut-down using first the Control Software emulator device, and local control panel
- Detection of power failure in the DMS enclosure and reporting of such failure to the Control Software
- Detection of UPS overload. Logging and reporting of such event to the Control Software

Approval of Operational Factory Test does not relieve the Contractor of the requirements to conform to the specifications in these Project Special Provisions.

4. NTCIP Requirements

This portion of the specification defines the detailed NTCIP requirements for the Dynamic Message Signs covered by the procurement package.

a. Definitions

The following terms shall apply within the scope of this procurement specification:

DMS - A Dynamic Message Sign, includes the sign display, controller, cabinet, and other associated field equipment. The specific type of dynamic message sign (i.e., blank-out sign, changeable message sign, character matrix sign, full-matrix

sign, etc.) for this procurement is specified elsewhere within this procurement specification.

FSORS - Full, Standardized Object Range Support for, and proper implementation of, all valid values of an object as defined within the object's OBJECT-TYPE macro in the subject NTCIP standard; this is further defined in two distinct sub-requirements. (1) If the ACCESS of the object is read-write, a Management System shall be able to set the object to any valid value as defined by the SYNTAX and DESCRIPTION fields (except that the value of 'other' need not be supported when such a value is defined) and the indicated functionality shall be provided. (2) The value indicated by the object (e.g., in response to a 'get'), regardless of the ACCESS, shall reflect the current condition per the rules specified in the object's DESCRIPTION.

Management System – A computer system used to control an NTCIP component. This includes any laptop software used for field control as well as the control software.

NTCIP Component – A DMS or a Management System.

NTCIP System – A Management System plus the various DMSs controlled by the Management System.

Response Time – The time to prepare and begin transmission of a complete response containing the requested Application Layer information. This is measured as the time from receipt of the closing flag of the request to the transmission of the opening flag of the response when the device has immediate access to transmit.

b. References

This specification references several standards through their NTCIP designated names. The following list provides the full reference to the current version of each of these standards. In many cases, the standard is more widely known by its original NEMA assigned number; in these cases, the NEMA number is also identified. The content of the NEMA standard is identical to that of the NTCIP standard.

Each NTCIP Component covered by these project specifications shall implement the most recent version of the standard that is at the stage of Recommended or higher as of Sunday, October 01, 2000, including any and all Approved or Recommended Amendments to these standards as of the same date. It is the ultimate responsibility of the VENDOR to monitor NTCIP activities to discover any more recent documents.

Table 1: NTCIP Standards

Abbreviated Number	Full Number	Title	Known Amendments
NTCIP 1101	**NTCIP 1101:1997** (NEMA TS 3.2-1996)	*Simple Transportation Management Framework*	Amendment #1 dated November 2, 1998
NTCIP 1201	**NTCIP 1201:1997** (NEMA TS 3.4-1996)	*Global Object Definitions*	Amendment #1 dated November 2, 1998

NTCIP 1203	**NTCIP 1203:1997** (NEMA TS 3.6-1997)	*Object Definitions for Dynamic Message Signs*	Amendment #1 dated July 3, 2001
NTCIP 2001	**NTCIP 2001:1997** (NEMA TS 3.3-1996)	*Class B Profile*	Amendment #1 dated November 2, 1998
NTCIP 2101	**NTCIP 2101**	*SP-PMPP/232* *Subnet Profile for PMPP over RS-232*	Amendment #1 dated November 2, 1998
NTCIP 2102	**NTCIP 2102**	*SP-PMPP/FSK* *Subnet Profile for PMPP over FSK Modem*	
NTCIP 2103	**NTCIP 2103**	*SP-PPP/232* *Subnetwork Profile for PPP over RS232 (Dial Up)*	
NTCIP 2104	**NTCIP 2104**	*SP-Ethernet* *Subnet Profile for Ethernet*	
NTCIP 2201	**NTCIP 2201**	*TP-Null* *Transport Profile*	
NTCIP 2202	**NTCIP 2202** (NEMA TS 3.Internet v99.01.03)	*TP-Internet* *Internet Transport Profile (TCP/IP and UDP/IP)*	
NTCIP 2301	**NTCIP 2301**	AP-STMF AP for Simple Transportation Management Framework	

c. General Requirements

i. Subnet Level

Each serial port on each NTCIP Component shall support NTCIP 2103 over a dial-up connection with a contractor provided external modem with data rates of 28.8 kbps, 19.2 kbps, 14.4 kbps, 9600 bps, 4800 bps, 2400 bps, 1200 bps, 600 bps, and 300 bps. The NTCIP Component shall be able to make outgoing and receive incoming calls as necessary and support the following modem command sets:

- Hayes AT - Command Set
- MNP5
- MNP10

- V.42bis

Each serial port on each NTCIP Component shall support NTCIP 2103 over a null-modem connection with data rates of 19.2 kbps, 14.4 kbps, 9600 bps, 4800 bps, 2400 bps, 1200 bps, 600 bps, and 300 bps.

Each serial port on each NTCIP Component shall support NTCIP 2101 with data rates of 9600 bps, 4800 bps, 2400 bps, 1200 bps, 600 bps, and 300 bps.

Additionally, NTCIP components shall support NTCIP 2102 and NTCIP 2104.

NTCIP Components may support additional Subnet Profiles at the manufacturer's option. At any one time, only one Subnet Profile shall be active on a given serial port of the NTCIP Component. The NTCIP Component shall be configurable to allow the field technician to activate the desired Subnet Profile and shall provide a visual indication of the currently selected Subnet Profile.

ii. Transport Level

Each NTCIP Component shall comply with NTCIP 2201 and 2202.

NTCIP Components may support additional Transport Profiles at the manufacturer's option. Response datagrams shall use the same Transport Profile used in the request. Each NTCIP Component shall support the receipt of datagrams conforming to any of the identified Transport Profiles at any time.

iii. Application Level

Each NTCIP Component shall comply with NTCIP 1101 and 2301 and shall meet the requirements for Conformance Level 1 (NOTE - See Amendment to standard).

Each NTCIP Component shall support SNMP traps. An NTCIP Component may support additional Application Profiles at the manufacturer's option. Responses shall use the same Application Profile used by the request. Each NTCIP Component shall support the receipt of Application data packets at any time allowed by the subject standards.

iv. Information Level

Each NTCIP Component shall provide Full, Standardized Object Range Support of all objects required by these procurement specifications unless otherwise indicated below. The maximum Response Time for any object or group of objects shall be 200 milliseconds.

The DMS shall support all mandatory objects of all mandatory Conformance Groups as defined in NTCIP 1201 and NTCIP 1203. Table 2 indicates the modified object requirements for these mandatory objects.

Table 2: Modified Object Ranges for Mandatory Objects

Object	Reference	Project Requirement
ModuleTableEntry	NTCIP 1201 Clause 2.2.3	Shall contain at least one row with moduleType equal to 3 (software). The moduleMake shall specify the name of the manufacturer, the moduleModel shall specify the manufacturer's name of the component and the modelVersion shall indicate the model version number of the component.
MaxGroupAddresses	NTCIP 1201 Clause 2.7.1	Shall be at least 1
CommunityNamesMax	NTCIP 1201 Clause 2.8.2	Shall be at least 3
DmsNumPermanentMsg	NTCIP 1203 Clause 2.6.1.1.1.1	Shall be at least 1*
DmsMaxChangeableMsg	NTCIP 1203 Clause 2.6.1.1.1.3	Shall be at least 21
DmsFreeChangeableMemory	NTCIP 1203 Clause 2.6.1.1.1.4	Shall be at least 20 when no messages are stored.
DmsMessageMultiString	NTCIP 1203 Clause 2.6.1.1.1.8.3	The DMS shall support any valid MULTI string containing any subset of those MULTI tags listed in Table 4
DmsControlMode	NTCIP 1203 Clause 2.7.1.1.1.1	Shall support at least the following modes: Local External central CentralOverride

* The Permanent Messages shall display the content shown in Table 3.

The sign shall blank if a command to display a message contains an invalid Message CRC value for the desired message.

Table 3: Content of Permanent Messages

Perm. Msg. Num.	Description
1	Permanent Message #1 shall blank the display (i.e., consist of and empty MULTI string). It shall have a run-time priority of one (1).

Table 4: Required MULTI Tags

Code	Feature
f1	field 1 - time (12hr)
f2	field 2 - time (24hr)
f8	field 8 – day of month
f9	field 9 – month
f10	field 10 - 2 digit year
f11	field 11 - 4 digit year
fl (and /fl)	flashing text on a line by line basis with flash rates controllable in 0.5 second increments.
fo	Font
jl2	Justification – line – left
jl3	Justification – line – center
jl4	Justification – line – right
jl5	Justification – line – full
jp2	Justification – page – top
jp3	Justification – page – middle
jp4	Justification – page – bottom
Mv	moving text
Nl	new line

Np	new page, up to 2 instances in a message (i.e., up to 3 pages/frames in a message counting first page)
Pt	page times controllable in 0.5 second increments.

The NTCIP Component shall also implement all mandatory and optional objects of the following optional conformance groups with FSORS.

v. Test Heading

(a) Time Management, as defined in NTCIP 1201

(b) Timebase Event Schedule, as defined in NTCIP 1201. The following list indicates the modified object requirements for this conformance group.

Table 5: Modified Object Ranges for the Timebase Event Schedule Conformance Group

Object	Reference	Project Requirement
MaxTimeBaseScheduleEntries	NTCIP 1201 Clause 2.4.3.1	Shall be at least 28
maxDayPlans	NTCIP 1201 Clause 2.4.4.1	Shall be at least 14
maxDayPlanEvents	NTCIP 1201 Clause 2.4.4.2	Shall be at least 10

(c) Report, as defined in NTCIP 1201. The following list indicates the modified object requirements for this conformance group.

Table 6: Modified Object Ranges for the Report Conformance Group

Object	Reference	Project Requirement
maxEventLogConfigs	NTCIP 1201 Clause 2.5.1	Shall be at least 50
eventConfigurationMode	NTCIP 1201 Clause 2.4.3.1	The NTCIP Component shall support the following Event Configuration Modes: onChange greaterThanValue smallerThanValue

MaxEventLogSize	NTCIP 1201 Clause 2.5.3	Shall be at least 200
MaxEventClasses	NTCIP 1201 Clause 2.5.5	Shall be at least 16

(d) PMPP

(e) Font Configuration, as defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

Table 7: Modified Object Ranges for the Font Configuration Conformance Group

Object	Reference	Project Requirement
NumFonts	NTCIP 1203 Clause 2.4.1.1.1.1	Shall be at least 4*
MaxFontCharacters	NTCIP 1203 Clause 2.4.1.1.1.3	Shall be at least 127**

*Upon delivery, the first font shall be a standard 18" font. The second font shall be a double-stroke 18" font. The third font shall be a 28" font. The fourth font shall be empty.

**Upon delivery, the first three font sets shall be configured in accordance with the ASCII character set for the following characters:

- "A" thru "Z"- All upper case letters.
- "0" thru "9"- All decimal digits.
- Space (i.e., ASCII code 0x20).
- Punctuation marks shown in brackets [. , ! ? - ‘ ’ “ ” / ( )]
- Special characters shown in brackets [# & * +< >]

(f) DMS Configuration, as defined in NTCIP 1203.

(g) MULTI Configuration, as defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

Table 8: Modified Object Ranges for the MULTI Configuration Conformance Group

Object	Reference	Project Requirement
DefaultBackgroundColor	NTCIP 1203 Clause 2.5.1.1.1.1	The DMS shall support the following background colors: black
DefaultForegroundColor	NTCIP 1203 Clause 2.5.1.1.1.2	The DMS shall support the following foreground colors: amber
DefaultJustificationLine	NTCIP 1203 Clause 2.5.1.1.1.6	The DMS shall support the following forms of line justification: left center right full
defaultJustificationPage	NTCIP 1203 Clause 2.5.1.1.1.7	The DMS shall support the following forms of page justification: top middle bottom
defaultPageOnTime	NTCIP 1203 Clause 2.5.1.1.1.8	The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds
defaultPageOffTime	NTCIP 1203 Clause 2.5.1.1.1.9	The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds
defaultCharacterSet	NTCIP 1203 Clause 2.5.1.1.1.10	The DMS shall support the following character sets: eightBit

(h) Default Message Control, as defined in NTCIP 1203

(i) Pixel Service Control, as defined in NTCIP 1203

(j) MULTI Error Control, as defined in NTCIP 1203

(k) Illumination/Brightness Control, as defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

Table 9: Modified Object Ranges for the Illumination/Brightness Control Conformance Group

Object	Reference	Project Requirement
dmsIllumControl	NTCIP 1203 Clause 2.8.1.1.1.1	The DMS shall support the following illumination control modes: photocell timer manual
dmsIllumNumBrightLevels	NTCIP 1203 Clause 2.8.1.1.1.4	Shall be at least 16

(l) Auxiliary I/O

(m) Scheduling, as defined in NTCIP 1203. The following list indicates the modified object requirements for this conformance group.

Table 10: Modified Object Ranges for the Scheduling Conformance Group

Object	Reference	Project Requirement
NumActionTableEntries	NTCIP 1203 Clause 2.9.1.1.1.1	Shall be at least 21

(n) Sign Status, as defined in NTCIP 1203

(o) Status Error, as defined in NTCIP 1203

(p) Pixel Error Status, as defined in NTCIP 1203

(q) Fan Error Status, as defined in NTCIP 1203

(r) Power Status, as defined in NTCIP 1203

(s) Temperature Status, as defined in NTCIP 1203

Install necessary hardware for the support of items q, r, and s above.

Table 11: Some Optional Object Requirements

Object	Reference	Project Requirement
DefaultFlashOn	NTCIP 1203 Clause 2.5.1.1.1.3	The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds
DefaultFlashOff	NTCIP 1203 Clause 2.5.1.1.1.4	The DMS shall support the full range of these objects with step sizes no larger than 0.5 seconds
DmsMultiOtherErrorDescription	NTCIP 1203 Clause 2.7.1.1.1.20	If the vendor implements any vendor-specific MULTI tags, the DMS shall provide meaningful error messages within this object whenever one of these tags generates an error.

vi. Documentation

Software shall be supplied with full documentation, including a CD-ROM containing ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format:

- The relevant version of each official standard MIB Module referenced by the device functionality.
- If the device does not support the full range of any given object within a Standard MIB Module, a manufacturer specific version of the official Standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro. The filename of this file shall be identical to the standard MIB Module, except that it will have the extension ".man".
- A MIB Module in ASN.1 format containing any and all manufacturer-specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.
- A MIB containing any other objects supported by the device.

The manufacturer shall allow the use of any and all of this documentation by any party authorized by the Procuring Agency for systems integration purposes at any time

initially or in the future, regardless of what parties are involved in the systems integration effort.

B. NTCIP Acceptance Testing

The NTCIP requirements outlined above shall be tested thoroughly by one of the firms listed in the section titled "Testing" of these Project Special Provisions. The Contractor shall submit to the Engineer for approval a portfolio of the selected firm. This shall include the name, address, and a history of the selected firm in performing NTCIP testing along with references. The Contractor shall also provide a contact person's name and phone number. The Contractor shall submit detailed NTCIP testing plans and procedures including a list of hardware and software to the Engineer for review and approval forty (40) days in advance of a scheduled testing date. These test documents shall be developed by the selected firm based on the NTCIP requirements of these Project Special Provisions. The acceptance test will use the NTCIP Exerciser, and/or other authorized testing tools and will follow the guidelines established in the ENTERPRISE Test Procedures. The test shall be conducted by the firm in North Carolina on the installed system at the presence of the Engineer. The results of the test shall be documented and certified by the firm and submitted by the Contractor to the Engineer for review and approval. In case of failures, the Contractor shall remedy the problem and the Firm retest in North Carolina. This process will continue until all failures are resolved. The Department reserves the right to enhance these tests as deemed appropriate to ensure device compliance.

C. NTCIP Submittal

Project-specific NTCIP manual shall be included in the list of deliverables that thoroughly documents the details associated with the various NTCIP options and features in the system.

D. Operational Field Test

Conduct an Operational Field Test of each DMS system installed on the project to exercise the normal operational functions of the installed operational field equipment. The Operational Field Test will consist of the following tests as a minimum:

1. Physical Examination

Test per section "Physical Examination" above.

2. Continuity Tests

Test per section "Continuity Tests" above.

3. Functional Tests

Perform the following functional tests:

- NTCIP exerciser/other testing on the assembled DMS system.
- Start-up and operation of the DMS locally using a laptop computer.
- Use automatic (photo-electric sensor controlled), DMS Control Software to switch between "dim", "normal", and "bright" light levels.
- Operation of the DMS with all display elements flashing continuously for 10 minutes at the maximum flash rate.

- Exercise the DMS by displaying static messages, flashing messages, and alternating static and flashing message sequences.
- Automatic polling of the DMS by the Control Software at various intervals and verification of data received by Control Software from DMS.
- Downloading and editing messages using Control Software.
- Execute status request on the DMS controller.
- Normal operations during uploading and downloading.
- Display two-phase flashing message sequence of 45 characters.
- Selection of messages from the sign controller's local control panel.
- Test sequence activation at chosen intervals.
- Display and verification of all stored messages.
- Resumption of standard operation upon interruption of electrical power.
- Demonstration of the Failure Detection and Response functions.
- Demonstrate proper operation of the Failure Log.
- Set controller clock using the Control Software.
- Execute system shutdown using first the Control Software and local control panel.
- Detection of power failure in the DMS enclosure and reporting of such failure to the Control Software.

Approval of Operational Field Test results does not relieve the Contractor to conform to the specifications in these Project Special Provisions. If a system does not pass its test, either document a correction or substitute a new unit as approved by the Engineer. Re-test the system until it passes all requirements.

15.4 CONSTRUCTION METHODS

Conduct and provide test for approval by the Engineer. The Engineer or a designated representative reserves the right to witness all tests.

15.5 METHOD OF MEASUREMENT

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

Payment for this work will be covered in the applicable sections of these Project Special Provisions at the contract unit price for "Dynamic Message Sign "DMS - __" and will be full compensation for all work listed above.

15.6 BASIS OF PAYMENT

None specified.

16. OVERHEAD DYNAMIC MESSAGE SIGN ASSEMBLY

16.1 DESCRIPTION

This section includes all design, fabrication, furnishing, and erection of each overhead Dynamic Message Sign (DMS) assembly; maintenance walkway for access to the DMS inspection door; and attachment of the DMS enclosure to the structure in accordance with the requirements of the plans and the provisions of this specification. Fabricate the supporting DMS assembly from tubular steel. The DMS assembly shall be full span (minimum of two vertical supports) with a boxed truss.

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

Where the Standard Specifications or plans require the design of an overhead sign assembly, including footings, submit design computations and shop drawings to the Engineer for acceptance. A Professional Engineer that is registered in the state of North Carolina will prepare such computations and drawings. These must bear his signature, seal, and date of acceptance.

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

Design, furnish and install, three (3) new DMSs as listed below:

- One (1) new overhead DMS assembly spanning all northbound and southbound lanes at I-95 just north of the Highway Patrol Station near the intersection of Dawn Drive and Nelson Way. **Design this overhead DMS assembly to support the proposed southbound DMS plus a future northbound DMS.**
- One (1) new overhead DMS assembly spanning the westbound lanes at US 74 approximately 2 miles (3.22 Km) east of NC 41.
- One (1) new overhead DMS assembly spanning the eastbound lanes on new US 74 at Station 86+00.

16.2 MATERIAL

Use materials that meet the requirements of Division 10 of the Standard Specifications shown below:

Structural steel	Section 1072 and 1096
Class A concrete	Section 1000
Steel bar reinforcement	Section 1070
Anchor bolts	Article 1072-6
Joint sealer	Article 1028-2
Zinc-rich paint	Article 1080-9
High strength bolts, nuts, and washers	Sub-article 1094-1 (A)

16.3 CONSTRUCTION METHODS

A. General

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

Do not weld, cut, or drill in any manner in the field unless approved by the Engineer.

Drill bolt holes and slots to finished size or you may punch them to finished size, provided the diameter of the punched holes is at least twice the thickness of the metal being punched. Do not flame cut bolt holes and slots.

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

B. Shop Drawing

Submit to the Engineer for approval a complete design for each overhead DMS assembly, including footings, sign assembly hardware, brackets for supporting the signs and the maintenance walkway. Base the design on the line drawings and wind speed shown in the plans and in accordance with the "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals".

The manufacturer of the overhead DMS assembly must coordinate with the manufacturer of the DMS to ensure that the sign and the sign structure are totally compatible, operational, and functional as a working unit.

To ensure the correct attachment of the DMS enclosure, submit plans and designs for both the DMS system and the DMS assembly to the Engineer to transmit to the Signing Engineer and Structures Engineer for approval and acceptance. Resolve discrepancies and conflicts arising from non-compatibility of either the assembly or the DMS enclosure through coordination between the structure designers and the sign designers.

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

The Engineer is responsible for evaluation, approval, and final acceptance of all DMS System, software, testing, and training submittals.

Allow a minimum of 50 days for shop drawing approval after the Engineer receives them. If revised drawings are necessary, allow appropriate additional time for review and approval of final shop drawings.

Approval of shop drawings by the Engineer will not relieve the Contractor of his responsibility for the correctness of drawings, or for the fit of all shop and field connections and anchors.

C. Design and Fabrication

1. Overhead Dynamic Message Sign Assembly

Fabricate the overhead DMS assembly in accordance with the details shown in the approved shop drawings and with the requirements of these Project Special Provisions.

Overhead DMS assembly dimensions shown in the plans were estimated from available project data for bid purposes. The Engineer will determine the actual dimensions from field measurements and DMS enclosure dimensions provided by the enclosure fabricator and will furnish revised plans. You may use a truss design for horizontal components of the supporting structures for the DMS enclosure. Provide permanent camber in addition to dead load camber in accordance with the "Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals". Indicate on the shop drawings the amount of camber provided and the method used in the fabrication of the assembly to obtain the camber.

Attach the overhead DMS assembly to concrete foundations by the use of galvanized anchor bolts. Furnish anchor bolts with galvanized nuts, flat washers and lock washers. Provide anchor bolts that have a right angle bend or anchor plate with a nut at the end you embed in concrete.

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

2. Maintenance Walkway

Provide a maintenance walkway, a minimum of 36" (914mm) wide with an open skid-resistant surface and safety railings, on the overhead DMS assembly for access to the DMS inspection door unless specifically stated otherwise in the plans. Provide a maintenance walkway that extends from the DMS inspection door to 3 feet (0.9 meter) over the edge of shoulder. Position the walkway so that there is no opening greater than 10" (254mm) that is unprotected. Provide walkways with fixed safety railings along both sides from the beginning of the walkway to the inspection door. When not in use, the safety railing may remain in a permanent upright position.

Connect the walkway sections rigidly where sections join to avoid an uneven walking surface. Attach the walkway directly to the walkway brackets.

Install a 4"x 4" (100 mm x 100mm) safety angle parallel to and along both sides of the walkway and extend it the entire length of the walkway. Design the safety angle to withstand loading equivalent to the walkway.

Provide a walkway in which the open ends have a galvanized steel coil safety chain attached on one end near the top of the safety railing, and on the other end to the walkway hanger, or other fixed member of the structure.

3. Footings for Overhead Dynamic Message Sign Assembly

Design footings for the combined effects of dead and wind loads; use either spread type or pole type as specified in the project plans. Design spread footings for a maximum soil bearing of 3 ksf (145 KPa) 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 (145 KPa) 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" (150 mm) layers. Remove all unneeded excavated material from the site.

Construct footing excavations for overhead 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 overhead DMS assembly in accordance with Section 825. Construct all footings of Class A concrete. Where rectangular forms are used, use forms with a chamfer strip at all corners for at least that distance protruding above ground level. Use a chamfer which measures 1" (25mm) 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 overhead DMS assembly on footings until the concrete has reached a minimum compressive strength of 3000 psi (20.64 Mpa). Determine concrete compressive strength by non-destructive test methods, or by compressive strength tests made in accordance with AASHTO 2001, 4th edition. Furnish equipment used for non-destructive tests and obtain Engineer approval.

D. Location

The Engineer will establish the location of the overhead DMS assembly longitudinally.

16.4 METHOD OF MEASUREMENT

The work covered by this section includes all design, fabrication, construction, transportation, and attachment of the complete overhead dynamic message sign assembly, supporting structure, hardware, maintenance walkway, footings, direct tension indicators specified in the section titled "DMS Direct Tension Indicators", preparing and furnishing shop drawings, additional documentation, incidentals, and all other equipment and features necessary to furnish the system described above.

16.5 BASIS OF PAYMENT

The Overhead Dynamic Message Sign Assembly, measured as provided above, will be paid for at the contract lump sum price per overhead assembly for "Overhead Dynamic Message Sign "DMS-__"".

Payment will be made under:

Overhead Dynamic Message Sign Assembly "DMS-1"..... Lump Sum

Overhead Dynamic Message Sign Assembly "DMS-2"..... Lump Sum

Overhead Dynamic Message Sign Assembly "DMS-3"..... Lump Sum

17. DMS DIRECT TENSION INDICATORS

17.1 GENERAL

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

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

17.2 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.

17.3 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.

17.4 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.

17.5 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 (690 KPa) 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" (0.125 mm) 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.

17.6 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 "Overhead Dynamic Message Sign Assembly "DMS-__" and will be full compensation for all work listed above.

17.7 BASIS OF PAYMENT

None specified.

18. TRAINING

18.1 DESCRIPTION

Provide training courses covering the operation and maintenance of the equipment being supplied as part of the system. Train Department personnel to properly operate, maintain, and troubleshoot each piece of equipment and software within the system. Provide training for a minimum of fifteen (15) Department personnel. Provide training for DMSs, CCTVs, video encoders/decoders, and video multiplexers. Provide training for each of the following categories and for the minimum number of hours shown:

DMS operation.....4 Hours

DMS troubleshooting and repair.....12 Hours

CCTV Operation.....4 Hours

CCTV troubleshooting and repair.....8 Hours

Video Encoder operation.....2 Hours

Video Encoder troubleshooting and repair.....4 Hours

Video Multiplexer operation..... 1 Hour

Video Multiplexer troubleshooting and repair.....2 Hours

Each category shall consist of demonstration and hands-on activities. All training courses shall be conducted at a Contractor provided location within the time mutually agreed upon by the Engineer and the Contractor. Provide documentation for up to 15 attendees. Provide 15 copies of the approved course materials at least 14 days in advance of the scheduled course. Training course shall not exceed 8 hours on any given day.

18.2 MATERIAL

The Contractor shall provide qualified instructors and training material in order to present formal classroom as well as "hands-on" user training in the operation, maintenance, and troubleshooting of the equipment being supplied as part of the system. Manufacturer's representatives, or personnel approved by the Engineer, shall conduct the training course. Particular attention shall be given to precautions that must be observed in operating the equipment. Training courses shall be required for both the control center elements and field elements of the system.

The training material generated for each course shall contain "hand-outs" for each attendee, which shall serve not only as subject guidance, but also as quick reference material for future use by the students. All course material, in reproducible form, shall be delivered to the Engineer immediately following course completion. In addition to on-site training, provide the required training on VHS videotape. All tape shall be labeled, noting at a minimum the date of the course and title of the course.

At least 40 days prior to commencement of the training course submit to the Engineer detailed course curricula, draft manuals and materials, and resumes of the instructor(s). Provide training for each of the following categories and for the minimum number of hours shown:

DMS.....16 Hours

CCTV ..... 8 Hours

Ethernet Switch ..... 4 Hours

Video Encoder ..... 4 Hours

Video Multiplexer ..... 2 Hours

Under each category, address the following topics as a minimum:

- Theory of operation
- Installation
- Operation
- Preventative maintenance of equipment
- Trouble shooting and equipment diagnostics
- Integration of equipment with wireless transmission systems, field hardware, central hardware, and software components.

18.3 METHOD OF MEASURMENT

This work shall include providing instructors, visual aid materials, documentation materials, VHS video taping of courses and other items required for the specified training. The work shall also include, but not be limited to, furnishing all labor, instructional materials (including sample equipment), room rental, transportation and expenses of Contractor personnel and providing other incidentals as necessary to prepare and conduct the training sessions.

18.4 BASIS OF PAYMENT

Payment will be made under:

Training ..... Lump Sum

19. SYSTEM SUPPORT EQUIPMENT

19.1 DESCRIPTION

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

19.2 MATERIAL

A. General:

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

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

B. System Support Equipment:

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

- One (1) DMS Controller
- One (1) CCTV Camera Assembly
- One (1) Video Multiplexer
- One (1) Video Encoder
- One (1) Video Decoder
- One (1) Video/PTZ System
- One (1) Ethernet Switch
- One (1) Video Signal Testing Kit
- One (1) CCTV Test Monitor

C. Video Signal Testing Kit:

Furnish video signal test equipment that will allow the determination and quantification of video signal quality using but not limited to the metric of signal-to-noise ratio at the receive end of the video circuit. Furnish video signal testing equipment as described below.

1. Handheld Scope/Meter

Provide handheld scope/meters with the following characteristics:

a. Overall:

- Less than 4.5 lbs.
- Size approximately 10 inches(L) by 6 inches(W) by 3 inches(D)
- Battery life of 4 hours using rechargeable NiCad batteries
- AC adapter/battery charger

- Optically isolated RS-232 interface/adapter for connection to laptop PC or serial printer
- Printer drivers including HP LaserJet, DeskJet, and Epson FX/LQ

b. Features:

- Operates selectably in "scope mode'" and in "meter mode"
- Sampling rates of 100 MHz and 5 GS/s
- Automatic set-up function for minimum 40 frequently used measurements
- Storage and recall functions for up to 70 storage locations (40 set-ups, 20 waveforms and 10 screens)
- Video triggering for NTSC video
- Eight bit vertical resolution (256 levels)
- Accuracy of ± 2 percent + 1 pixel

c. Accessories:

- All appropriate probe accessories
- Hard carrying case

2. Waveform Monitor/Vector Scope

Furnish one (1) combination waveform monitor/vector scope unit designed to view video signal waveforms with the following characteristics:

a. Overall:

- Weight less than 15 lbs.
- Size approximately 6 inches(H) by 10 inches(W) by 2 inches(D)
- 120 VAC and 12 VDC @ 3.5 amps adapter
- High-brightness CRT display with non-glare contrast filter, approximately 3 inches by 4 inches
- Internally etched graticule

b. Features:

- Operates selectably in "waveform monitor mode'" and in "vector scope mode"
- Three composite loop through inputs with any input as a selectable reference
- Displays waveform parade of overlay of 3 waveforms and 3 filters, vector overlay of 3 inputs, combination of vectors overlaid and waveforms paraded and/or overlaid simultaneously.
- Display up to twelve filters simultaneously
- Stores and defines minimum of 4 user-defined front panel set-ups
- Flat, Low Pass and Chroma filters

c. Accessories:

- Portable case with extendable sun hood and 20 degree folding stand

3. Video Signal Generator

Furnish one (1) hand held video signal generator to generate a known, stable video source for the testing of transmitted video signal quality. Furnish video signal generator with the following characteristics:

a. Video Input Formats

- NTSC
- PAL

b. Patterns

- 16 Built-in including:
- color bars
- gray bars
- linearity (crosshatch)
- flat white screen
- crosshatch with dots
- 80 dots
- 16 gray levels
- 16 colors

c. Horizontal Timing

- Frequency: 1 KHz – 130 KHz
- Total pixels: 144 to 4096
- Active range: 16 to 4096 pixels

d. Vertical Timing

- Frequency: 1 Hz – 650 Hz
- Active lines: 1-4096
- Sync types: Separate, digital/analog, composite
- Scan types: Progressive, interlace

e. Video Outputs

- NTSC/PAL: BNC
- Timing accuracy: 2%

f. User Interface

- Display: 20x4 Char. LCD/Backlight

- LCD select: buttons next to LCD for selection of formats, images, and tests
- Function: 9 button, menu driven
- Arrows for page screen up and down

g. Computer port

- Type: RS-232C
- Communication Rates: 300-19,200 bps
- Handshake: none, Xon/Xoff
- Connector: 9 pin D-Sub receptacle
- Download: Copy formats and firmware updates

h. Power

- DC: 4 – AA Batteries

i. Weight

- 8 oz.

j. Size

- 4 in x 6 in x 1.5 in

k. Model Number

- Quantum Data Model 607 or approved equivalent

D. CCTV Test Monitor:

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

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

Display	4" (100 mm) Liquid Crystal Display, active matrix
Input Signal	2 NTSC inputs
Color	Full Color or Black and White
Picture Elements	480 (H) x 234 (V)
Dot Pitch	0.171 (W) x 0.264 (H)
Back Light	Built In
Controls	Color, brightness, on/off, tint, red & blue drive
Supply voltage	12 VDC, 500mA
Connectors	Switchable video – BNC; Power – DC jack
Operating Temperature	32° F to 104° F (0° C to 40° C)
Dimensions (maximum)	5.5" (W) x 3.6" (H) x 1.8" (D) (140 mm x 91 mm x 46 mm)
Weight (maximum)	1 lbs. (0.45 kg)

Include 12 feet (3.6 m) of power and video cables with the monitor and case. Furnish monitor with all equipment necessary to operate from 120 VAC power source.

19.3 METHOD OF MEASUREMENT

Actual number of DMS Controllers furnished and accepted.

Actual number of CCTV Camera Assemblies furnished and accepted.

Actual number of Video Multiplexers furnished and accepted.

Actual number of Video Encoders furnished and accepted.

Actual number of Video Decoders furnished and accepted.

Actual number of Video/PTZ Systems furnished and accepted.

Actual number of Ethernet Switches furnished and accepted.

Actual number of Video Signal Testing Kits furnished and accepted.

Actual number of CCTV Test Monitors furnished and accepted.

19.4 BASIS OF PAYMENT

The quantity of DMS Controllers, measured as provided above, will be paid for at the contract unit price each for "Furnish DMS Controller".

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

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

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

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

The quantity of Video/PTZ Systems, measured as provided above, will be paid for at the contract unit price each for "Furnish Video/PTZ System".

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

The quantity of Video Signal Testing Kits, measured as provided above, will be paid for at the contract unit price each for "Furnish Video Signal Testing Kit".

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

Payment will be made under:

Furnish DMS Controller ..... **Each**

Furnish CCTV Camera Assembly ..... **Each**

Furnish Video Multiplexer ..... **Each**

Furnish Video Encoder ..... **Each**

Furnish Video Decoder ..... **Each**

Furnish Video/PTZ System ..... **Each**

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

Furnish Video Signal Testing Kit ..... **Each**

Furnish CCTV Test Monitor ..... **Each**