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PROJECT SPECIAL PROVISIONS

I-85/I-40 HILLSBOROUGH WEIGH STATION UPGRADE

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1. GENERAL REQUIREMENTS

1.1 DESCRIPTION.

A. General:

These Sections of the Project Special Provisions consist of the requirements for the weigh station upgrade work and are generally written in the imperative mood. In sentences using the imperative mood, the subject, "the Contractor," is implied. Also implied in such language is "shall," "shall be," or similar wording and phrases. In material specifications, the subject may also be the supplier, fabricator, or manufacturer supplying the material, products, or equipment for use on the project. The Engineer shall be as defined in the NCDOT Standard Specifications for Roads and Structures.

In as much as the segment of I-85/I-40 contained within the project limits runs primarily in an east/west direction, the westbound I-40 / southbound I-85 weigh station and scale house are referred to in these Project Special Provisions as the "westbound" weigh station. Similarly, the eastbound I-40 / northbound I-85 weigh station and scale house are referred to in these Project Special Provisions as the "eastbound" weigh station.

Furnish all material, equipment, supplies, labor, and incidentals required to provide a Commercial Vehicle Information Systems and Networks (CVISN) compatible commercial vehicle weigh-in-motion system. Furnish all material, equipment, supplies, labor, and incidentals required to enable the monitoring and control of a full-motion video closed circuit television (CCTV) camera system from both the existing Hillsborough westbound and eastbound weigh stations. Install communications cable and devices to communicate between all devices contained within the new system. Integrate the components of this project into a full and completely operational "system" in conformance with the Contract Documents.

Where the Project Special Provisions describe portions of the work in general terms, but not in complete detail, it is understood that only the best general practice is to prevail and that only materials and workmanship of the first quality are to be used. Unless otherwise specified, furnish all labor, materials, tools, equipment, and incidentals, and do all work involved in executing the Contract in a satisfactory and workmanlike manner. Unless otherwise specifically noted, perform all of the work explicitly or implicitly required by the Contract Documents.

Conform to these Project Special Provisions, the Plans, NCDOT Roadway Standard Drawings, the Manual on Uniform Traffic Control Devices (MUTCD), and the 2002 NCDOT Standard Specifications for Roads and Structures, hereinafter referred to as the "Standard Specifications". The Standard Specifications may be found at:

http://www.doh.dot.state.nc.us/preconstruct/highway/dsn_srvc/specifications

The current edition of these specifications and publications in effect on the date of advertisement, and all addenda shall apply. Materials and work described in these Project Special Provisions apply in addition to the requirements of the Standard Specifications. If there is any conflicting information between the Contract Documents, the order of precedence (in descending order) shall be as follows:

1. Project Special Provisions

2. Project Plans

3. Standard Special Provisions
4. Standard Specifications
5. Standard Drawings
6. QPL

Compliance with the operational and technical specifications of these Project Special Provisions pertaining to individual elements of the work does not in itself constitute compliance with the requirement to provide a complete, fully functional, integrated system.

B. System Description:

Furnish and install as part of the CVISN Upgrade of the Hillsborough Weigh Station: Weigh-In-Motion (WIM) equipment, Automatic Vehicle Identification (AVI) Equipment, vehicle classification equipment, enforcement cameras and weigh station computer software. Furnish and install a fiber optic communications network consisting of multimode fiber optic cable. Make modifications to the existing weigh station computers and peripherals to integrate new equipment with the existing weigh station equipment. The final product of the work shall be a fully operational and integrated CVISN-compatible weigh station at the westbound Hillsborough Weigh Station.

C. Required System Operations:

Provide under this Contract a fully operational and integrated commercial vehicle processing system. All subsystems, including the new subsystems described in these Project Special Provisions and the existing static scales, lane control signals, ramp weigh-in-motion and classification equipment and communications networks must be compatible with each other and must be integrated into a working system. Configure the completed system in such a manner that failure of the proposed mainline WIM scale shall not interfere with the operation of the existing ramp WIM scales and vice versa. Further, the failure of any one or more components of the westbound weigh station subsystem shall not affect the operation of the eastbound weigh station subsystem, and vice versa. The two weigh station operations shall be completely independent of one another. The only shared component shall be a common connection to the Department's wide area network (WAN).

Note that this project entails major modifications to a working system whose operation cannot be interrupted for more than a total of 20 days. To minimize the risk of impairing operation of the weigh station, the Contractor is required to conduct elaborate testing of the new equipment and software at his facility. (See the section, "Testing and Acceptance").

The required operations of the new, fully integrated system provided under this Contract for the westbound Hillsborough Weigh Station are based on processing transponder equipped vehicles; meeting weight and credentials criteria, while the vehicle is traveling on the Interstate. Vehicles meeting the aforementioned criteria will be allowed to bypass the weigh station, thus ensuring greater efficiencies for both the commercial vehicle and the weigh station. Vehicles not meeting the criteria will be processed at the weigh station.

The new CVISN equipment for the westbound Hillsborough Weigh Station can be described as a series of locations that process and communicate with commercial vehicles as the vehicles travel on westbound I-40 / southbound I-85. These locations include:

- Advance Location,
- Notification Location, and
- Compliance Location.

1. Advance Location:

The Advance Location shall consist of an automatic vehicle identification (AVI) reader and antenna, weigh-in-motion scales and electronics, an overheight vehicle detector, a freeze-frame CCTV camera, vehicle classification equipment and associated roadside electronics and communications equipment. The vehicle classification equipment shall consist of inductive loops and piezoelectric sensors. Locate the Advance Location equipment in the two right-most lanes as shown on the Plans.

2. Notification Location:

The Notification Location shall be comprised of an AVI reader and antenna, and associated roadside electronics and communications equipment.

3. Compliance Location:

The Compliance Location shall consist of an AVI reader and three antennae, inductive loops and piezoelectric sensors, a freeze-frame CCTV camera and associated roadside electronics and communications equipment. The inductive loops and piezoelectric sensors will be located in the two right lanes on the Interstate as shown on the Plans.

4. Other Equipment:

In addition to the equipment located at each of the mainline Interstate locations, supply a video surveillance system at the Efland interchange and central control equipment at the existing scale houses. The video surveillance system shall consist of a full-motion video closed-circuit television (CCTV) camera installed at the interchange as shown on the Plans. The video from this CCTV camera shall be transmitted to the westbound scale house. Install a video switch/camera controller and desktop video control panel in the westbound scale house. Replacement cameras for the two existing cameras adjacent to each scale house shall also be installed. The new, existing and replacement cameras; new and existing desktop control panels; and the new video switch/camera controller will all be integrated to allow control and viewing of all cameras from both scale houses. The CCTV camera system will be used by scale house operators to identify commercial vehicles that are attempting to bypass the weigh station via parallel routes.

Integrate with the central control equipment, a vehicle sorting computer, operator computers, communications equipment, and printing equipment to allow system operators to process commercial vehicles. The central control equipment shall allow operators to view, control and process commercial vehicles using the new equipment installed under this Contract, and existing equipment at the weigh station.

D. Processing of Commercial Vehicles:

The following scenario describes how commercial vehicles will be processed.

All trucks approaching the weigh station will be directed into the right hand lane by means of static signing located prior to the Advance Location.

As a truck first passes over the equipment at the Advance Location, the equipment in the right-most lane will collect axle weight and spacing, gross vehicle weight, vehicle speed, classification, vehicle length, and overheight data. If the vehicle is equipped with an AVI transponder, the AVI transponder's unique identification number is read. All of the data is then sent to the Sorting Computer for processing and database lookup. If the truck is in the lane immediately to the left of the WIM lane, the loops and piezoelectric sensors detect the truck and an alarm is activated in the station to alert operators that the truck was not weighed with the mainline WIM equipment, and was not processed by the AVI. System operators will define internal processes for handling these vehicles.

The freeze-frame CCTV camera located at the Advance Location captures images of trucks in the right lane as they travel past the location. Images of trucks that are not pre-cleared at the Notification Location are transmitted with the vehicle record (i.e. weight, vehicle length, overheight indication, AVI data, etc.) to the scale house computer.

At the Notification Location, vehicles equipped with AVI transponders are sent a message via the Notification Location's AVI system as to whether the vehicle has been pre-cleared, based on weight, credentials and other criteria, to bypass the weigh station. The pre-clearance criteria are identified in the section, "Central Computer Software" of these Project Special Provisions. If a commercial vehicle is pre-cleared, a message is sent to the truck's transponder, which activates a green light on the transponder. If the weight or credentials need to be checked further, or the truck is selected for random inspection, a message is sent via the AVI system to activate a red light on the truck's transponder.

If the truck's transponder receives a green light, it proceeds along the Interstate passing under the Compliance Location's AVI antenna, which verifies that the truck was pre-cleared to bypass the station. The Compliance Location freeze-frame CCTV camera captures images of non-compliant trucks in the right-hand lane that were not pre-cleared. When non-compliant trucks are detected, an alarm message is sent to the operator computers at the scale house. The image of the truck is transferred to the scale house operator computer display where operators can view the image.

If a truck is not pre-cleared, then it is required to report to the scale house. The existing WIM scale, loops and sensors located on the station ramp detect that a truck has entered the weigh station and match the truck record to the Advance Location record. The new AVI reader on the ramp will also be used for this matching. The scale house operator uses the information from the Advance Location, displayed on the operator computer display, to identify why a truck was required to report to the station (i.e. no transponder, credentials check, weight check or random pull-in), and processes the truck accordingly. All AVI-equipped trucks that are not bypassed by the mainline CVISN equipment will automatically be directed to report to the scale house, where they are weighed on the static scales and inspected.

1.2 MATERIALS.

A. General:

Unless otherwise stated in these sections of the Project Special Provisions, furnish new equipment, materials, and hardware that meets the requirements of the Standard Specifications.

Permanently write the manufacturer's name, model number, serial number, and any additional information needed for proper identification on each piece of equipment housed in a case or housing.

B. Qualified Products List:

The Department has a signal equipment Qualified Products List (QPL) available for the Contractor's use. The QPL web site is:

http://www.doh.dot.state.nc.us/preconstruct/traffic/tmssu/sms/qpl/

Where a piece of equipment is covered by the QPL, only equipment listed in the QPL may be used unless approved by the engineer.

C. Computer System Hardware and Software

Install and integrate computer hardware and software in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

D. Software Requirements:

Ensure that all Contractor-furnished equipment, including pieces and components of equipment, hardware, firmware, software, middleware, internal components, and subroutines which perform any date or time data recognition function, calculation, or sequencing will support a four digit year format for a period of at least 35 years.

Provide proof of all software licenses required to be installed as part of this project, including but not limited to any supporting software licenses that may be required.

E. Firmware Licensing and Upgrades:

Provide the Department with backups of the WIM computer operating system, application programs, data files and any other element necessary to restore any of the WIM computers to normal operation after repair or replacement. Provide this material on diskette or other approved media. Include instructions for restoring the software and data.

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

Software upgrades that are developed to correct operating characteristics shall be available to the Department at no additional cost until the warranty period expires.

F. Wire and Cable:

Furnish wire and cable on reels. When requested, furnish samples of the wire and cable at no additional cost for inspection and testing.

G. Surge Protection:

Equip every ungrounded conductor entering a cabinet and the scale house with a surge protector meeting the requirements of these Project Special Provisions and Section 1098 of the Standard Specifications.

H. Painting:

Where painting of cabinets, poles, and pedestals is required, apply paint at the factory. No field painting shall be allowed except when the paint on portions of equipment has been scratched or marred. In such cases, apply two field coats of enamel of the same color and grade as the original paint to the scratched or marred portions.

I. Environmental Conditions:

Equipment shall continue to operate as specified under the following ranges of environmental conditions, except as noted in the Standard Specifications and these Project Special Provisions for individual pieces of equipment:

1. Outdoor equipment:

Equipment that is not in a heated and air conditioned environment shall meet the temperature and humidity requirements of -40° F to 140° F. Liquid crystal displays shall be undamaged by temperatures as high as 165° F, and shall produce a usable display at temperatures up to 122° F.

2. Indoor equipment:

Equipment in a heated, air conditioned environment shall operate normally at any combination of temperature between 50° F and 104° F, and humidity between 5 percent and 90 percent, non-condensing, and with a temperature gradient of 40° F per hour.

3. Conductors, pins and circuit boards:

All conductive connector pins (except pins connected by soldering), and socket contacts shall be gold plated.

4. Vibration and shock:

The equipment, when packaged in its normal shipping container, shall not be damaged, nor shall the operational performance be degraded after exposure to vibrations of 1g, 15 Hz to 500 Hz, or shocks of 5 g, 10 + 1 milliseconds in each of three mutually perpendicular planes. Camera assemblies and any other equipment mounted atop poles or on structures shall not be impaired by the continuous vibration caused by winds (up to 80 mi/hour) and traffic.

5. Duty cycle:

Continuous.

6. Electromagnetic radiation:

The equipment shall not be impaired by ambient electrical or magnetic fields, such as those caused by power lines, transformers, and motors. The equipment shall not radiate signals that adversely affect other equipment.

7. Operating power:

Operate the equipment on 120 volts, 60 Hz, single-phase unless otherwise specified. Conform to its specified performance requirements when the input voltage varies from 97 to 135 volts and the frequency varies + 3 Hz.

8. High frequency interference:

The equipment operation shall be unaffected by power supply voltage spikes of up to 150 volts in amplitude and ten microseconds duration.

9. Line voltage transients:

The equipment operation shall be unaffected by voltage transients of plus or minus 20 percent of nominal line voltage for a maximum duration of 50 milliseconds. Equipment in the field shall meet the power service transient requirements of NEMA Standard TS-2 when connected to the surge protectors in the cabinets.

10. Protection:

Use readily accessible, manually resettable or replaceable circuit protection devices, such as circuit breakers or fuses, for all equipment and power source protection.

11. Brownouts:

The equipment shall not be damaged when the main power drops to 95 VAC for a period or eight hours. If the equipment does not operate normally at 95 volts, the equipment shall automatically resume normal operation within five minutes after normal power returns.

12. Software and Firmware Source Code Escrow Requirements:

Provide the source code for all software and firmware developed by the Contractor, and which is not commercial off the shelf software provided by other vendors, to a third party escrow agent. If the Contractor is no longer in business or fails to meet the requirements of the warranty provisions of this contract, the Engineer shall have the right to access the source code and to modify the software and firmware.

1.3 CONSTRUCTION METHODS.

A. General:

Unless otherwise stated in these sections of the Project Special Provisions, perform work that meets the requirements of the Standard Specifications and the Plans.

Locate the existing conduit, cable runs, inductive detection loops, lead-in, junction boxes, and detection equipment before installing or using equipment that can damage or interfere with such facilities. The locations of existing inductive detection loops shown on the Plans are approximate.

Locate all underground utilities before beginning drilling, digging, or trenching operations.

Immediately cease work and notify the Engineer and the affected owners if damage to existing utilities, cables, or equipment occurs. Make all required repairs and replacements at no additional cost to the Department.

B. Regulations and Codes:

Furnish material and workmanship conforming to the National Electric Code (NEC), the National Electric Safety Code (NESC), Underwriter's Laboratories (UL), and all local safety codes in effect on the date of advertisement. Comply with Article 4, Chapter 87 of the North Carolina General Statutes (Licensing of Electrical Contractors). Comply with all regulations and codes imposed by the owner of affected utility poles. In the event of a conflict between these documents and the Project Special Provisions contained herein, the cited documents will govern.

Notify the Engineer and local utility company seven business days before operational shutdowns to coordinate connection or disconnection to an existing utility or system.

Install standoffs, meter bases, and service disconnects as required by the NESC, the NEC, local utility companies, and ordinances.

C. Utility Services:

Coordinate all work to ensure that electrical power of the proper voltage, phase, frequency, and ampacity is available to complete the work. Use electrical services cables that have THW insulation.

When electrical and telecommunication service is not furnished by the Department and is required, contact the utility company and make application to ensure that all work can be completed. Obtain authorization for service in the Department's name and make application for service in the Department's name.

The Department will be responsible for direct payment of utility company charges.

D. Removal of Existing Equipment and Material:

Remove all Department-owned communications related equipment and material that will not be used. Return all equipment and material between 8:00 a.m. and noon, Monday through Thursday, to the Traffic Services Office within the Division responsible for administration of the project.

The Department will deduct the cost of Department-owned equipment damaged by the Contractor from money due to the Contractor.

E. Wire and Cable:

For installation in a conduit system, lubricate cable and wires prior to installing in conduit. Use lubricant that will not physically or chemically harm the cable jacket, wire insulation, and conduit.

Splice all electrical wire and cable at recessed-screw, barrier type terminal blocks or in junction boxes.

Maintain color coding of wires through splices.

Protect ends of wire and cable from water and moisture.

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F. Grounding:

Provide a grounding system at all new and revised electrical service points unless otherwise noted.

Provide a length of detectable metallic burial tape at a depth of 1 to 1.5 feet directly over grounding electrodes and conductors.

1.4 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 shall be full compensation for all work covered by this section.

2. DOCUMENTATION

2.1 DESCRIPTION.

All documentation, except as specifically approved by the Engineer, shall be no smaller than 8 1/2 x 11 inches and no larger than 22 x 34 inches. Do not use blue line paper for documentation.

Bind all 8 1/2 x 11-inch documentation, except standard bound manuals, in logical groupings in 3-ring loose-leaf binders or plastic slide-ring, loose-leaf binders. Such binders may also include 11 x 17-inch documentation, if "Z-folded". Permanently and appropriately label each bound grouping of documentation.

For final system documentation that exceeds 11 x 17 inches, furnish good quality, highly legible, reproducible drawings. Reproducible drawings may be vellum, sepias, or photographically created vellums of the original drawings. Provide at least one copy of reproducible drawings. Ensure vellums are 22 x 34 inch and are reverse reading. If smaller drawings exist, place these in the lower left-hand corner of the vellums. Provide either single-matte or double-matte reproducible drawings; however, if single-matte, the text shall read correctly when viewed from the matte side. Do not fold or crease reproducible drawings.

Conform to the following electronic documentation file formats. Provide tables in Microsoft Excel 97 or Microsoft Word 97 file format; provide manuals, reports and other narrative text documents in Microsoft Word 97 file format; and provide drawings in MicroStation format. Provide electronic documentation on a CD-ROM

Provide all literature from manufacturers as original documents or copies equal to originals.

2.2 MATERIALS.

A. Equipment List:

Within four (4) weeks following award of Contract, submit to the Engineer for approval a list of major equipment and materials proposed for use. Provide written certification to the Department that all Contractor-furnished equipment is in accordance with the Plans and Project Special Provisions. Highlight any proposed deviation from the Plans or Project Special Provisions. Such deviations are subject to review of the Engineer. The Engineer may reject any proposed deviations and require the Contractor to supply equipment in accordance with the Plans and Project Special Provisions.

For Contractor-furnished equipment that is listed on the QPL, furnish submittals in the format defined by the QPL.

For Contractor-furnished equipment that is not on the QPL, furnish four (4) copies of a list of the equipment including four (4) copies of catalog cuts. Identify the proposed equipment on the catalog cuts by a reproducible means. Equipment lists must contain the material description, brand name, manufacturer's address and telephone number, stock number, size, identifying trademark or symbol, and other appropriate ratings.

Do not fabricate or order equipment until receipt of the Engineer's approval.

B. Submittal Data:

Prior to the purchase or fabrication of any equipment or material for use on this project, submit for review by the Engineer catalog cut sheets and specifications for all standard, off-the-shelf items, and shop drawings for all custom items. These documents shall contain sufficient technical data for the Engineer to evaluate the system proposed. The quality, function, and capability of each deliverable item shall be described. Furnish original documents or copies equal to originals. Submit shop drawings for each fabricated item, which contain all information required for complete fabrication in accordance with the Contract Documents, such as materials, welds, finish, etc. Furnish shop drawings on sheets 22 inches in height and 34 inches long.

Provide four (4) copies of 8 1/2 x 11-inch submittals, and four copies of shop drawings. One of these will be returned to the Contractor with appropriate notations within forty (40) calendar days.

The purpose of the submittal data is to show specifically and in detail how the Contractor intends to satisfy the requirements of the Contract Documents. If preprinted literature is utilized to satisfy some or all of these requirements, no statements on the literature should conflict with the Contract Documents. Cross off and initial any such statements and attach an appropriate statement clearly indicating how the requirements of the Contract Documents will be fulfilled. Clearly label each item of submittal data with the bid item number or other description of the item(s) to which it applies.

Each submittal must contain sufficient information and details to permit the Engineer to fully evaluate the particular component. Submittals which are, in the judgment of the Engineer, insufficient to permit proper evaluation will not be reviewed. Do not deviate from submittals marked "Approved" or "Approved as Noted" without the prior written consent of the Engineer. The Department will not be liable for any material purchased, labor performed, or delay to the work prior to the approval of the equipment.

Because of the nature of this work, unusually detailed submittal data is required prior to approval of most of the items in order to avoid nonconformance, which does not become apparent until it is too late to correct without serious consequences. In addition, because certain groups of items as set forth below are closely interrelated, it is required that the submittals be made in groups. If more than one submittal is required, complete information from the entire group must be resubmitted. Plan the submittal data effort accordingly.

In order to expedite the submittal data process and equipment review, take care to address all of the requirements of the Contract Documents in the submittal data, leaving nothing to assumption, and clearly addressing the functional and technical interrelationships among the various items. In general, detailed wiring diagrams are not required as part of the submittal data, nor will they be reviewed unless specifically required by these Project Special Provisions or by the Engineer's request.

Submit the data for the items in each of the following groups as an integrated unit:

GROUP A

Weigh-in-Motion Scale

WIM Electronics/Computer

Piezoelectric Sensors

Loop Amplifiers

Loop Detector Lead-in Cables

Loop Detector Splice Kits

Group B

AVI Reader

AVI Antennae

Group C

CCTV Camera Assembly

CCTV Camera Mounts

Video Monitor

Local Video Control Panel

Video Switcher/Camera Controller

GROUP D

Sorting Computer

Operator computer and peripherals

GROUP E

Fiber Optic Cable

Fiber Optic Interconnect Centers

Transceivers

Multiplexers / Demultiplexers

GROUP F

Metal Poles

Mast Arm with Metal Pole

Metal Pole Foundations

The items in each of these groups will be reviewed and approved as an integrated unit. Submittals for items not included in the above groups may be made independently.

Plan for any given package of submittal data to be in the possession of the Engineer for forty (40) calendar days. The Engineer will date stamp the letters of transmittal for all such data and return a copy of the stamped letters to the Contractor with the submittal data for his records. Following review of the submittal data, the Engineer will return to the Contractor one copy of the submittal marked "Approved", "Approved as Noted", or "Rejected". Proceed with any items marked "Approved" and items marked "Approved as Noted". Do not proceed with any items marked "Rejected", but proceed immediately to correct said items and resubmit them for review. No time extensions will be granted to the Contractor as a result of the need to resubmit items for review.

Develop a submittal data transmittal form and submit same to the Engineer for approval as to format. Assign a submittal number to each submittal package, to be transmitted under the cover of the approved form. The numbering system must be logical and ascending. Specifically list on the transmittal sheet each item or element included and the bid item and Special Provision section to which that element belongs. (An element is one part of several parts of information related to the same bid item.) When drawings are submitted, list each separately. Completely fill out all portions of

the transmittal sheet except those reserved for use by the Engineer. The transmittal sheet will be used by the Engineer to indicate the action taken on the submittal package, and a copy of the transmittal sheet showing these actions will be returned to the Contractor. Transmit only clearly related items under the same transmittal sheet.

Approval by the Engineer of a catalog cut sheet and/or shop drawing does not relieve the Contractor of any of his responsibility under the Contract for the successful completion of the work in conformity with the requirements of the Contract Documents in providing a fully integrated operational system.

C. Equipment Documentation:

Supply two manuals for each individual component of the system. The manuals supplied for the off-the-shelf items shall be those supplied by the equipment manufacturer.

Provide maintenance procedures manuals containing detailed preventive and corrective maintenance procedures for each different type or model of equipment.

D. Plans of Record:

A set of full size reproducible plans will be furnished to the Contractor before work begins along with an electronic version in MicroStation (DGN) file format. Mark all changes on them in reproducible red. Provide the Engineer both a hard copy of the red-line markups and an electronic version incorporating the markups. Provide the drawings as MicroStation files MicroStation (DGN) file format compatible with the most recent version of MicroStation. These will constitute the Plans of Record for the project.

Show all construction changes in detail on the Plans of Record sheets, including conduit runs, conduit call outs, junction boxes and the final location and depth of conduits; locations of fiber splice points and fiber optic splicing diagrams; electrical panel boards and wiring diagrams; other wiring external to equipment cabinets; the locations of all field equipment; the final locations of all elements located within the scale house. Correct any errors to the Plans of Record upon review by the Engineer prior to final acceptance of the project.

In every new and modified cabinet, supply a cabinet schematic and a wiring diagram in a weatherproof holder and mounted to the door with stainless steel fasteners. Provide reproducible copies of each to the Engineer. Also provide the Engineer provided with a CD-ROM containing an electronic file with these diagrams.

E. Fiber Optic Cable Documentation:

Prepare Plans of Record fiber assignment diagrams based on those shown in the Plans. Supply a color code to supplement the assignments in the Plans depicting the corresponding color of each fiber and buffer tube. Also prepare a splicing diagram for every cabinet, and the scale house. Additionally, provide a hardcopy of each individual fiber trace and a disk or CD-ROM with the results of OTDR testing of each fiber segment.

F. Software Documentation:

1. Weigh Station Software:

Furnish software manuals for the new weigh station CVISN-compatible system. For each screen, the manual shall explain the controls and parameters that are associated with the screen, including: the acceptable range of parameter values; any default values that may exist; and a procedure for modifying these ranges and default values. Present these screens and messages in logical sequence.

Submit the software manual to the Engineer for approval. Provide five hard copy sets and an electronic copy. The manuals required by this Subsection are in addition to any material given to participants in the operator training course. The System Acceptance Test will not begin until the Engineer has approved the user's manual.

2. Standard Software Packages:

For each standard software package incorporated into the system or used to create software for that system, provide the manuals and other documentation that the software package's vendor normally provides with the product. Deliver standard software packages on CD-ROM. Provide one set of documentation for each computer on which the software is installed.

Provide system software user's manuals that cover the proper use of all applications software furnished for all microcomputers. Ensure user's manuals are written for use by personnel who have no understanding of the operation of a computer system.

G. Operating Procedures:

Prepare a document that describes the proper operating procedures of the system. In addition to describing how an operator interacts with the system, detail the procedures by which the various computer systems are powered up and down and the proper sequence for doing so. Describe in the procedures manual the operation of the system from the perspective of the operator sitting at the operator computer at the scale house. Identify all of the screens and messages, including error messages, which may be seen by the operator. Present the procedures in a logical sequence.

Submit the operating procedures documentation to the Engineer for approval. Provide five hard copy sets and an electronic copy. The System Acceptance Test will not begin until the operating procedures documentation has been approved by the Engineer.

2.3 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 by this section.

3. ELECTRICAL SERVICE

3.1 DESCRIPTION.

Install a new electrical service at locations called out in the Plans. Coordinate all work involving electrical service with the local power company, Duke Power, before any work begins.

3.2 MATERIALS.

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. Run service cables separately to each of the cabinets in 1" rigid metallic conduit (RMC).

Install the service on a new electrical service pole according to Section 1407 of the Standard Specifications. Supply and install conductors as identified in the Plans according to Section 1410 of the Standard Specifications. Coordinate with Duke Power to ascertain the practicality of installing electrical service at each location before performing any work.

3.3 CONSTRUCTION METHODS.

A. Acquisition of Electrical Service:

Contact the local power company and make application to ensure completion of the work. Obtain authorization from the Engineer for power service in the Department's name and make application for service in the Department's name. Assume responsibility for the cost of service acquisition.

The Department will be responsible for direct payment of the monthly use utility bills.

B. Electrical Service:

At locations shown on the Plans, furnish and install electrical service. After installation of the meter base, the local power company will install a new meter and make any connections to the power lines. Ground the new electrical service in accordance with the Plans, Standard Drawings and Standard Specifications.

Furnish and install new external electrical service disconnect (breaker box). Route the electrical service through the meter base and service disconnect to the equipment cabinet to form a complete electrical service assembly. Perform necessary work and supply necessary materials to ensure that the grounding system complies with the Plans, Standard Drawings and the Standard Specifications.

Furnish and install new electrical service poles as required in accordance with Section 1407 of the Standard Specifications.

3.4 METHOD OF MEASUREMENT.

Electrical service will be measured by the number of complete functional electrical service locations furnished, installed and tested. Risers, meter bases, service disconnects, underground and exposed conduit runs, acquisition of service fees, electrical service conductors, service poles, 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.

Actual number of electrical service installations furnished, installed, and accepted.

3.5 BASIS OF PAYMENT.

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

Payment will be made under:

Electrical Service ..... Each

4. UNDERGROUND CONDUIT

4.1 DESCRIPTION.

Furnish and install conduit systems for underground installation with all necessary hardware in accordance with the Plans and Project Special Provisions. Comply with the provisions of Section 1700 of the Standard Specifications.

Furnish conduit for underground installation with backfill, graded stone, paved materials, detectable metallic marker tape, tracer wire, miscellaneous fittings, seeding and mulching, and all necessary hardware.

4.2 MATERIAL

A. General:

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

Refer to Division 10 except as noted herein:

Non-metallic Conduit.....Article 1097-5

Metallic Conduit .....Article 1097-5

Backfill.....Article 1018-2

Graded Stone..... Articles 545-2 and 545-3

Provide schedule 40 non-metallic conduit.

Furnish ½-inch, prelubricated, woven polyester tape, pull line with a minimum rated tensile strength of 2,500 lb.

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.

Furnish "green" insulated Number 14 AWG, THWN, stranded, copper, wire to serve as a tracer wire in conduits containing fiber optic communications cable.

B. Polyethylene Conduit:

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

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

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

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

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

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

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

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 and performance.

4.3 CONSTRUCTION METHODS.

A. General:

Install conduit for underground runs. Clean existing underground conduit that will be incorporated into the new system. 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 alternating cabinets.

In unused/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.

B. Trench and Backfill:

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

Install longitudinal runs of conduit at a minimum of 1 foot from the back of curb or 6 feet from the edge of pavement in the absence of curb.

Remove all rock and debris from backfill material. Remove excess material from the site and compact the excavation.

Place detectable metallic marker tape at a depth of 12 to 18 inches below the finished grade.

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. Tamp backfill material in 6 inch lifts with a mechanical tamp until compact density is at least equal to surrounding density.

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 causing a deviation in the elevation height of the multi-duct 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 multi-duct 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. If damage has occurred, replace the entire length of conduit.

C. Polyethylene Conduit Installation by Directional Drilling:

1. 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 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 below grade. Maintain a minimum clearance of 30 inches 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' horizontal & 4' vertical (clearances greater than minimum horizontal should continue to use the 4V:5H ratio, i.e., 10' horizontal should be no deeper than 8')
Drainage pipes less than 60"	1' above or below (while maintaining a minimum depth of 30" below grade)
Drainage pipes greater than 60"	1' above or 4' below (while maintaining a minimum depth of 30" below grade)
Box Culverts	1' above or 4' below (while maintaining a minimum depth of 30" below grade)
Slope protection	2' below
Slope protection foundation footing	5' 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.

2. 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 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 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 larger than the outer diameter of the ducts) to simultaneously facilitate back drilling of the drill hole and installation of the conduit. The reamer is sized larger than the actual conduits to ensure the conduits are not subjected to extraneous deviations caused by the original drill operation and are as straight as possible in their final position.

The intent of these specifications is to limit the diameter of the actual drill shaft/hole such that it is no more than 2 inches larger than the conduit(s) outer diameter. The 2-inch 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 above concrete surfaces and 4 inches above crushed stone bases.

3. 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% 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.

4. 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.

5. 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.

6. 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.

D. Polyethylene Conduit Installation by Trenching:

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 below finished grade or 6 inches below roadway subgrade, whichever is deeper.

Install longitudinal runs of conduit at a minimum of 1 foot from the back of curb or 6 feet 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. Install the non-detectable marker tape approximately 15 inches 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 above concrete surfaces and 4 inches 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.

E. Polyethylene Conduit Installation by Plowing:

In lieu of trenching, the Contractor may, with approval of the Engineer, install polyethylene conduit by the plowing method at no additional cost to the Department. Perform conduit plowing as follows:

- Direct plow the number of HDPE ducts called for in the plans simultaneously using chute plow method. Direct plow ducts at a minimum depth such that the top of the highest duct is 30 inches 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 duct to the depth called for in these Project Special Provisions. Do not exceed reel dimensions, burial depths, and weight limits called for by the equipment manufacturer. Follow all procedures required or recommended by the equipment manufacturer,
- Provide sufficient personnel to feed chute, operate prime mover and equipment carrying reels (if separate equipment is used), observe chute feeding, observe plowing, and observe reel payout. Use chute with adequate dimensions to allow for passage of duct and cable without damage to either, and
- 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.

F. 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.

G. 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.

4.4 METHOD OF MEASUREMENT.

Measured horizontal linear feet of underground conduit of each type, size, method and quantity furnished and accepted. Measurement will be from point to point horizontally along the approximate centerline. Vertical segments will not be paid for as these distances will be considered incidental to the underground conduit installation. No additional payment will be made for 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, multi-duct conduit organizers, mandrel test, tracer wire and Plans of Record, as they will be considered incidental.

4.5 BASIS OF PAYMENT.

The quantity of underground conduit of each type, size and quantity measured as provided above, will be paid for at the contract unit price per linear foot as "Underground Conduit, (type), (method), (size), (quantity)."

Payment will be made under:

Underground Conduit, (type), (method), (size), (quantity) .....Linear Foot

5. JUNCTION BOXES

5.1 DESCRIPTION.

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

5.2 MATERIALS.

A. General:

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

Comply with the following except as noted herein:

Graded Stone ..... Articles 545-2 and 545-3

Junction Boxes ..... Article 1411-2

Provide junction boxes and covers that have a minimum static coefficient of 0.5 as determined by ASTM D-1894 for all exposed surfaces. Provide junction boxes and covers that are sunlight resistant in accordance with ASTM G-53 and have a water absorption ratio no greater than 0.5 percent in accordance with ASTM D-570.

Unless otherwise required, provide junction boxes able to withstand a vertical load of 15,000 lbs. and tested up to a vertical lateral load of 22,533 lbs. Provide junction boxes able to withstand a lateral load of 800 lbf/ft2 and tested up to a lateral load of 1,200 lbf/ft^2. Provide certification that testing methods complied with Western Union Standard 3.6.

Provide junction box covers with standard "NCDOT ELECTRIC" or "NCDOT FIBER OPTIC" logos, pull slots, and stainless steel pins.

Do not provide a sealant compound between junction boxes and covers.

B. Standard Size Junction Boxes:

Provide standard size junction boxes with minimum inside dimensions of 16(l) x 10(w) x 10(d) inches. Provide a depth range for vertical extension of the junction box of 6 to 12 inches.

C. Oversized Junction Boxes:

Provide oversized junction boxes with minimum inside dimensions of 30(l) x 15(w) x 24(d) inches.

5.3 CONSTRUCTION METHODS.

Comply with the following except as noted herein:

Junction Boxes ..... Article 1411-3

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

Install junction boxes at locations as shown on the Plans and at locations where underground splicing of lead-in cable is necessary.

5.4 METHOD OF MEASUREMENT.

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

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

5.5 BASIS OF PAYMENT.

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

Payment will be made under:

Junction Box (_____) ..... Each

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6. INDUCTIVE DETECTION LOOPS

6.1 DESCRIPTION.

Furnish and install standard saw-cut inductive detection loops, loop lead-in cable and all necessary hardware in accordance with the Plans, Project Special Provisions, Standard Specifications and Standard Drawings.

6.2 MATERIALS.

A. General:

Furnish saw-cut inductive detection loops with loop slot sealant, loop wire, 1- inch conduit with fittings, and all necessary hardware.

Furnish loop lead-in cable for the saw-cut inductive loops and all necessary hardware.

B. Lead-in Cable (1098-9):

Page 10-230, Article 1098-9

Replace the entire article with the following:

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

- Provide the following two pair (4 conductor) conductor insulation pair colors: clear-yellow and red-green,
- Provide the following four pair (8 conductor) conductor insulation pair colors: clear-yellow, red-green, clear with black stripe tracer-yellow with black stripe tracer, and red with black stripe tracer-green with black stripe tracer. Apply continuous stripe tracer on conductor insulation with a longitudinal or spiral pattern,
- Provide cable jacket formed from black polyethylene. Ensure the finished jacket provides environmental stress resistance, outdoor weatherability, toughness, low temperature performance, and ultraviolet resistance,
- Provide a ripcord to allow the cable jacket to be opened without using a cutter, and
- Install all underground lead-in cable in non-metallic conduit.

6.3 CONSTRUCTION METHODS.

Page 17-14, Article 1726-3

Replace paragraph 1 with the following:

"Install lead-in cable."

Delete paragraph 3.

In paragraph 4, delete "type 1."

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

Page 17-15, Article 1726-4

Delete the last sentence.

6.4 METHOD OF MEASUREMENT.

The actual linear feet of inductive loop saw cut furnished, installed, and accepted. No measurement will be made of loop slot sealant, loop wire, 1-inch conduit and conduit fittings as this will be considered incidental to furnishing and installing inductive detection loops.

The actual linear feet of lead-in cable furnished, installed, and accepted. No measurement will be made for conduit, conduit fittings and trenching as this will be considered incidental to furnishing and installing lead-in cable.

6.5 BASIS OF PAYMENT.

The quantity of inductive loop saw cut, measured as provided above, will be paid for at the contract unit price per linear foot for "Inductive Loop Saw Cut."

The quantity of loop lead-in cable for saw-cut inductive loops, measured as provided above, will be paid for at the contract unit price per linear foot as "Lead-In Cable."

Payment will be made under:

Inductive Loop Saw Cut .....Linear Foot

Lead-In Cable .....Linear Foot

7. WEIGH-IN-MOTION SCALE

7.1 DESCRIPTION.

Furnish and install the WIM scale and scale frames with all necessary hardware and software in accordance with the Plans and Project Special Provisions.

7.2 MATERIALS.

Include Single Load Cell WIM scales manufactured by International Road Dynamics, or approved equivalent to ensure the compatibility with existing equipment at the Hillsborough Weigh Station.

Configure the Single Load Cell WIM Scale as two independent weighing platforms placed side-by-side across a travel lane, enabling weighing of all wheel sets on an axle at one time. Do not stagger the weighing platforms in the direction of travel, since staggering potentially increases pit and construction costs and may decrease performance due to vibration.

Make each scale module to be a self-contained weighing unit, with a single hydraulic load cell making up the weighing element. Multiple load cells within a single scale module are not allowed, as it decreases reliability. Make each scale module, including frame, to measure approximately 72" x 38". Incorporate the scale mechanism load transfer torque tubes to transfer all loading on the weighing surface to the single hydraulic load cell, so that the scale accuracy is not affected by the location of the truck's tires on the platform.

Each weighing platform shall form a scale module complete with load cell and offscale detectors. A complete lane of WIM scales, including frame, shall cover a typical travel lane width, measuring approximately 144" x 38". Weighing platforms must be fastened to the scale frames with mounting bolts.

The scale design should be such that the scale can be set up to reduce, as much as possible, mechanical ringing associated with vehicle wheels passing over the scale. Acceptable methods of achieving this result include the use of internal shimming of load components, such that the scale is in a pre-loaded state, or the use of other mechanical pre-load methods.

Each load cell shall be serviceable and removable from the scale module without the need to remove the scale mechanism from the roadway. The load cell removal shall require only one person with normal hand tools and shall be accomplished within 90 to 120 minutes.

Each scale module shall incorporate two offscale detectors at the outside edges of the weighing surface. Construct the offscale detectors of a force sensing resistive technology, and integrate into the scale assembly to sense any vehicle missing the weighing surface of the scale.

The WIM scale shall operate properly in a temperature range of -50° F to +160° F.

Furnish two scale frames into which the two scale modules will be mounted. Install the WIM scale flush with the road surface in a minimum 34-inch deep concrete vault to provide a solid foundation for long life and reliability. The vaulted installation of the scale frames will include ground rod and grounding cable attached to the frames. Protect the load cell and its signal processing electronic components/modules against lightning. Provide drainage in the WIM vaults to prevent any water intrusion into the scale area. Use separate conduits for drainage and electrical cabling. Do not run electrical cables through drainage conduits.

Environmentally seal the WIM scale and make it water tight. Seal all surface holes with drive in frost plugs, to allow no intrusion of water, ice, snow, salt, debris, dirt, moisture, or sand into the load cell, the load cell wiring compartment, the weighing mechanism and/or the entire WIM scale in general. Seal all points where water may enter with a flexible, waterproof caulking.

In installations where there is negligible speed variation of vehicles, the weighpads will be installed in conjunction with loop detectors for the determination of speed and axle spacing. In installations were there is a chance of a speed change over the sensors, install the sensors in conjunction with an additional axle sensor in the array to allow the determination of axle by axle speed. In this way, the speeds of adjacent axles will be averaged in order to increase the accuracy of the axle spacing calculations.

Rust proof the WIM scale and its frame. Rust proofing shall take the form of an epoxy finish applied to sandblasted metal. All installation hardware shall be either stainless steel or rust proofed.

Use the following cables:

- An individual cable for each load cell using twisted shielded pairs. Individually shield each pair. Connect all unused pairs and all shields to earth ground at the cabinet end,
- Install an individual ground wire for each load cell at the vault. Bond the ground wire at one of the transducer bolts using a soldered crimp lug and sealed with permatex blue RTV (room temperature vulcanizing) silicone gasket material. Cover the seal over all of the bond point, lug, and bare wire. Remove all paint, rust, grease, etc. at the bond point,
- Provide a single twisted pair of wires for each offscale, and
- Connect all signal cables to the respective sensing element in the scale and waterproof all connections. Make all signal cables from the connection points within the scale to the roadside enclosures continuous and splice free.

For connection of the signal cables to the sensing element, solder connect individual cable wires and then seal using individual in-line, self sealing shrink tubing with internally applied sealant. Overlap this tubing with the individual wire's outer insulation a minimum of 0.25in. Make the sealant visible form the ends of the tubing after shrinking.

Install hydraulic load cells in the platform so the transducer is on the upper side. Install the transducer cable as received from the manufacturer and not cut. Furnish stainless steel bolts to hold the transducer in the load cell.

Supply a list of at least five installations where the scale has been installed in similar environmental conditions with the same or higher traffic volume and speeds for a minimum of ten years. Also supply clients' contact information for the five installations.

Suitably demonstrate that the WIM scale design will provide a service life exceeding 12 years. This can be provided by documented customer feedback on operating sites in use and by life cycle cost evaluation.

The system must meet ASTM E1318-02 Type III performance requirements.

7.3 CONSTRUCTION METHODS.

A. General:

Place the WIM scale platforms in the metal frame installed in the road surface. Totally seal the scale platforms to prevent intrusion by water, salt, dirt and other debris. Anchor the scale platforms to the in-road frames, and mount flush with road surface so that the scale will not to be damaged by road maintenance such as sweeping and snow removal.

B. Calibration and Acceptance:

Perform calibration using a single calibration truck. The five (5) axle, test vehicle shall be of a tractor/trailer combination (3S2), complete with air ride suspension and a non-shifting static load. Load the truck to within 90 to 100% of allowable Gross Vehicle Weight for the road under test.

Conduct the calibration procedure as follows:

- Weigh the vehicle weigh using the static weigh scales at the Hillsborough Weigh Station. Record the weight information on the front (single axle), drive (tandem axle group), and trailer (tandem axle group). Calculate the Gross Vehicle Weight (GVW) of the vehicle by adding the three weights together,
- Measure and record the distance between the five (5) individual axles on the truck,
- Use a test vehicle and make three (3) test passes over the system under test at a selected speed that is indicative of the truck traffic at the site. Make adjustments on site during this time to fine tune the axle spacing, and weight output of the WIM system, and
- Once all initial adjustments have been made, make two (2) additional test passes with the test vehicle to confirm the accuracy of the adjustments. If all the readings fall within the ASTM ranges for the WIM, continue the tests. If this is not the case, make additional adjustments and make two (2) more confirming passes with the test truck.

Demonstrate through the acceptance tests that the system passes all criteria according to ASTM E1318 Standard, achieving ASTM accuracy type III. Perform the acceptance test as follows:

- Using the test truck, make an additional ten (10) passes at a selected speed that is indicative of the truck traffic at the test site;
- Place all of the data into a spreadsheet with the approval of the Engineer;
- Calculate the mean error and standard deviation for all recorded measurements at the end of the ten (10) test passes. Perform the calculations as follows:
  - For weight measurements, calculate the percent error for each test pass using the following formula,
  - [(WIM Weight - Static Weight)/Static Weight] x 100 = % error,
  - Calculate the mean error for each weight type (single, group, GVW) as follows (with each weight type calculated individually),
  - % errors for single, group or GVW/# of samples = Mean error,
  - Calculate the error for individual axle spacings using the following formula (each of the four axle spacings calculated individually), and

  - 10 of [(WIM Axle Spacings - Actual Axle Spacing)]/10 = Mean Axle Spacing Error,

- Enter all of the calculated errors into the spreadsheet;
- Check the calculated result against the acceptable range for the ASTM values. There will be one of two results;
  - If 95% of all recorded test results, (single axles, axle groups, GVW, axle spacing) fall within the ASTM specified tolerance then the system will have passed the requirements, or
  - If less than 95% of the calculated differences fall within the ASTM specified tolerance then readjust the system make and an additional ten (10) test passes to retest the system.

7.4 METHOD OF MEASUREMENT.

Weigh-In-Motion scales furnished, installed, and accepted. No measurement will be made for WIM cables, electrical conductors, conduit, conduit fittings and trenching as this will be considered incidental to furnishing and installing the weigh-in-motion scales.

7.5 BASIS OF PAYMENT.

Weigh-In-Motion scales, measured as provided above, will be paid for at the contract unit price each for "Weigh-In-Motion Scale"

Payment will be made under:

Weigh-In-Motion Scale ..... Each

8. WEIGH-IN-MOTION ELECTRONICS

8.1 DESCRIPTION.

The electronic equipment provided under this Contract is an expansion of an existing commercial vehicle weight enforcement system. The new equipment must work with the existing equipment. No impairment of the existing system's operation will be tolerated.

Design and install the WIM electronics, along with inductive loops, piezoelectric sensors, scales, overheight vehicle detector, and AVI reader to work as a single, integrated system in the creation of a vehicle record, and in the processing of commercial vehicles.

Furnish and install the WIM electronics with all necessary hardware and software in accordance with the Plans and Project Special Provisions.

8.2 MATERIALS.

A. General:

Furnish the WIM Electronics with the interface and signal conditioning for the inroad sensors, an integral power supply within a single chassis and integrate a process computer. Provide all material necessary for set-up and operation of the system, including all mounting hardware and cabling. Provide the system with the required software pre-loaded so that it will automatically execute when the system is powered up. Make the electronics modular in design to facilitate easy maintenance, troubleshooting and on-site servicing.

1. WIM Computer:

Provide the WIM computer with the minimum specifications as described below:

- RAM Memory: 128 Mb minimum,
- Processor: Pentium III (or better),
- Minimum Processor Speed: 733 MHz minimum,
- Peripherals:
  - One (1) 3.5", 1.44 Mb floppy disk drive,
  - Hard disk drive,
  - Non-volatile storage for vehicle information to prevent data loss during power outages (i.e., hard disk drive, battery backed RAM or Flash Drive),
  - 2 Async RS232-C Serial Ports,
  - 1 Parallel Centronics Interface,
  - Expansion bays for CD-ROM, Tape Drives, one half height 3.5" drive,
  - CD-ROM Drive (48x),
  - 2 USB (Universal Serial Bus) Ports,
  - 10Base-T network interface card,

- Expansion Slots:
  - Five (5) PCI card slots,
  - One (1) AGP slot,
- Separate 104 style keyboard with 12 programmable function keys,
- Separate monitor (minimum SVGA),
- Casing:
  - Shelf or 19" rack mount,
  - Powder coated aluminum panels,
- Power Supply:
  - 110 VAC 60Hz,
  - 80 watt supply,
- Analog Input Card:
  - 16 single-ended analog input channels,
  - Industry standard 12 bit successive approximation A/D converter,
  - Minimum sampling rate 47 KHz - Must sample each analog input at no less than 1600 Hz,
  - On board programmable timer for A/D clock,
- Digital Input/Output:
  - 16 Digital Inputs,
  - 16 Digital Outputs,
  - 72 Programmable Input/Output Lines,
- Software:
  - Diagnostics programs,
  - Operating system,
  - WIM operating programs (paid separately under Central Computer Software),

The system must provide for at least the following sensor interfaces:

- Sixteen (16) Analog Input Channels, capable of interfacing with a combination of up to 16 sensors including:
  - Temperature Sensor (up to 2),
  - Voltage Sensor (up to 1),
  - Current Sensor (up to 1),
  - WIM Sensor (up to 12),
- 16 Digital (Interrupt) Input channels capable of interfacing with a combination of up to 16 loops and piezoelectric sensors,

- 16 Digital (Polled) Input channels capable of interfacing with a combination of up to 16 devices such as off-scale detectors and overheight detectors,
- 16 Digital Output channels for control of lights, cameras or other externally triggered devices,
- 32 additional Digital Input/Output channels for future applications.

2. Roadside Operation Computer:

Integrate the ramp sorter system with a CVISN-compliant Roadside Operations Computer (ROC) server for electronic screening of vehicles. Provide a ROC server that is a Dell Poweredge 1600SC, or approved equivalent, with 2 GHz or greater processor and 1 Gb DRR running MS Windows 2000 Server for an operating system, 3 hot plug SCSI 73Gb or greater hard drives with RAID 5, and CD-RW/DVD ROM drive. Furnish ROC with an Oracle 9.2 Standard Edition database licensed appropriately for the anticipated usage.

Integrate one Windows-based workstation for use as operator interface and display terminal with the ROC system, which will include a minimum 19-inch monitor, English keyboard, and a two-button mouse with the workstation.

3. Ethernet Hub:

Provide a 10Base-T hub or switch with at least eight ports equipped with RJ-45 connectors. The hub shall have an operating temperature range of at least –40° F to 158° F, unless it is in a heated and air conditioned environment. It shall permit communication among all devices connected to the network. Include mounting hardware and UTP jumpers between the hub and each piece of connected equipment.

4. Uninterruptible Power Supply:

The uninterruptible AC power supply shall power the computer. When submitting catalog cuts for this item, provide calculations to show that it has capacity, plus an additional 50%, to power the computer during a power outage lasting ten minutes. The power supply must be of the line interactive type and all components must have a warranty of at least two years. Provide indicators and contact closure outputs for AC power on, rectifier failure, and low voltage disconnect. It must have the capability to signal the WIM computer that a power failure has occurred so that the WIM computer can automatically shut down before losing power. Mount it in the rack or on the floor of the cabinet.

5. Frame Grabber:

Furnish a frame grabber card inserted in the WIM computer where necessary. When triggered by the WIM computer's software, design it to capture a frame of the video coming from the freeze-frame camera, digitizing it and storing it in memory.

6. Operator Computer:

Integrate operator computers into the WIM system. Provide operator computers that meet following minimum requirements.

Mechanical / architecture:

- Color stealth black,

- Form factor small form factor (2x3),
- Bus type / architecture PCI,
- Slots x bays total (available) 2(2) x 3(0).

Processor:

- Processor manufacturer Intel®,
- Processor type Intel® Pentium® 4,
- Processor speed 2.40 GHz,
- Front side bus 533 MHz,
- L2 internal CPU cache 512KB.

Memory:

- Memory speed 266MHz,
- Memory type PC2100 DDR SDRAM,
- Memory slots total 2 DIMM,
- Memory slots available 1 DIMM.

Hard disk:

- Hard disk type ATA-100 (Enhanced IDE).

Graphics Subsystem:

- Graphics type 2D/3D,
- Graphics chipset Intel® Extreme Graphics,
- Video RAM type DVMT,
- Max resolution 2048x1536 256 colors,
- Max color 16777216,
- Graphics bus interface direct AGP.

Removable Media Drives:

- Floppy diskette size 3.5" 1.44 MB,
- 48X CD-RW.

Communications:

- Network speed 10Mbps, 100Mbps,
- Network features Remote Deployment Manager (RDM).

Audio:

- Audio SoundMAX Cadenza.

Keyboard and mouse:

- Mouse (2 button),
- Keyboard type IBM Preferred Pro full size PS/2.

Security:

- Security features hardfile I/O control,
- Serial port I/O control,
- Power on password,
- Boot sequence control,
- Boot without keyboard or mouse,
- Configuration password,
- Diskette I/O control,
- Diskette boot inhibit,
- Security slot (for attachment of optional cable lock).

Dimensions:

- Weight 7.4 Kgs,
- Height 84 mm,
- Width 309 mm,
- Depth 345 mm.

Expansion options:

- Slots x bays total (free) 2(2) x 3(0),
- Slots total (free) and type 2(2) PCI,
- 3.5 inch bays - accessible (free) and height 1(0) HH,
- 3.5 inch bays - not accessible (free) and height 1(0) HH,
- 5.25 inch bays - accessible (free) and height 1(0) HH,
- Plug and play support,
- Serial port(s) 2 (9-pin 16550),
- Parallel port(s) 1 (IEEE 1284),
- Additional expansion ports 4 USB 2.0 (front),
- Keyboard,
- External display,
- External microphone (1 front/1 back),
- Headphone/Line out (1 front/1 back),

- 2 USB 2.0 (back),
- Line in, 2 Serial, RJ-45.

Power management:

- Power supply 200 watts,
- Power supply type 115 or 230 volt universal manual switch,
- Power management features ACPI compliant,
- Standby Mode.

7. Report Printer:

Install and integrate a laser printer with an integral print server and 10Base-T Ethernet interface. Provide the report printer that has 600 x 600 dpi resolution or better, at least 4 megabytes of memory, and a speed of 11 or more black and white pages per minute.

B. Advance Location:

Unless otherwise specified, provide and integrate the following:

- WIM computer ,
- Frame grabber,
- Interfaces for three piezoelectric sensors, five inductive loops, the overheight detector, two load cells, four off-scale detectors, and two AVI readers, and
- Uninterruptible power supply.

C. Compliance Location:

Unless otherwise specified, provide and integrate the following:

- WIM computer,
- Frame grabber,
- Interfaces for the existing scales and loops plus the following additional equipment: four piezoelectric sensors, six loops, and one AVI reader, and
- Uninterruptible power supply.

D. Scale House:

Unless otherwise specified, provide and integrate the following:

- WIM computer,
- Roadside Operation Computer (ROC),
- Two operator computers,
- Report printer,
- Ethernet hub,

- Interfaces for the existing scales, loops, signs, and manual control panel, and
- Uninterruptible power supply.

The scale house WIM computer will also be known as the Sorting Computer. Interface the Sorting Computer to the ROC system, which together shall contain the central database that maintains vehicle records and provides the bypass screening logic as defined in the section, "Central Computer Software." Receiving, transmit and process AVI credentials information from the North Carolina Statewide CVISN database with these systems as well.

E. Obsolete Equipment:

In addition to providing the WIM electronics equipment listed in the previous subsections, remove and return to the Department certain obsolete equipment as identified by the Department.

8.3 CONSTRUCTION METHODS.

Prior to installing the WIM electronics, submit and receive approval of a plan for installing the new equipment and removing the old equipment with no significant disruption to the operation of the weigh station. In addition, successfully complete the "table top" test at the Contractor's facility (see the section, "Testing and Acceptance") on the new equipment and software.

8.4 METHOD OF MEASUREMENT.

Advance Location WIM Electronics will be paid as a lump sum and includes the frame grabber, uninterruptible power supply and interfaces for three piezoelectric sensors, four inductive loops, the overheight detector, two load cells, four off-scale detectors, and two AVI readers. The work includes all materials, electrical conductors, integration, documentation, and testing.

Compliance Location WIM Electronics will be paid as a lump sum and includes the frame grabber, and interfaces for four piezoelectric sensors, four loops, uninterruptible power supply, one AVI reader and the existing scales, and loops. The work includes all materials, electrical conductors, integration, documentation, and testing.

Scale house WIM Electronics will be paid as a lump and includes the Ethernet hub, uninterruptible power supply and interfaces for the existing scales, loops, signs and manual control panel. The work includes all materials, electrical conductors, integration, documentation, and testing.

8.5 BASIS OF PAYMENT.

Advance Location WIM Electronics will be paid for at the contract lump sum price for "Advance Location WIM Electronics"

Compliance Location WIM Electronics will be paid for at the contract lump sum price for "Compliance Location WIM Electronics"

Scale house WIM Electronics will be paid for at the contract lump sum price for "Scale House WIM Electronics"

Payment will be made under:

Advance Location WIM Electronics ..... **Lump Sum**

Compliance Location WIM Electronics ..... **Lump Sum**

Scale House WIM Electronics ..... **Lump Sum**

9. PIEZOELECTRIC SENSORS

9.1 DESCRIPTION.

Furnish and install piezoelectric sensors with all necessary hardware in accordance with the Plans and Project Special Provisions.

Furnish and install the piezoelectric sensor as a permanent sensor used for the detection of axles on a roadway. Embed the sensors into the roadway.

9.2 MATERIALS.

Construct the piezoelectric sensor of a material sensitive to pressure. The sensor must be enclosed in a semi-rigid material, impervious to moisture and roadway de-icing chemicals. The piezoelectric sensor shall be approximately 0.75 inches wide and 0.75 inches high.

The piezoelectric sensors shall have an operating temperature range of –50° F to +160° F. The insulation resistance of the sensor shall exceed 30 ohms. When correctly installed, a wheel load of 400 pounds will produce a minimum output signal of 250 mV at 70° F and 55 mph.

Attach the piezoelectric sensor to a lead-in cable, which extends from the piezoelectric sensor to the equipment cabinet. The lead-in cable shall be a two-conductor 18 AWG twisted shielded cable.

9.3 CONSTRUCTION METHODS.

Install the piezoelectric sensors as recommended by the manufacturer of the sensor. Install the sensor flush with the pavement to reduce vehicle bouncing and ensure that the piezoelectric sensor is not ripped out of the pavement during snow plowing operations. Ensure that no element of the piezoelectric sensor equipment is elevated above the surface of the roadway once installed in the pavement

Hold each piezoelectric sensor in place using an epoxy mixture recommended by the manufacturer of the sensor.

9.4 METHOD OF MEASUREMENT.

The actual number of piezoelectric sensors furnished, installed and accepted. No measurement will be made of the epoxy mixture, lead-in cable, conduit, conduit fittings and trenching as these will be considered incidental to furnishing and installing piezoelectric sensors.

9.5 BASIS OF PAYMENT.

The quantity of Piezoelectric Sensors, measured as provided above, will be paid for at the contract unit price each for "Piezoelectric Sensor."

Payment will be made under:

Piezoelectric Sensor ..... Each

10. OVERHEIGHT VEHICLE DETECTOR

10.1 DESCRIPTION.

A. General:

Furnish and install the overheight detector with all necessary hardware in accordance with the Plans and Special Provision.

The overheight vehicle detector assembly consists of a transmitter and a receiver, mounted on poles on either side of the roadway. A beam of infrared light from the transmitter is aimed at two light detectors in the receiver. When the light reaching the two detectors is interrupted in the proper sequence, the receiver closes an electrical contact. The transmitter and receiver are mounted at such a height that overheight vehicles break the beam but other vehicles do not. The receiver's contact closure output is connected to the WIM computer at the Advance Location, and any truck breaking the beam is flagged as overheight in the message about the truck that the Advance Location WIM computer sends to the Sorting Computer.

B. Accuracy and Performance:

Design the detector to detect a two-inch diameter object that is one inch above the detection height when the object is moving at any speed between 1 mph and 75 mph.

10.2 MATERIALS.

A. Transmitter and Receiver:

Furnish the transmitter and receiver with the following characteristics:

- Power: 120 VAC power,
- Output: Form C dry relay contact closure with contacts rated 115 VAC, 10 amps. Protected by an 8 amp circuit breaker,
- Weight : 30 pounds or less, each unit,
- Operating temperature: -40° F to +135° F,
- Response: within 1 second of beam break,
- Enclosure: NEMA 6P, ALMAG casting and sheet aluminum at least 1/8-inch thick,
- Two LEDs, bore sight, and meter for alignment,
- Bird perch denial rod for each eye cone, and
- Range: 700 feet under ideal conditions; 200 feet in bad weather.

Furnish the transmitter and receiver with mounting hardware, power and communication cables, connectors, and power connection.

B. Overheight Detector Pole:

Mount the overheight detector receiver unit to a galvanized steel pole conforming to Section 1404 of the Standard Specifications with the following modifications to the standard:

- Bracket arms and transformer bases shall not be required,
- Design the standard to support the overheight detection equipment specified herein, and
- Furnish the pole with a height as shown on the Plans.

Mount the overheight detector transmitter unit to the proposed mast arm pole supporting the AVI antenna at the Advance Location.

C. Overheight Detector Pole Foundation:

Mount the overheight detector pole on a standard foundation as defined in Section 1405 of the Standard Specifications. Design the foundation type and depth and submit for approval by the Engineer.

10.3 CONSTRUCTION METHODS.

Install the overheight vehicle detectors and align in accordance with the recommendations of the detector manufacturer. Field verify the detectors to assure that the infrared beam is transmitted at 13'-6" above the lowest point in the travel lane that is equipped with the WIM scale.

10.4 METHOD OF MEASUREMENT.

The actual number of overheight vehicle detector, detector pole and detector pole foundation, furnished, installed and accepted. The price includes mounting hardware, cables, electrical conductors, connectors, surge protectors, documentation, and testing.

10.5 BASIS OF PAYMENT.

The quantity of overheight vehicle detector assemblies, measured as provided above, will be paid for at the contract unit price each for "Overheight Vehicle Detector." No measurement will be made for overheight vehicle detector cables and power conductors as this will be considered incidental to furnishing and installing the overheight vehicle detectors.

Payment will be made under:

Overheight Vehicle Detector ..... Each

11. AUTOMATIC VEHICLE IDENTIFICATION EQUIPMENT

11.1 DESCRIPTION.

Furnish and install automatic vehicle identification (AVI) equipment with all necessary hardware and software in accordance with the Plans and Project Special Provisions.

11.2 MATERIALS.

Provide the AVI system consisting of a Dedicated Short Range Communications (DSRC) system to provide two way communications between vehicle-mounted active transponders, and a roadside-based reader unit. Provide an AVI system that meets the technical requirements of current North American Commercial Vehicle Operations (CVO), Intelligent Transportation Systems (ITS) projects as defined by ASTM, draft 6 protocol for an ITS/CVO system. At a minimum, utilize Time Division Multiple Access (TDMA) technology as the DSRC technology.

Integrate the AVI system into the operation of the WIM System. Furnish the AVI systems with hardware and software interfaces for communications with the WIM system. Design the AVI system to transmit AVI transponder information to the roadside electronics. Include the transponder ID into the roadside electronics as part of the vehicle record.

At a minimum, design the AVI system to read transponders and cause the transponder to activate red or green signals and audible alerts on the transponder. The AVI system shall be able to direct a specific trigger to a specific target transponder.

A. Single-Antenna AVI Reader:

Install AVI readers installed at the Advance Location, the Notification Location and the Compliance Location as shown on the Plans.

With an accuracy of 99.95%, design the AVI reader to read and write to transponders at vehicle operating speeds up to 80 mph and correctly report the transponder ID to the WIM computer system.

Furnish AVI readers whose power requirements do not exceed 120V, 60 Hz, 20W AC power.

Design the communications between the AVI Reader and other devices to be through an EIA-232 or EIA-422 interface with a minimum data rate of 9600 baud asynchronous.

B. Double-Antenna AVI Reader:

Furnish this reader to meet the specifications for the single-antenna AVI reader, but to accommodate two antennae.

C. AVI Antennae:

Provide two different types of AVI antenna under this contract. Use a Dipole 915 MHz, Sinclair Model 4701-8134 or compatible antennae at the Advance Location, Compliance Location and on the ramp into the weigh station. Provide lane discrimination with the dipole antenna where transponders installed in vehicles in adjacent lanes will not be read by the antenna. This functionality is required at the Advance Location because the AVI record for the vehicle shall be matched up with the WIM and

other in-lane sensors to create a complete vehicle record for processing. The functionality is required at the Compliance Location to clearly identify a violating vehicle's lane position and capture the image of violating vehicles using the freeze-frame CCTV camera at this location.

Use a 915 MHz Yagi, Scala RY-900A or compatible antenna at the Notification Location. Furnish the Yagi antenna with a wider communications zone to allow for the system to transmit the bypass status to the transponder (i.e. green light or red light on transponder to signify clearance to bypass the weigh station or pull into the weigh station) regardless of the vehicles lane position in the two right lanes.

11.3 CONSTRUCTION METHODS.

Complete a RF survey at the locations where the AVI system is to be installed. Identify with the RF survey all potential interference effects caused by permanent RF sources, operating within the same frequency bandwidth as the AVI. Report the survey results to the Engineer and provide recommendations on the installation of the AVI system to ensure that the system meets the requirements of these Project Special Provisions. Do not install AVI equipment until the completion of the RF survey and acceptance by the Engineer of AVI installation recommendations.

To remove interference effects between AVI readers, designate one of the readers as the master reader and the other reader as slave reader. A sync signal shall be transmitted from the master reader to sync readers for the purposes of removing the interference effects.

Mount the AVI readers in cabinets as identified on the Plans. Install the AVI antenna per AVI reader manufacturer's specifications. Mount the AVI antenna at a height and angle to ensure the lane coverage as identified in this Special Provision for each antenna type. At a minimum, mount the antenna at a sufficient height to meet Department requirements for vertical clearances of sign and bridge structures. For Sinclair antenna locations, mount each antenna over the center of the lane as identified on the Plans.

Prepare all forms and complete all necessary requirements on behalf of the Department to obtain any FCC licenses required for the AVI equipment provided under this Contract.

11.4 METHOD OF MEASUREMENT.

The actual number of single-antenna AVI readers furnished, installed and accepted.

The actual number of double-antenna AVI readers furnished, installed and accepted

The actual number of AVI Sinclair antennae, furnished, installed and accepted. No measurement will be made for AVI Sinclair antennae cables as this will be considered incidental to furnishing and installing the AVI antennae.

The actual number of AVI Scala antennae, furnished, installed and accepted. No measurement will be made for AVI Scala antennae cables as this will be considered incidental to furnishing and installing the AVI antennae.

11.5 BASIS OF PAYMENT.

The quantity of AVI Readers, measured as provided above, will be paid for at the contract unit price each for "AVI Reader (type)."

The quantity of AVI Antennae, measured as provided above, will be paid for at the contract unit price each for "AVI Antenna (type)"

Payment will be made under:

AVI Reader (type) ..... **Each**

AVI Antenna (type) ..... **Each**

12. FREEZE-FRAME CAMERA EQUIPMENT

12.1 DESCRIPTION.

Furnish and install freeze-frame camera equipment with all necessary hardware and software in accordance with the Plans and Project Special Provisions.

The freeze-frame camera assemblies will be used to send video snapshots of vehicles to the weigh station staff, so that they can easily associate the measured weight and dimensional violations with specific trucks, and so that they can easily identify violators.

12.2 MATERIALS.

A. Dual Channel CCTV Camera:

Furnish cameras that comply with the following:

- Dual Channel Design:
  - Color Day
  - Black & White Night
- Lens:
  - 40-240mm afl Auto Iris Motorized Zoom (Day Channel)
  - 40-240mm afl Motorized Zoom (Night Channel)
- Light Sensitivity:
  - 2 lux w/Digital Backlight Compensation (Day Channel)
  - 0.6 lux (Night Channel)
  - Faceplate
- Horizontal Resolution:
  - 480 Lines (Day Channel)
  - 570 Lines (Night Channel)
- Signal to Noise Ratio:
  - 50dB (Day Channel)
  - 46dB (Night Channel)
- Geometric Distortion:
  - None
- Video Output:
  - 1.0 Vp-p NTSC Composite, 75 ohms/BNC
- Humidity:
  - 100%

- Operating Temperature Range:
  - -58° F to +122° F
  - +140° F w/ sun shield
- Enclosure:
  - All aluminum weather proof enclosure:
  - Complete with thermostat, heater, blower and defrost/defogger
- Power Input:
  - 24 VAC + 5%
  - 34 Watts (At night w/heater and blower engaged)

B. Camera Housing:

Furnish the camera housing to meet the following requirements:

- Fabricated from corrosion resistant aluminum, finished in a neutral color of weather resistant enamel or polyester powdercoat,
- Equipped with tempered glass front window,
- Equipped with sunshield,
- Equipped with surge suppressors on all ungrounded conductors. Design the video surge suppressor specifically for coaxial video transmission lines, and
- Includes mounting hardware to match mounting bracket.

Purge the enclosure of air and pressurized to at least 5 psi. with dry nitrogen. Furnish each enclosure with a Schrader valve for pressurization, and an overpressure relief valve. Design the housing's leak rate to be less than 2 psi per year. Affix a decal stating that the unit is pressurized and that safety precautions are to be observed to the rear housing plate. Provide a pressure tight connector receptacle for connection of the camera and lens control cable. Design all external connections to be watertight.

C. Mounting Bracket:

Provide the camera mounting bracket to be a horizontal arm that attaches to a vertical pole, which meets the following requirements:

- Cable feed through hole,
- Maximum supported weight: 40 lbs.,
- Designed to mount on a vertical pole,
- Separation between center of camera housing and pole: 15 inches,
- Attachment to pole: a minimum of two (2) stainless steel bands approximately five inches apart,
- Pan adjustment: unlimited (360 degrees),
- Tilt adjustment: +/- 75 degrees, and
- All aluminum with polyester powdercoat finish

D. Cables:

Provide a composite cable carrying power and video between the camera housing and the nearby base-mounted cabinet. Use coaxial conductors for the video. Size the power and video conductors to correspond to the load and the distance. Furnish cable recommended by the manufacturer for conduit installation, and furnish crimp-on type connectors. In the base mounted cabinet, terminate the video conductors on surge protectors like those in the camera housing. All cabling between the camera and WIM electronics shall be fiber optic as per the fiber optic cable detailed in the section "Fiber Optic Cable."

E. Freeze Frame Camera Pole:

Mount the freeze frame cameras to galvanized steel poles conforming to Section 1404 of the Standard Specifications with the following modifications to the standard:

- Bracket arms and transformer bases are not be required,
- Design the standard to support the freeze frame camera equipment specified herein, and
- Furnish the pole with a height as shown on the Plans.

F. Freeze Frame Camera Pole Foundation:

Mount the freeze frame camera poles on standard foundations as defined in Section 1405 of the Standard Specifications. Design the foundation type and depth and submit for approval by the Engineer.

12.3 CONSTRUCTION METHODS.

Ensure that the camera is aimed to provide optimum coverage. Adjust the camera's position as necessary until the Engineer agrees that the position is optimal from the point of view of the users. Also, adjust the light threshold for the color/monochrome video switch as necessary until the Engineer agrees that the threshold is optimal from the point of view of the users.

12.4 METHOD OF MEASUREMENT.

The actual number of freeze-frame camera assemblies furnished, installed and accepted. The price includes the cameras, housing, pole-mounted cabinet and contents, pole and pole foundation, mounting brackets and mounting hardware, cables, electrical conductors, connectors, surge suppression, circuit breakers, documentation, and testing for all locations as shown on the Plans.

12.5 BASIS OF PAYMENT.

The work described above will be paid for at the contract unit price each for "Freeze-Frame Camera Equipment".

Payment will be made under:

Freeze-Frame Camera Equipment ..... Each

13. FULL MOTION VIDEO CAMERA SYSTEM

13.1 DESCRIPTION.

Furnish full motion video camera assemblies, cabinet assemblies, local video control panels, video monitors, screen splitters and video switcher/camera controller.

The full motion video camera system will be used by weigh station operators to view commercial vehicle movements at the Buckhorn Road and Efland Interchanges as well as within both weigh stations. The cameras will allow operators to identify commercial vehicles that are attempting to bypass the weigh stations by traveling on roads parallel to the Interstate, thus avoiding the weigh station. The cameras will also allow operators to view the Interstate and detect any traffic problems that could affect weigh station operations.

Install a new full motion video camera and galvanized steel pole at the Efland interchange. Existing full motion video cameras at both weigh stations will be replaced on existing metal poles. Design to system to allow operators to independently select, control and view all video cameras, including the existing camera at Buckhorn Road, from both the eastbound and westbound weigh stations.

13.2 MATERIALS.

A. Camera Assembly:

Furnish and install a weatherproof camera assembly capable of withstanding winds of 80 miles per hour with a 30 percent gust factor. Furnish an assembly that maintains all mechanical and electronic components within their operating temperature ranges for all external temperatures between –30° F to 110° F. Use 24-volt AC power on the assembly and furnish the following features:

1. Pressurized Dome Housing:

To the mounting bracket on the camera pole, attach a dome camera housing using attachment hardware that prevents the entry of moisture and prevents the housing from moving relative to the bracket. Furnish a housing that includes the following features:

- A hemispheric sun shield covering the top half of the housing and extending below the junction of the lens with the rest of the housing,
- Hemispherical lens made of clear acrylic, no larger than 10 inches in diameter. Attach it to the rest of the housing by a safety wire. Ensure that all fasteners used to attach the lens to the housing are captive. Ensure that removing the lens does not require a technician to exert forces on the housing that could loosen it from the bracket or change the camera's position,
- Heater/fan assembly controlled by a thermostat,
- Surge suppressors meeting the requirements of the Standard Specifications on the data and power cables,
- Surge suppressor for the video cable that clamps the voltage at 6.5 volts, maximum, and
- Sealed and pressurized with dry nitrogen to 5 psi. Provide a relief valve on the housing that prevents the pressure from exceeding 7 psi. Include a low pressure

switch that causes the camera's remote operator to be notified when the pressure drops below 1 psi. Design the housing such that the leak rate is less than 2 psi per year.

2. Pan/Tilt/Zoom (PTZ) Controller:

Provide the PTZ unit with the following features and functions:

- Multipoint EIA-232 or 422 communication with the CCTV central equipment. Provide a unique, easily changed ID with each camera with the range of permissible IDs encompassing at least the values 1 through 250,
- At least 25 preset positions, each defined by a pan angle, tilt angle, zoom setting, and title of up to 16 characters that is superimposed on the picture. Furnish a PTZ that will not deviate from the original position by more than 0.3° when the camera returns to any preset position,
- Servo or stepper-drive motors capable of accurate, drift-free positioning of the camera,
- Panning mechanism capable of continuous 360 degree rotation and operator controlled speed in the range of one to 270 degrees per second,
- Tilting mechanism capable of rotation from horizontal through straight down, and operator-controlled speed in the range of one to 110 degrees per second,
- Movement to a commanded preset position via the shortest route,
- At least 16 zones with user-programmed boundaries and user programmed on-screen titles, such that the camera image displays the zone name whenever the camera is aimed anywhere in the zone, unless the camera has been commanded to a preset view. Include the capability for each individual sector to be blanked out (no video display),
- Nonvolatile memory for preset and zone information, such that the information does not have to be reentered after power failures. If the memory uses battery backup, the batteries shall maintain the memory for at least ten years with no external power,
- Quick disconnect attachment of the entire camera, lens, PTZ and controller assembly to the camera housing, with a single electrical connector for all conductors,
- Ability to display diagnostic information on the screen in response to user commands. Include the diagnostic information on current PTZ and focus positions, and error codes for power, communication, position, and memory problems,
- Manual override of automatically controlled iris, and
- A means of restricting the user's field-of-view to protect the privacy of people living adjacent to the roadway. This may consist of affixing a mask to the inside of the dome.

3. Camera/Lens Assembly:

Attach to the PTZ unit in the dome housing an integrated camera/lens assembly. Include in the assembly a high-resolution color CCD camera and a motorized zoom lens, which meets the following minimum requirements:

- Horizontal resolution of 450 TV lines,
- 720 (H) x 582 (V) pixels,
- ¼" format CCD with interline transfer,
- Designed for use in both low light and bright sun,
- Automatic white balance,
- Automatic iris control with manual override,
- Auto focus, with provision for disabling,
- Signal-to-noise ratio of 50 dB or better,
- Line-lock synchronization with +/-90 degrees phase adjustment,
- Overexposure protection: Protect the camera from damaged if inadvertently pointed directly at the sun,
- NTSC standard output,
- Maximum magnification: 176x (22x optical zoom and 8x digital zoom),
- Range of focal lengths: 4-88 mm, and
- Maximum aperture: 1:1.6.

4. Mounting Bracket:

Provide a cast aluminum bracket recommended by the manufacturer of the dome housing. Completely enclose the cables running between the dome and the pole with the bracket. Connect it to a metal pole mount adapter using at least four stainless steel bolts. Secure the adapter to the pole with stainless steel bands in such a way that the camera remains stationary in strong winds. Install grommets on the holes in the adapter through which cables pass.

B. CCTV Cabinet Assembly:

Provide a pole mounted cabinet assembly consisting of the following:

1. Cabinet:

Equip the door shall with a brass or stainless steel lock, which permits the key to be removed in the locked position only. Furnish an aluminum cabinet with a white polyester powdercoat finish.

Furnish a NEMA 3R aluminum cabinet enclosure of sufficient size to hold the equipment called out below. Equip the cabinet with louvers and replaceable air filters on each side, low on one side and high on the other.

Equip the cabinet with a 19-inch EIA rack, an aluminum back panel, or other means proposed by the Contractor and approved by the Engineer, for mounting the equipment inside the cabinet.

Make all cables to enter the cabinet through the bottom. Use a bushing on conduits inside the cabinet to prevent chaffing of the cables. The fittings used to make these connections are all part of the cabinet assembly and will not be paid separately.

Mount the cabinet to the pole according to the Standard Drawings and Standard Specifications for mounting pole-mounted traffic signal cabinets.

2. Power Distribution Panel:

Provide a power distribution panel containing a 30 amp main breaker and two 15-amp breakers, each for a separate branch circuit within the cabinet. One of the branches shall serve only sensitive electronics (the equipment in the dome, the camera control panel, and the fiber optic video/data modem) and shall be protected by the second stage of the surge suppressor. Install a duplex ground fault convenience receptacle rated at 15 amps inside the cabinet.

3. Equipment:

Provide the following equipment mounted inside the cabinet:

- A splice enclosure, paid separately,
- A fiber optic video/data transceiver, paid separately,
- A thermostat-controlled exhaust fan designed to engage at 95° F and turn off at 84° F. Position the fan in front of the upper set of louvers,
- Power supplies for the camera assembly and any other equipment that requires power at less than 115 volts,
- A data converter if the dome does not use EIA-232 communication, and
- A local control panel with provision for local control of all camera assembly functions, with a BNC connector for attachment of test equipment to the video signal coming from the camera. Provide an EIA-232 connection to a laptop computer to control the camera assembly functions. The BNC connector for the video shall be one output of a 1 x 2 distribution amplifier, with the other output feeding the video signal to the fiber optic video/data transceiver.

Items in the above list are part of the cabinet assembly, unless designated for separate payment.

4. Cables:

Provide, as part of the CCTV camera assembly, all cables required for transmission of video, power, and communication between the camera assembly and the cabinet assembly.

5. Surge Protectors:

Inside the cabinet at the bottom of the pole, provide protectors meeting the requirements of the Standard Specifications for every ungrounded conductor entering the cabinet. Arrange the cabinet layout such that the surge suppressors are as close as possible to the point where the cables enter the cabinet.

For the coaxial cable carrying the video signal from the camera, use a suppressor designed for baseband CCTV signals that conform to the following:

- Surge: 18,000 amps with an 8 x 20 µsecond waveform,
- Turn-on time: 4ns for 2 kV/ns,
- VSWR: 1.1 : 1 or less,

- Insertion loss: 0.3 dB or less,
- Frequency range: DC to 30 MHz,
- Connectors: BNC,
- Operating voltage: 1.5 volt,
- Impedance: 75 ohms

6. Laptop Software:

Provide software that enables a laptop computer to control and troubleshoot a camera assembly when directly connected to the assembly. The Department reserves the right to make unlimited copies of this software for use by its staff. Provide the software on diskette or CD. Provide a connectorized cable to connect the laptop to a camera control panel.

C. Westbound Scale House Equipment:

1. Video Switch/Camera Controller:

Provide a microprocessor-controlled matrix switch compatible with the existing Vicon Surveyor 2000 full motion video camera at the Buckhorn Road interchange that consists of an equipment bay containing video input and output cards. Equip the switch to handle 4 camera inputs and 8 video outputs. Design the equipment bay to accommodate sufficient input and output cards to handle 8 camera inputs and 16 video outputs. Install the equipment as designated in the plans. Provide all cables needed to connect the central video equipment to the control panels, screen splitters, fiber optic communication equipment, graphics display system, and electric power.

Furnish the switch with the following performance characteristics:

- Video crosstalk isolation: at least 50 dB.
- Frequency response (+/-0.5 dB): 30 Hz to 10 MHz.
- Bandwidth (+/-3 dB): 20 Hz to 15 MHz.

2. Tours:

Furnish a control system capable of running tours, in which preset views, which may be from multiple cameras, are displayed in a programmed sequence and for programmed durations. Provide the ability for the viewer to pause the tour to watch the action in a particular scene, and then resume the tour. Automatically repeat at the end of the sequence, until the user ends the tour. Store at least 20 different tours in the system's nonvolatile memory.

3. Local Video Control Panels:

Provide a desktop video control panel in the westbound weigh station scale house compatible to the existing Vicon 1411-VC video control panel in the eastbound scale house, which enables an operator to select what camera output, or tour is displayed on the monitor, and to control any camera's pan, tilt, zoom, focus, and iris. Provide operator the ability to call up a particular preset view and control the speed of panning and tilting. Install the video control panel next to the operator computer and video monitor and provide communication to the video switch/controller. Furnish the control panel with a power supply and a joystick that enables a user to control the pan

and tilt. Provide preset views with titles, zones with titles, programmed tours, and use any other feature that the system offers.

4. Interface with Camera Assemblies:

Provide a device or devices that interface the camera control communication port of the video switch/camera controller to the data ports of at least eight fiber optic video/data transceivers. Connect the device to transceivers you provide in this project, providing remote control of all the cameras provided. If the communication port of the video switch/camera controller is not an EIA-232 port, provide an appropriate converter as part of this device.

5. Set Up Software:

Provide software that facilitates the configuration of the camera control and switching system, and use that software to properly configure the equipment provided. Install the software on the operator workstation.

6. Video Monitor:

Furnish and install a 15" color video monitor in the westbound scale house with at least 450 lines of horizontal resolution and an amplifier bandwidth (+/-3 dB) of 10 MHz. Furnish monitors that use NTSC video and that have all controls on the front.

7. Screen Splitter:

Provide a color quad splitter for each scale house that has four video inputs and at least one full color video output of 1024 x 512 pixels. Provide controls on the front of the splitter to permit the operator to select any of the four inputs for full screen display, or to have all four inputs displayed simultaneously in separate quadrants of the monitor.

Include time base correction in the splitter to prevent vertical roll when a different video source is selected for display, regardless of whether the switching is done by the matrix switch or the splitter.

When presenting four pictures on the same screen, provide the capability to separate the pictures with a thin line or border.

Furnish and install cables to connect the splitter to the video monitor. Mount the splitter beneath the monitor.

D. Eastbound Scale House Equipment:

Integrate the existing Vicon desktop video control panel in the eastbound scale house to the proposed video switch/camera controller to furnish the functional operation described in 14.2.C.3. Configure the existing desktop video control panel to communicate with the proposed video switch/camera controller through the bidirectional data channel of the "4-channel video mux/demux pair with data."

13.3 CONSTRUCTION METHODS.

Mount the camera so that the camera pole does not obstruct the view of the roadways. Create up to eight preset views with titles and up to eight zones with titles, as directed by the Engineer.

At locations shown in the Plans, install the camera assemblies on both new and existing metal poles. Run the video and control cables through a 1" hole drilled in the side of the pole behind the pole mounting adapter plate. Install a weatherproof grommet or other means to protect the cable from chafing, and to prevent moisture entry inside the pole. Run the cables inside the pole, and extend to the controller cabinet as indicated in the Plans. Also ground the camera assembly to the pole using a suitable copper bonding strap. Furnish shop drawings detailing the methods and materials proposed for mounting and grounding the camera assembly.

13.4 METHOD OF MEASUREMENT.

Actual number of full motion video camera assemblies furnished, installed and accepted, including setting up and testing the video camera/lens unit, dome camera housing. PTZ controller, and mounting hardware.

Actual number of full motion video cabinet assemblies furnished, installed and accepted, including cabinet attachment hardware, electrical conductors, all cables from the cabinet to the camera assembly and laptop software.

Actual number of local video control panels furnished, installed, and accepted.

Actual number of video monitors furnished, installed and accepted.

Actual number of screen splitters furnished, installed and accepted.

The items specified as video switcher/camera controller will be measured on a lump sum basis.

13.5 BASIS OF PAYMENT.

The quantity of full motion video camera assemblies, measured as provided above, will be paid for at the contract unit price each for "Full Motion Video Camera Assembly."

The quantity of full motion video cabinet assemblies, measured as provided above, will be paid for at the contract unit price each for "Full Motion Video Cabinet Assembly."

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

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

The quantity of screen splitters, measured as provided above, will be paid for at the contract unit price each for "Screen Splitter."

The video switcher/camera controller, measured as provided above, will be paid for at the contract lump sum price for "Video Switcher/Camera Controller."

Payment will be made under:

Full Motion Video Camera Assembly ..... **Each**

Full Motion Video Cabinet Assembly ..... **Each**

Local Video Control Panel ..... **Each**

Video Monitor ..... **Each**

Screen Splitter ..... **Each**

Video Switcher/Camera Controller ..... **Lump Sum**

14. LED OPEN / CLOSED SIGN

14.1 DESCRIPTION.

Furnish the LED Open/Closed signs with message display capabilities on both sides of the sign.

When not illuminated, the message shall not be visible regardless of outside lighting conditions.

Messages shall be clear and legible under any lighting conditions at a distance of up to 900 ft.

The exterior dimensions of the sign shall be 52.5 inches wide, 20 inches high and 8 inches deep.

14.2 MATERIAL

A. Environmental:

Furnish an LED Open/Closed sign rated for use in the ambient operating temperature range of -40° F to +165° F.

Completely seal the LED display module against dust and moisture intrusion as per the requirements of NEMA Standard 250-1991 sections 4.7.2.1 and 4.7.3.2 for type 4 enclosures to protect all internal components.

B. Chromaticity:

The measured chromaticity coordinates for the messages shall conform to the chromaticity requirements of section 8.04 and figure 1 of the VTCSH Standard.

The chromaticity measurements shall remain unchanged over the input line voltage range of 90 VAC to 135 VAC.

C. LED Message Display:

Furnish a message display consisting of LEDs mounted on a PCB matrix with a mat black solder mask.

Provide a "universal" PCB matrix with the capabilities to display 2 overlaid text messages, a red "CLOSED" and green "OPEN".

Provide characters forming the message that are true "highway gothic alphabet" 12 inch series C for the "CLOSED" message and 12" series E for the "OPEN" message.

Arrange the LEDs in a manner to form "double stroke" characters, distributed evenly along the message. Do not exceed 0.5 inches between consecutive LEDs and do not vary by more than 10%.

The PCB matrix shall have a minimum thickness of .093 inches.

The PCB shall have a component identifier silk screen.

Furnish the red LEDs to be of the latest AlInGaP technology, and the bluish green LEDs of the latest InGaN technology.

Furnish LEDs with a minimum nominal luminous intensity of 6,000 mcd at 20mA.

Interconnect the individual LED light sources so that a catastrophic failure of a single LED will result in a total loss of not more than 5 LEDs.

Ensure that no electronic components are visible on the front of the display and that the display face consists solely of LEDs mounted on a mat black PCB.

Protect the rear side of the PCB by a molded polymeric back cover to seal and protect it from any potential damage.

Design the display PCB with back cover to fit into the front door consisting of an aluminum frame and face lens.

Make the face lens of ¼" non-glare polycarbonate with UV resistant surface treatment. The lens shall have light transmission properties of at least 82%.

Assemble the entire display face as a one-piece, self-contained module that can be removed from the sign housing in less than 5 minutes without the need of any tools.

Mount the door face on the sign housing on three (3) stainless steel "lift-off" type hinges and that latches using three (3) stainless steel ¼ turn link locks.

Provide the display module with a multi-conductor cable with an individual 2 pin connector for each message.

Provide two retaining cables to hold the front door in the "open position.

D. Drive Circuitry:

Furnish individual LED drive modules for each message in the OPEN / CLOSED.

Design the drive modules to be "rack mounted" as per standard industry dimensions of 6.5" X 4.5".

Design the drive modules to consist of a PCB (0.62" thick) with an aluminum front plate and handle as commonly used for inductive loop detectors.

Design the drive modules to drive the LEDs at a DC current not exceeding the maximum rating recommended by the LED manufacturer (20mA).

Design the drive modules to regulate the LED drive current to compensate for line voltage fluctuations over the range of 90VAC to 135 VAC. Prevent the luminous output of the display from varying more than 10% over the voltage range and from being perceptible to the human eye.

Fuse the drive modules and include voltage surge protection to withstand high-repetition noise transients and low-repetition, high-energy transients as stated in section 2.1.6, NEMA Standard TS-2, 1992.

Provide on-board circuitry that meets FCC title 47, sub-part B, section 15 regulations concerning the emission of electronic noise.

Ensure circuitry compatibility, proper triggering and operation of load switches and conflict monitors in signal controllers currently in use by the procuring traffic authority.

Furnish drive modules with a capacity of 25 watts.

Design the drive modules to maintain a constant LED drive current regardless of outside temperature in the range -22° F to 104° F.

Design the drive modules to dim automatically based on the ambient light level. Tune the automatic dimming circuit to reduce the light intensity of the display by 35 - 40%. Include a 30 sec. delay in the dimming circuit to prevent interference caused by shadows and headlights.

LED drive current shall be regulated just as effectively when in the "dimmed state".

Design the drive modules to monitor the proper operation of the message display and to provide an alarm signal if the display is not operational.

Furnish the drive modules with the capability of providing a "confirmation" or "alarm" signal, which can be configured for 120VAC or 24VDC PLC application (sinking or sourcing type).

Provide drive modules with a green LED for power status and a red LED for alarm status.

Furnish all industry standard type, UL listed electronic components, available from wholesale electronics distributors.

14.3 CONSTRUCTION METHODS..

A. Housing:

Design the sign construction to be a modular concept consisting of the following "hand removable" self-contained modules: message displays, rack mounted individual message drivers, driver rack assembly and housing body.

Design the assembly of the sign to assure all internal components are adequately supported to withstand mechanical shock and vibration from wind ratings meeting AASHTO's requirements of 70mph with a 30% gust factor.

Do not use any self-tapping fasteners on the exterior of the sign.

Use only stainless steel mechanical fasteners.

Fabricate the weather proof housing entirely of .125 inches aluminum, 8 inches deep or 10 inches deep for two (2) sided signs.

Weld all corner seams to their full length using the "tig" (tungsten inert gas) process.

Affix a face shield lens to the inside aluminum door frame. Design the front door frame assembly to cover a gutter surrounding the full perimeter of the housing body and fit flush to the exterior of the sign body.

Provide a 12-inch deep sun visor made of 1/16 inch aluminum.

B. Driver Rack Assembly:

Furnish the driver rack assembly as a single part, self contained module consisting of an interconnect PCB and an anodized aluminum frame.

House up to 6 drive modules with the driver rack.

Vent the aluminum rack from top to bottom and include latches to lock the modules in place.

Secure the driver rack assembly in the sign enclosure by four (4) captive type spring-loaded thumbscrews. Design the entire assembly to be removable in less than one minute without the need of any tools.

Include connectors for 6 drive modules and 6 display messages in the interconnect PCB.

Include terminals for all field wiring in the interconnect PCB: 120VAC controls, external photocell, and alarm signals.

Furnish field wiring and display terminals to be the spring loaded "anti-vibration" type.

Make all interconnections within the OPEN/CLOSED sign through this PCB, and permit no internal wiring with the exception of a single cable for the message display.

Equip the interconnect PCB with a 10-position binary switch for each message to allow the drive current to be calibrated for each individual message and to increase drive current in case of long-term degradation to LED's. Each step shall provide a 1mA increment up to a maximum of 25mA.

Identify all connectors and terminals via the silk screen identifier on the surface of the PCB.

Mount the driver rack assembly on the left side of the sign enclosure.

Mount all PCB's vertically to facilitate air-cooling and prevent collection of dust and moisture.

C. Maintenance:

Design the sign as a "Total Modular Concept" requiring no preventative maintenance.

Furnish all components to be "plug-in type" that can be removed by hand without any tools.

Design the sign such that defective modules are easy to locate for immediate replacement in case of malfunction. Defective modules may be repaired in shop or returned to manufacturer for warranty repairs.

Design the sign such that required on-site servicing time is kept to a minimal (less than 5 minutes) to prevent extended lane closures that could result in safety hazards and traffic disruptions.

Use only "Solid State" type components.

Use no electro-mechanical components such as relays, transformers or solenoids to control this sign.

Warrant the LED OPEN/CLOSED for a period of two (2) years after installation date. Replace or repair signs that fail to function as intended due to workmanship or material defect.

14.4 METHOD OF MEASUREMENT.

The actual number of LED OPEN / CLOSED signs furnished, installed and accepted. The price includes the sign housing, display elements, all electronics, cabling and wiring, electrical conductors, hardware to mount the sign, documentation, testing and all necessary hardware to provide a functional system.

14.5 BASIS OF PAYMENT.

The work described above will be paid for at the contract unit price each for "LED OPEN / CLOSED Sign".

Payment will be made under:

LED OPEN / CLOSED Sign..... Each

15. CENTRAL COMPUTER SOFTWARE

15.1 DESCRIPTION.

A. General:

Furnish and install Central Computer Software in accordance with the Plans and Project Special Provisions.

Furnish and install an integrated software package under this Contract that provides, at a minimum, the functionality of the existing software at the Hillsborough Weigh Station, in addition to providing the functionality described in Section 1 of these Project Special Provisions and described herein.

B. Screening Criteria:

1. Operation Overview:

Interface the ROC System to the WIM Sorting System and preclearance program. The only vehicles that will be notified by the ROC system will be commercial vehicles that possess a preclearance transponder, all other vehicles will not be effected. The ROC system must match the data structure of the existing Hillsborough ROC system so the Department can use their existing data transfer procedures. The system must be upgradeable to the newest version of SAFER.

The ROC System will provide two way communication between vehicle-mounted active transponders, and a roadside-based reader unit. The ROC system shall have the capability to read transponders and cause the transponder to activate red or green signals and audible alerts on the transponder. The ROC system shall be able to direct a specific trigger to a specific target transponder.

The ROC system interfaces to three locations: Advance, Notification, and Compliance locations.

The advance location purpose is to read transponders of specific carriers. Carrier identification is obtained from the transponder at this location. This information is cross referenced with valid transponders in the preclearance system to determine credential and load information.

As the driver passes the In-Cab Notification location the preclearance system will send a signal to the in-cab transponder which conveys the response. This notification is presented to the driver visually and/or audibly. The driver will either receive a green light to bypass the weigh station or a red light and audible sound to enter the weigh station.

The final AVI location that a preclearance user will encounter is the Compliance location. This location is used to verify that the user has performed the action as communicated to them via their transponder.

If a commercial vehicle continues down the mainline, bypassing the weigh station exit ramp, the vehicle will pass by a sensor configuration of loop-axle sensor-loop -axle sensor-loop. This sensor configuration is used for the purpose of vehicle tracking and data collection. An alarm will sound on the scale house manual console in the event that a commercial vehicle bypasses an "open" station.

Provide a ROC system that consists of three major components:

- A snapshot database containing a local copy of CVIEW and SAFER data,
- A credential processing and screening software algorithms, and
- A Windows-based graphical user interface (GUI) for accessing the snapshots and credential screening components.

The specific major functions fulfilled by the baseline ROC software are:

- record all vehicle characteristics in a database,
- produce reports of recorded vehicle characteristics,
- screen vehicles for credential violations,
- screen vehicles for safety violations,
- screen vehicles using operator defined hot lists,
- allow duly authorized operators to adjust screening criteria, and
- allow the operator to view vehicle screening results and CVIEW snapshot information.

The software must maintain a configurable number of months, minimum of 3 months, maximum of 12 months, of historical vehicle data for analysis and reporting. Purge this data from the system on a weekly basis (i.e., once per week the software will examine all of the vehicle records to determine which are older than the specified expiry period and delete them from the database). The day and time at which this purging takes place shall be configurable by a system administrator. Set the purging to normally occur during Saturday or Sunday or during some other time when the weigh station is not busy.

2. ROC System Characteristics:

a. Roadside Operations Requirements:

Provide the ROC System with the following functions:

- vehicle screening,
- vehicle display,
- vehicle reporting,
- CVIEW interface, and
- Station controls (CMS, VMS, LCS1, LCS2, static scales)

Furnish the ROC System to produce printed reports detailing vehicle activity at the weigh station. This function is known as vehicle reporting.

Furnish the ROC System to provide an interface to the state CVIEW system to update the local credential and safety database. This function is known as the CVIEW interface.

Furnish the ROC System maintain a vehicle record for each vehicle entered into the system.

Furnish the ROC System vehicle record to contain the following information about each vehicle (when available):

- Unique vehicle identifier,
- Vehicle number,
- Time and date stamp,
- Lane,
- Axle counts,
- Vehicle classification,
- Overall vehicle weight,
- Maximum gross vehicle weight,
- Vehicle length,
- Error code,
- Vehicle speed,
- Axle record type,
- ESAL value,
- Screening decision,
- Transponder ID from DSRC transponder,
- Vehicle identification number from DSRC transponder,
- Carrier ID from DSRC transponder,
- Carrier ID (USDOT number) from CVIEW data,
- Axle weights, and
- Axle spacing.

Interface the ROC System to the CVIEW system for receiving commercial vehicle data as described below.

b. Screening Requirements:

Design the ROC System to maintain an operator-defined hot list of carriers that are required to report to the scale house regardless of their weight or safety credential status.

Include on the carrier hot list an active date range for each entry defining the period in which the entry is valid.

Include the following information on the carrier hot list:

- Carrier ID,
- Comments – the user can enter what action to take when the vehicle reports or any other information that would be useful,
- Start date – when the hot list status starts, and
- End date – when the hot list status ends.

Design the ROC System to maintain an operator-defined hot list of vehicles that are required to report to the scale house regardless of their weight or safety credential status.

Include on the vehicle hot list an active date range for each entry defining the period in which the entry is valid.

Include the following information on the vehicle hot list:

- Vehicle ID (which could be the VIN or license plate number),
- Comments – the user can enter what action to take when the vehicle reports or any other information that would be useful,
- Start date – when the hot list status starts,
- End date – when the hot list status ends, and
- Jurisdiction – identifies registering jurisdiction.

Program the ROC System to maintain a local database of carrier snapshot data received from CVIEW.

Program the ROC System to maintain a local database of vehicle snapshot data received from CVIEW.

Program the ROC System to permit the operator to override each specific credential/safety screening check on a carrier by carrier basis. Any credential or safety item that is overridden is not checked as part of the screening process for the designated carrier.

Program the ROC System to permit the operator to override each specific credential/safety screening check on a vehicle by vehicle basis. Any credential or safety item that is overridden is not checked as part of the screening process for the designated vehicle.

c. Display Requirements:

Program the ROC System to provide a Screening Results Display screen that permits the operator to do the following:

- View the credentials and safety scores that were used in screening a particular vehicle,
- Display which credentials and safety scores failed,
- Display which credentials and safety scores a vehicle is currently failing (if the operator requested updated snapshot data from CVIEW, the screening results may no longer be accurate), and
- Display whether the vehicle was directed to report as a result of appearing on a particular hot list.

Design the ROC System to permit an operator with the proper authority to:

- Specify which credentials and safety items to use to screen vehicles,
- Enable or disable each individual screening criteria,
- Enter a minimum/maximum allowable value to be used for each safety item while screening vehicles,
- Save a default configuration of screening criteria to be recalled at some point in the future,
- Quickly and easily return all credential and safety score screening criteria to their default values,

- Permit the operator to retrieve current vehicle and carrier snapshot data from CVIEW and store it in the local database,
- View snapshot data retrieved from CVIEW for any requested vehicle or carrier.
- Restrict access to system functions with a user identification and password scheme. The adjustment of screening criteria in particular must be restricted to only personnel with the required privileges,
- Produce reports on vehicle data,
- Permit the operator to view all historical, vehicle data for any vehicle that has passed through the station in the last three months, and
- Edit each of the hot lists.

d. Reporting Requirements:

Program the ROC system to produce the following reports:

- CLASS BY HOUR: showing the count of vehicles in each class for each hour of the day,
- CLASS BY DAY: showing the count of vehicles in each class for each day of the week,
- SPEED BY CLASS: showing the count of vehicles in each speed range for each class of vehicle,
- SPEED BY HOUR: showing the count of vehicles in each speed range for each hour of the day,
- FRONT AXLES: showing the count of all front axles recorded within different weight ranges for each vehicle class,
- SINGLE AXLES: showing the count of all single axles recorded within different weight ranges for each vehicle class,
- TANDEM AXLES: showing the count of all tandem axles recorded within different weight ranges for each vehicle class,
- TRIDEM AXLES: showing the count of all tridem axles recorded within different weight ranges for each vehicle class,
- QUADREM AXLES: showing the count of all quadrem axles recorded within different weight ranges for each vehicle class,
- GROSS VEHICLE WEIGHT: showing the count of vehicles in each Gross Vehicle Weight range for each vehicle class. Display the total GVW in a separate column,
- ERRORS: showing the hourly count of vehicle display errors reported by the system,
- TOTAL ESAL: showing the hourly summary of Equivalent Single Axle Loads for each vehicle class,
- LANE COUNT: showing the count of vehicles in each class for each lane at the weigh station,

- WEIGHT VIOLATION BY CLASS: showing for each vehicle class, the total vehicle count, the number of valid vehicles, the number of warning vehicles, the number of violating vehicles, what percentage of the total was violating, the number of single axle violations, and the number of tandem axle violations,
- WEIGHT VIOLATION BY HOUR: showing for each hour of the day, the total vehicle count, the number of valid vehicles, the number of warning vehicles, the number of violating vehicles, what percentage of total was violating, the number of single axle violations, the number of tandem axle violations and the number of GVW violations, and
- WEIGHT VIOLATION COUNT: showing for each hour of the day and each vehicle's class, the total vehicle count, the number of valid vehicles, the number of warning vehicles, the number of violating vehicles, what percentage of total were violating, the number of single axle violations, the number of tandem axle violations and the number of GVW violations.

Program the ROC system to produce two specific reports that are based on data stored in the ROC system. These reports include:

- Number of vehicles traveling down each lane, and
- listing of a carrier's vehicles passing the station during a specific time period, include when the vehicle passed the station, whether it was given a bypass or report signal, and the reason a report signal was given.

e. Intra-State Credential Enforcement Screening:

All of the Intra-State credential enforcement screening items identified below shall be capable of being enabled and disabled by the operator in the screening setup screen and the vehicle display screen:

- Direct a vehicle to report if the vehicle's Intra-state vehicle registration expired prior to a user-definable number of days ago,
- Direct a vehicle to report if the vehicle's measured GVW is greater than the vehicle's registered GVW plus 1000 lbs,
- Direct a vehicle to report if the vehicle is registered to use six axles and the WIMS detects fewer than six axles and the vehicle's measured GVW is greater than 73,280 lbs, and
- Direct a vehicle to report if the Intra-state enforcement registration is suspended.

Program the ROC System to display the registered weight of the vehicle at the operator workstation.

f. SSRS Credential Enforcement Screening:

All of the SSRS credential enforcement screening items identified below shall be capable of being enabled and disabled by the operator in the screening setup screen and the vehicle display screen:

- Direct a vehicle to report if the carrier has an MC (ICC) number in CVIEW and does not have an SSRS credential in State. When the MC or ICC numbers are eliminated, the same rule will apply with the USDOT number,

- Direct a vehicle to report if the SSRS credential is suspended, and
- Display the HazMat status in SSRS at the operator workstation to aid in operator inspections.

g. Exempt Credential Enforcement Screening:

All of the exempt credential enforcement screening items identified below shall be capable of being enabled and disabled by the operator in the screening setup screen and the vehicle display screen:

- Direct a vehicle to report if the vehicle's Exempt credential is revoked, and
- Direct a vehicle to report if the vehicle's Exempt credential is cancelled.

h. HazMat Credential Enforcement Screening:

All of the HazMat credential enforcement screening items identified below shall be capable of being enabled and disabled by the operator in the screening setup screen and the vehicle display screen:

- Direct a vehicle to report if the vehicle's HazMat credential is revoked,
- Direct a vehicle to report if the vehicle's HazMat credential is suspended,
- Direct a vehicle to report if the vehicle's HazMat status is expired,
- Use a separate random screening adjustment to decide whether to direct vehicles with HazMat credentials to report. This random screening is used to direct a percentage of vehicles to report when no other screening rule results in an inspection, and
- Display the HazMat permit number and type at the operator workstation to aid in operator inspections.

i. IRP Credential Enforcement Screening:

All of the IRP credential enforcement screening items identified below shall be capable of being enabled and disabled by the operator in the screening setup screen and the vehicle display screen. IRP enforcement only applies to inter-state carriers.

- Direct a vehicle to report if the vehicle's IRP credential expired prior to a user-definable number of days ago,
- Direct a vehicle to report if the vehicle's IRP credential is suspended,
- Direct a vehicle to report if it is an out-of-state vehicle, the measured GVW is greater than 26,000 lbs. and it does not have an IRP credential,
- Direct a vehicle to report if the GVW measured by the WIM is greater than the IRP registered GVW plus 1000 lbs.,
- Direct a vehicle to report if the vehicle is registered to use six axles and the WIM detects fewer than six axles and the WIM measures a GVW greater than 73,280 lbs., and
- Direct a vehicle to report if the HVUT status is unsatisfactory.

j. IFTA Credential Enforcement Screening:

All of the IFTA credential enforcement screening items identified below shall be capable of being enabled and disabled by the operator in the screening setup screen and the vehicle display screen. IFTA enforcement only applies to inter-state carriers.

- Direct a vehicle to report if the IFTA credential is suspended for the carrier,
- Display the reason for suspension of a carrier's IFTA credential at the operator workstation,
- Direct a vehicle to report if the IFTA credential for the carrier expired prior to a user-definable number of days ago, and
- Direct a vehicle to report if the carrier is an out-of-state carrier and no IFTA credentials are found for the carrier.

k. Safety Enforcement Screening:

All of the safety enforcement screening items identified below shall be capable of being enabled and disabled by the operator in the screening setup screen and the vehicle display screen.

- Direct a vehicle to report if the SCE/ISS safety score is greater than an operator defined threshold for screening,
- Display the vehicle SAFESTAT score at the operator workstation,
- Exclude a vehicle from the random pull-in process if the vehicle has a current CVSA decal in the vehicle snapshot and the vehicle does not have a current HazMat credential,
- Direct a vehicle to report if the carrier is designated as currently OOS, and
- Direct a vehicle to report if the vehicle has been designated as OOS within the last user-definable number of days.

l. Oversize/Overweight Enforcement Screening:

All of the oversize/overweight enforcement screening items identified below shall be capable of being enabled and disabled by the operator in the screening setup screen and the vehicle display screen.

- Direct a vehicle to report if the vehicle has a current over-width permit and the WIM measured GVW is greater than the empty weight on the permit plus a user settable tolerance,
- Direct a vehicle to report if the WIM measures a vehicle length greater than the length allowed in any current over-length permit for the vehicle,
- Direct a vehicle to report if the over-height detection feature of the WIM is disabled and the vehicle has a current over-height permit and the WIM measured GVW is greater than the empty weight on the permit plus a user settable tolerance,
- Direct a vehicle to report, regardless of any current over-height permits issued for the vehicle, if the WIM makes an over-height determination,

- Direct a vehicle to report if the WIM measures a GVW that is equal to or greater than the GVW permitted in any current over-weight permits for the vehicle,
- Direct a vehicle to report if the vehicle fails the bridge formula for legal sized loads and does not have a current oversize/overweight or overweight permit,
- Treat vehicles with a current single trip or annual permit that have a WIM measured GVW less than the empty vehicle permit weight plus a user settable tolerance as if the vehicle does not have a permit. Specifically, the vehicle will be checked using "legal" height, weight, and length settings and will be directed to report if any legal settings are violated.
- Direct a vehicle to report if the vehicle does not have a current single trip permit and it has a current annual permit with a height, width, length or weight category greater than the user specified maximums for reduced restrictions and a current route approval does not exist and the empty permit weight has been exceeded by more than a user settable tolerance, and
- Direct a vehicle to report if the vehicle has a current annual permit and no current single trip permit and the vehicle violates any of the following:
  - the WIM measured distance between any 2 axles is less than the minimum allowed for annual permits where the minimum is user settable,
  - the WIM measured distance between the steering axle and the next axle is less than the minimum allowed for annual permits where the minimum is user settable,
  - the WIM measured distance from the front axle to the rearmost axle is greater than the maximum allowed for annual permits where the maximum is user settable,
  - the WIM measured spacing on any tridem is greater than the maximum allowed for annual permits where the maximum is user settable,
  - the WIM measured spacing on any quadrem is greater than the maximum allowed for annual permits where the maximum is user settable,
  - the WIM measured spacing on any tandem is greater than the maximum allowed for annual permits where the maximum is user settable,
  - the permit is an "overweight" or "oversize/overweight" permit and the number of axles detected by the WIM is less than the minimum number allowed for annual permits where the minimum is user settable, and
  - the permit is an "overweight" or "oversize/overweight" permit and the number of axles detected by the WIM is greater than the maximum number allowed for annual permits where the maximum is user settable;
- Direct a vehicle to report if the vehicle has a current single trip permit or a current annual permit with an approved route that required actual axle spacings and axle group weights to be specified and the vehicle violates any of the following,

- axle spacing detected by the WIM is greater than the axle spacing on the permit plus a user specified tolerance,

- axle spacing detected by the WIM is less than the axle spacing on the permit minus a user specified tolerance, and

- axle group weights detected by the WIM are greater than the axle group weights specified on the permit;

- Allow the weight tolerance for permits to be adjusted in a way similar to how the weight tolerance for non-permitted vehicles is adjusted in the existing system,
- Direct a vehicle to report if the vehicle has a current single trip permit or a current annual permit and the weight distribution on the axles within any axle group is uneven and it is uneven by more than a user specified tolerance,
- Allow a user to enter the maximum single axle weight that is allowed for each axle group (single, tandem, tridem, quadrem) in each of the annual permit axle load weight categories (A, B, C),
- Direct a vehicle to report if the vehicle has a current annual permit and no current single trip permit and the WIM detected axle group weights exceed the maximum for the annual permit axle load weight category specified in the route approval or in the annual permit, if no route approval exists,
- Allow a user to enter the maximum GVW that is allowed for a vehicle in each of the annual permit axle load weight categories (A, B, C) when the vehicle has 5 axles, 6 axles, 7 axles with 2 tridem groups, 7 axles with tandem and quad groups, or 8 axles, and
- Direct a vehicle to report if the vehicle has a current annual permit and no current single trip permit and the WIM detected GVW exceeds the maximum allowed for the vehicle's axle configuration in the annual permit axle load weight category specified in the route approval or in the annual permit, if no route approval exists.

3. External Interface Requirements:

Program the ROC System to support the receipt of carrier and vehicle snapshot data from the State CVIEW system using the same interface as the existing northbound IROC.

Program the ROC System to continue normal operation while receiving and processing files from the state CVIEW system and to support the processing of data at a rate to be determined, but which may be as often as an update every 15 minutes.

C. Operator Interface and System Controls:

1. General Operation:

A system operator shall be able to view and control system operations via the operator computers; one located in the scale house and the other located in the static scale booth. Using the operator computer, the operator will view vehicle data collected by each of the detectors and sensors in the system, view and print reports, identify and respond to system alarms, view freeze-frame images of violating vehicles and control the pull-in multipliers. At a minimum, the operator display screens shall allow the system operator to view the following information:

a. Vehicle Queue Data:

Design the system to allow operators to view vehicle records for each of the queues at the weigh station (left lane static scales, right lane static scales, and ramp bypass queue. Program the system to show data collected by the mainline and in-station detectors.

b. Individual Vehicle Data:

Program the system to display all information on a specific vehicle collected by the new equipment installed on the Interstate as well as all ramp equipment. Have the system identify why a vehicle was not provided mainline bypass (i.e. no transponder, overweight, overheight, etc.). Program the system to allow operators to view snapshot photographs taken of vehicles via the freeze-frame CCTV camera at the Advance Location. Program the system to allow operators to view all credential information (for transponder-equipped vehicles).

c. Alarms:

Program the system to allow operators to review alarms reported by the Advance Location and the Compliance Location and to allow operators to view snapshot photographs taken by the freeze-frame CCTV camera of violating vehicles at the Compliance Location.

d. Back-Up Types:

- Static Scale Queue > 4, increase weight threshold to 110% automatically. When < 3 weight threshold, return to original setting,
- Report Lane Loop on > 30 seconds, automatically bypass vehicles. Operator manually re-opens report lane when queue has shortened, and
- Ramp WIM Loop > 30 seconds, automatically close the station. Operator manually re-opens station when queue has shortened.

e. Summary Data:

Program the system to allow operators to review summary data for all lanes equipped with system devices. Have the Summary data include total vehicle counts, vehicle classifications, vehicle speeds, gross vehicle weights (by category), axle weights and system violations (by type including weight, length, overheight and credentials).

2. Periods of Inactivity

Design the operator computer software interface such that following a user-specified period of inactivity (i.e., no keystrokes and no mouse movements), the operator computer will lock out. An operator may regain access by 1) either striking any key or moving the mouse, and 2) entering a valid user ID, and 3) entering the appropriate password for the user. The user will then be immediately reconnected to the WIM system. Protracted delays and/or multiple steps, beyond those just described, to reconnect the operator computer to the WIM system are unacceptable.

D. System Reports:

Design the software to provide all of the reports available from the existing system software and to provide the following additional reports for the new system components, as a minimum:

- Violations,

- Classification (by hour, by day of the month and by day of the week),
- Vehicle speed (by class and by hour),
- ESALs (Equivalent Single Axle Loads) by Hour,
- Weight violations (by hour and by class),
- Weight violations count,
- % of transponder-equipped vehicles,
- % of vehicles bypassed by the mainline equipment,
- % of vehicles bypassed by the in-station equipment,
- Truck count (by day of the month and by day of the week),
- Truck count by gross vehicle weight,
- Vehicle speeds (by class and by hour),
- System errors (errors reported by system diagnostics),
- Vehicle heights (by class and by hour), and
- Vehicle lengths.

E. Database Queries

Design the software to provide an operator at any operator computer the ability to perform data queries on any database item and combination of database items. Furnish the ability to view the results of database queries on the operator computer screen and to optionally print the database queries on the laser printer in a format acceptable to the Department.

F. System Updates

During the course of project construction, as system components are made operational and brought online for the westbound weigh station, perform software updates to corresponding system components of the eastbound weigh station such that the two stations are operating from identical software versions and that operators are always presented with identical functionality and the same user interface. Continue to update the WIM software of both weigh stations with identical software versions throughout the project and through to the end of the warranty period.

15.2 MATERIALS.

Provide reproducible copies of all software on CD-ROM. Furnish all software pre-installed on computer hardware prior to installation. Provide source code for the portions of the software that must be changed in order to change the screening criteria.

Computer hardware used to run the software described in this Special Provision is accounted for in other specifications in this document.

Provide mockups for all operator screens and system reports prior to generating/developing the screens and reports. Make changes to the report formats and screen views based on the Department's comments.

15.3 METHOD OF MEASUREMENT.

Central Computer Software will be paid for as a lump sum for the software furnished, installed, updated and accepted and for software source code for the screening criteria. Supply the necessary Oracle tools to compile screening criteria portion of software.

15.4 BASIS OF PAYMENT.

Central Computer Software, as describe above, will be paid for at the contract lump sum price for "Central Computer Software"

Payment will be made under:

Central Computer Software .....Lump Sum

16. TWISTED-PAIR COMMUNICATIONS CABLE

16.1 DESCRIPTION.

Furnish and install twisted-pair communications cable with all necessary hardware in accordance with the plans and specifications. Comply with the provisions of Section 1700 of the Standard Specifications.

16.2 MATERIALS.

A. General:

Furnish communications cable with all other tools, materials, and hardware required for successful completion of the work, including but not limited to communications cable identification markers (cable wraps), couplings, connectors, machine bolts, eye bolts, strandvises, cable suspension clamps, and pole bands.

B. Communications Cable:

Furnish RUS CFR 1755.390 6-pair, 19-gauge, shielded, twisted-pair, underground communications cable.

Have the manufacturer factory test the communications cable on reels for each pair's mutual capacitance, crosstalk loss, insulation resistance, and conductor resistance. Furnish the Engineer with a certified report for each reel showing compliance with the IMSA or REA specification, the factory test results, and the manufactured date of the cable. Do not use communications cable manufactured more than one year before the date of installation.

Provide sequential foot markings within one percent of the actual cable length and as required by Section 350G of the National Electrical Safety Code. Provide approximately 1/10-inch character height of the markings.

16.3 CONSTRUCTION METHODS.

A. General:

Install communications cable in conduits to bring the cable into out of each equipment cabinet.

Take all precautions necessary to ensure the communications cable is not damaged during storage and installation. Do not step on the cable nor run over the cable with vehicles or equipment. Do not pull the cable over or around obstructions, or along the ground.

Immediately cease work and notify the Engineer and the affected owner should damage to existing cables or equipment occur. Make the required repairs at no additional cost to the Department.

Install communications cable in continuous lengths from one signalized intersection to the next with no splices outside the cabinet.

Keep the communications cable ends sealed at all times during installation to effectively prevent the ingress of moisture. Use a silicone impregnated heat shrink cable end cap approved by the Engineer. Do not use tape to seal the cable ends.

Notify the Engineer in writing a minimum of ten days before beginning communications cable testing.

Test the integrity of the communications cable before installation based on IMSA 20-4, 19-gauge wire standard.

Test the cable insulation for a resistance of more than 500 megohms for each insulated conductor when measured with all other insulated conductors and the shielded ground before installation. Make the measurement with a DC potential of at least 100 volts but not more than 550 volts applied for 1 minute. Furnish the test results to the Engineer.

Wire communications cable into the cabinet. Allow a minimum of 10 feet of slack for communications cable that is not immediately terminated.

B. Underground Installation:

Install underground communications cable in conduit as called for in the Plans using cable-pulling lubricants approved by the communications cable manufacturer and the Engineer. Obtain the Engineer's approval of the cable lubricant and method of pulling before the installation of underground communications cable.

Do not exceed 80 percent of the manufacturer's maximum pulling tension when installing underground communications cable.

Use a clutch device (dynamometer) so as not to exceed the allowable pulling tension if the cable is pulled by mechanical means. Do not use a motorized vehicle to generate cable-pulling forces.

Keep tension on the cable reel and the pulling line at the start of each pull. Do not release the tension in the cable if the pulling operation is halted. Restart the pulling operation by gradually increasing the tension until the cable is in motion.

Set cable reels up on the same side of the junction box as the conduit section in which the cable is to be installed. Place the reel level and align the reel with the conduit section such that the cable will pass from the top of the reel in a smooth bend into the conduit without twisting. Do not pull the cable from the bottom of the reel. Manually feed the cable by rotating the reel. Do not pull the cable through intermediate junction boxes, pull boxes, handholes, or openings in conduit unless otherwise approved by the Engineer.

C. Bonding and Splicing:

Terminate all cable pairs in a neatly arranged manner. Use binding-type screw terminal strips of sufficient size to terminate all cable pairs. Clean the terminals before terminating the cable. Apply non-insulated, Number 18-20, spade crimp terminals to the cable using a calibrated ratchet type crimp tool. Solder the terminals and coat the binding-type screw terminal strips and connections with a corrosive-prevention material after crimping.

Splice communications cable within the controller cabinets and splice cabinets. Do not splice within pull boxes.

Ground the shield only on one end of the cable to a ground rod using insulated (green) number 14 AWG standard copper wire at all controller cabinet locations. Bond and ground the cable shields as required by REA Standard PC-2.

16.4 METHOD OF MEASUREMENT.

Actual linear feet of twisted-pair communications cable furnished, installed, and accepted. Measurement will be made by calculating the difference in length markings located on the outer jacket of the twisted-pair communications cable from the start of the cable run to the end of the cable run for each cable run. Terminate all pairs before determining the length of cable run.

16.5 BASIS OF PAYMENT.

The quantity of twisted-pair communications cable, measured as provided above, will be paid for at the contract unit price per linear foot for "Communications Cable (___-Twisted-Pair)."

Payment will be made under:

Communications Cable (___-Twisted-pair) .....Linear Foot

17. FIBER OPTIC CABLE

17.1 DESCRIPTION

Furnish and install multi mode fiber optic (MMFO) communications cable and all necessary hardware in accordance with the Plans and Project Special Provisions.

17.2 MATERIALS.

Furnish loose tube, dielectric fiber optic cable that is listed in the latest edition of the Rural Utilities Service (RUS) List of Materials Acceptable for Use on Telecommunications Systems of RUS Borrowers, category oc-d-F, and having a tensile rating of at least 600 pounds. The cable sheath shall have length markings in feet, and shall indicate that the unit of measure in feet. The cable shall have an operating temperature range of –40° F to 160° F.

Furnish all fibers that are suitable for transmission using both 850 nm and 1300 nm wavelengths. Attenuation shall not exceed 5.5 dB/mi for 850 nm and 1.5 dB/mi for 1300 nm signals, respectively. Bandwidth shall be at least 125 MHz-mi for 850 nm and 310 MHz-mi for 1300 nm signals, respectively. Core size shall be 62.5 µm in a 125 µm fiber.

17.3 CONSTRUCTION METHODS.

A. Installation:

Install the cable such that the optical and mechanical characteristics of the fiber are not degraded. Unless otherwise approved by the Engineer, use equipment and procedures specified in the latest edition of Corning Cable Systems Recommended Procedure SRP-005-011, and as indicated below. Install the cable in such a way that neither the minimum bend radius nor the maximum tension are violated, both during and after installation.

Before any cable installation is performed, provide the Engineer with four (4) copies of the cable manufacturer's recommended and maximum pulling tensions for each cable size. These pulling tensions shall be specified for pulling from the cable's outer jacket. Also provide a list of the minimum allowable cable bending radius and the cable manufacturer's approved pulling lubricants. Only these lubricants will be permitted.

If the cable is pulled by mechanical means, use a clutch device to ensure the allowable pulling tension is not exceeded. Attach a strain gauge to the pulling line at the cable exit location, and at a sufficient distance from the take-up device, such that the strain gauge can be read throughout the entire cable pulling operation.

Use an approved lubricant, in the amount recommended by the cable manufacturer, to facilitate pulling the cable. After the cable has been installed, wipe the exposed cable in a junction box or cabinet clean of cable lubricant with a cloth before leaving the junction box or cabinet.

Store slack fiber optic cable in oversized junction boxes as shown in the Plans. Neatly store slack cable in the junction box.

B. Labeling:

Label every new cable or wire immediately upon installation. Label the cables at every point of access, including junction boxes, and termination points. Use self-laminating vinyl labels at least 1 ½ in. wide and long enough that the translucent portion of the label completely covers the white area bearing the legend. Provide vinyl coated with pressure sensitive acrylic adhesive on one side. The labels shall resist oil, water, and solvents and shall be self-extinguishing. The legend shall be machine printed in letters at least 1/8 in. high. The method of identifying the cables shall be as directed by the Engineer.

C. Splicing:

Splice all optical fibers, including spares, to provide continuous runs. Perform splices only in equipment cabinets.

Perform all splices using a fusion splicer that automatically positions the fibers to minimize splice loss. Provide all equipment and consumable supplies.

Package each spliced fiber in a protective sleeve or housing. Recoat bare fibers completely with a protective room temperature vulcanizing (RTV) coating, gel or similar substance, prior to application of the sleeve or housing, so as to protect the fiber from scoring, dirt or microbending.

Provide organizer trays to hold the spliced fibers, with each fiber neatly secured to the tray.

Test each splice using equipment and procedures approved by the Engineer. The test shall measure the attenuation of light injected into the fiber, passing through the splice. Average splice loss shall not exceed 0.05 dB and no splices may have a loss above 0.1 dB. Remake any splice with a loss exceeding 0.1 dB until its loss falls below 0.1 dB.

Prepare a form or table for use in documenting the splices that are made, and submit this form or table for approval by the Engineer. Use this form or table in recording the splice loss associated with each splice. The Engineer or his representative will witness all splice loss measurements. Submit these forms or tables to the Engineer within 5 days of the splice being made.

D. Termination:

In cabinets where the optical fibers are connected to terminal equipment, provide matching connectors with factory-installed fiber pigtails of sufficient length, plus 5 feet of slack, and splice them to the corresponding optical fibers. Furnish fiber pigtails that are buffered and strengthened with aramid to reduce the possibility that accidental mishandling will damage the fiber or connection. Use ST connectors with ceramic ferrules for fiber pigtails.

Anchor pigtails within the splice enclosure by clamping the aramid yarn to ensure that pulling on the pigtail does not result in a stress on the splices, fibers, or other components inside the enclosure. Ensure that the pigtail cannot pivot around the point where it is anchored, causing flexing of the fibers inside the enclosure.

Use spiral wrap to guide and protect bundles of pigtails between the splice enclosure and equipment.

17.4 METHOD OF MEASUREMENT.

Actual linear feet of fiber optic cable of each fiber count furnished, installed, and accepted. Measurement will be made by calculating the difference in length markings located on the outer jacket of the fiber optic cable from the start of the fiber run to the end of the fiber run for each fiber run. Terminate all fibers before determining the length of the cable run.

No measurement will be made for terminating, termination panels, wall-mounted cable enclosures, splicing, labeling, and testing of the fiber optic cable, or for splice trays, cable support hooks, and pigtails as this will be considered incidental to the installation of the fiber optic cable.

17.5 BASIS OF PAYMENT.

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

Payment will be made under:

Communications Cable (____-Fiber) .....Linear Foot

18. FIBER OPTIC INTERCONNECT CENTERS

18.1 DESCRIPTION.

Furnish and install fiber optic interconnect centers and all necessary hardware in accordance with the Plans and Project Special Provisions.

18.2 MATERIALS.

Furnish and install splice enclosures large enough to hold all the splices made at the location. The enclosure shall include mounting hardware suitable for the cabinet in which it is installed.

The splice enclosure shall use 3/8 in. tall splice trays, each holding 12 fusion splices.

The enclosure shall have provisions for cable and pigtail strain-relief, and shall be equipped with strain-relief hardware.

Mount the splice trays such that individual trays can be removed from the enclosure without disturbing the other trays or removing the enclosure itself from the cabinet.

Furnish enclosures that include storage for slack cable or fibers, mounting and strain relief hardware.

Furnish enclosures complete with all fiber optic jumpers as indicated in the splice details included in the plans.

18.3 CONSTRUCTION METHODS.

Label all fiber optic connectors to prevent improper connection. Obtain approval of the fiber optic connectors labeling method.

Ensure that all buffer tubes are contained within the splice tray so that no bare fibers are outside the tray.

No splicing will be permitted in the scale house or any existing cabinet until the WIM electronics and other new equipment pass the tabletop test at the Contractor's facility.

18.4 METHOD OF MEASUREMENT.

Actual number of fiber optic interconnect centers furnished, installed and accepted. No measurement will be made for pigtails, jumpers, and fusion splicing as these will be considered incidental to furnishing and installing fiber optic interconnect centers.

18.5 BASIS OF PAYMENT.

The quantity of fiber optic interconnect centers, measured as provided above, will be paid for at the contract unit price each for "Fiber Optic Interconnect Center."

Payment will be made under:

Fiber Optic Interconnect Center ..... Each

19. FIBER OPTIC TRANSCEIVERS

19.1 DESCRIPTION.

Provide and install fiber optic transceivers that enable the various devices in the field to communicate with each other and with the equipment in the scale house.

19.2 MATERIALS.

A. General:

Transceivers must meet the following requirements:

- Designed for multimode fiber,
- Compatible with the equipment to which it is connected,
- All transceivers of the same type shall be identical,
- Input Power: 115 VAC,
- Operating Wavelength: 850 or 1300 nm,
- Optical Connector: ST, and
- One or more LED indicators to permit monitoring of transceiver performance.

B. Multimode Field Transceiver:

Furnish and install this transceiver for use with the full motion video CCTV camera. Use this transceiver to convert the video signals from the camera into optical signals for transmission over a multi mode cable network. At the same time, use this transceiver to receive optical signals from the scale house converting them to electrical signals to control the pan, tilt, lens and camera functions. The serial data channel shall use EIA-422 communication. Furnish a transceiver with the following properties:

1. **Connectors:**
   - Video Output Type: BNC
   - Optical Output: Type ST
2. **Electrical Characteristics:**
   - Impedance: 75 ohms
   - Level 1 volt peak-to-peak nominal
   - Frequency Response: 30 Hz to 6 MHz, +/- 1 dB
   - Power Requirements: Not exceed 115 +/- 20 VAC, 60 +/- 3 Hz
3. **Optical Characteristics:**
   - Optical Power Budget: 18 dB minimum, at a distance of 3 miles
   - Optical Emitter: LED

C. Multimode Control Center Transceiver:

Furnish and install this transceiver to communicate with the full motion video CCTV camera. Use this fiber optic transceiver to convert the optical signals from the camera into electrical video signals for processing within the scale house. At the same time, use this transceiver to convert the electrical signals from the pan, tilt, camera and lens functions from the scale house into optical signals for transmission via the multi mode fiber to the CCTV camera. The serial data channel shall use EIA-422 communication. Furnish a transceiver with the following properties:

1. **Connectors:**
   - Video Output Type: BNC
   - Optical Output: Type ST
2. **Electrical Characteristics:**
   - Impedance: 75 ohms
   - Level 1 volt peak-to-peak nominal
   - Frequency Response: 30 Hz to 6 MHz, +/- 1 dB
   - Power Requirements: Not exceed 115 +/- 20 VAC, 60 +/- 3 Hz
3. **Optical Characteristics:**
   - Optical Power Budget: 18 dB minimum, at a distance of 3 miles
   - Optical Emitter: LED

D. 4-Channel Video Mux/Demux Pair with Data:

Furnish and install these devices to simultaneously transmit four channels of unidirectional real-time color video and one channel of bidirectional data over a single multimode fiber. The pair shall have a bandwidth of at least 10 MHz per channel and an optical budget of at least 10 dB. Rack mount the multiplexers in the existing racks within each scale house. Furnish devices that have the following properties:

1. **Video:**
   - Video Input: 1 volt pk-pk (75 ohms)
   - Input/Output Channels: 4
   - Differential Gain: <5%
   - Differential Phase: <5 degrees
   - Signal-to-Noise Ratio: 55 dB (typical)
2. **Data:**
   - Data Interface: RS-232, RS-422 and RS-485
   - Data Format: Manchester – Bi-phase
   - Data Rate: DC 100 kbps

3. **Optical:**
   - Wavelength: 850/1300 nm, Multimode
   - Number of Fibers: 1
   - Optical Power Budget: 10 dB at a distance of 1.2 miles

4. **Connectors:**
   - Optical: ST
   - Video: BNC
   - Data: Terminal Block with screw clamps

E. Contact Closure Transceiver:

Furnish and install these transceivers to provide one-way transmission of a contact closure over a single multimode fiber. Mount the transceiver in the westbound scale house in the operator's console as shown in the plans. Surface mount the transceiver in the LED OPEN/CLOSE sign controller cabinet. Furnish devices that have the following properties:

1. **Data:**
   - Contact Interface: Response time: 0.5 msec
   - Input: Dry contact closure
   - Output: SPST normally open relay, 0.5 A contact rating

2. **Optical:**
   - Wavelength: 850 nm, Multimode
   - Number of Fibers: 1
   - Optical Power Budget: 14 dB at a distance of 2.5 miles

3. **Connectors:**
   - Optical: ST
   - Contacts: Terminal Plug with screw clamps

F. Media Converter:

Furnish and install these device to pass Ethernet packets between unshielded twisted pair cable and two multimode fibers. Furnish devices that have the following characteristics:

- Operating humidity: 0-95 %
- Connectors: two RJ-45; two ST
- Standards: IEEE 802.3 and IEEE 802.3u
- Indicators: power, link, activity
- Enclosure: Metal
- 10Base-T and 100Base-T compatibility

- Full- and half-duplex compatibility
- 1 MB buffer memory

G. Data and Sync Transceiver:

Use this device for AVI transceivers to carry two serial data channels and two sync channels over four multimode fibers. Use a device recommended by the manufacturer of the weigh-in-motion electronics.

19.3 CONSTRUCTION METHODS.

The equipment in this section may not be installed until the successful completion of the tabletop test at the Contractor's facility (see the section, "Testing and Acceptance").

19.4 METHOD OF MEASUREMENT.

Actual number of fiber optic transceivers of each type tested, furnished, installed and accepted.

Actual number of 4-channel video mux/demux pairs with data furnished, installed, tested and accepted.

Actual number of contact closure transceivers furnished, installed, tested and accepted.

Actual number of media converters tested, furnished, installed and accepted.

19.5 BASIS OF PAYMENT.

The quantity of multimode field transceivers, measured as provided above, will be paid for at the contract unit price each for "Multimode Field Transceiver."

The quantity of multimode control center transceivers, measured as provided above, will be paid for at the contract unit price each for "Multimode Control Center Transceiver."

The quantity of 4-channel video mux/demux pairs with data, measured as provided above, will be paid for at the contract unit price each for "4-Channel Video Mux/Demux Pair with Data". This item includes a multiplexer, demultiplexer, power supply, cables, and labeling.

The quantity of contact closure transceivers, measured as provided above, will be paid for at the contract unit price each for "Contact Closure Transceiver." This item includes transceivers, power supplies, cables, and labeling.

The quantity of media converters, measured as provided above, will be paid for at the contract unit price each for "Media Converter."

The quantity of data and sync transceivers, measured as provided above, will be paid for at the contract unit price each for "Data and Sync Transceiver."

Payment will be made under:

Multimode Field Transceiver ..... Each

Multimode Control Center Transceiver ..... **Each**

4-Channel Video Mux/Demux Pair with Data ..... **Each**

Contact Closure Transceiver ..... **Each**

Media Converter ..... **Each**

Data and Sync Transceiver ..... **Each**

20. DELINEATOR MARKERS

20.1 DESCRIPTION.

Furnish and install delineator markers with all necessary hardware in accordance with the Plans and Project Special Provisions.

20.2 MATERIALS.

Furnish delineator markers and all necessary hardware. Furnish delineator markers that are a tubular design, approximately 8 feet long, and constructed of a Type III, high density polyethylene material. Provide delineator assemblies that are ultraviolet stabilized to help prevent components from color fading, warping, absorbing water and deteriorating with prolonged exposure to the elements. Provide delineators designed to self-erect after being knocked down or pushed over. Provide delineators posts that are orange in color.

Provide text, including the Division contact number, that is hot stamped in black on a yellow reflective background material that will not fade or deteriorate over time. Provide delineator markers with a nominal message height of 15 inches and that contain the following text visible from all directions approaching the assembly

W A R N I N G	F O C I P A B T B E I L R C E S
BEFORE EXCAVATING **OR IN AN EMERGENCY** **CALL (336) 334-3192**	
NORTH CAROLINA **DEPARTMENT OF TRANSPORTATION**	

20.3 CONSTRUCTION METHODS.

Submit a sample of the proposed delineator markers for approval prior to installation.

Install delineator markers using a method that firmly and securely anchors the delineator marker in the ground to prohibit twisting and easy removal.

20.4 METHOD OF MEASUREMENT.

Actual number of delineator markers furnished, installed and accepted.

20.5 BASIS OF PAYMENT.

The quantity of delineator markers, measured as provided above, will be paid for at the contract unit price each for "Delineator Marker."

Payment will be made under:

Delineator Marker..... Each

21. EQUIPMENT CABINETS

21.1 DESCRIPTION.

Furnish and install base-mounted equipment cabinets and all necessary hardware in accordance with the Plans and Project Special Provisions.

21.2 MATERIALS.

Furnish unpainted, natural, aluminum cabinet shells that are insulated. With the exception of the base-mounted cabinet at the LED OPEN/CLOSED sign, equip base-mounted cabinets with thermostatically controlled heater and air conditioning units. Provide heater/air conditioning units equivalent to Kooltronic Model K2A4C3P28L.

Ensure all non-aluminum hardware on the cabinet is stainless steel or a Department approved non-corrosive alternate. Unless the cabinet has a rear door, provide a roof with a slope from front to back at a minimum ratio of 1 inch drop per 2 feet. Ensure each exterior cabinet plane surface is constructed of a single sheet of aluminum and is seamless.

Provide a handle and three point latching mechanism designed to be disassembled using hand tools. Provide a shaft connecting the latching plate to the door handle by passing through the door within a bushing, bearing, or equivalent device. Provide a latching plate at least 1/8 inch thick and that mates securely with the lock bolt. Provide a lock bolt with a flat end (no bevel) and that has at least 1/4 inch of length in contact with the latching plate.

Ensure the handle and lock are positioned so that the lock does not lie in the path of the rotating handle as the door is unlatched, and that the handle points down in the latched position.

Provide continuous welds made from the inside wherever possible. On the exterior, provide joints that are smooth and flush. Ensure no screws, bolts, or rivets protrude to the outside of the cabinet shell.

Provide a main door opening that encompasses the full frontal area of the cabinet shell exclusive of the area reserved for plenums and flanges.

Ensure the cabinet shell is sturdy and does not exhibit noticeable flexing, bending or distortion under normal conditions except that a minor amount of flexing is permitted in door only when the cabinet is open. In such case, the flexing shall not result in permanent deformation of the door or damage to components mounted on the door.

Furnish the cabinet with a 19-inch EIA rack, aluminum shelves, or other means proposed by the Contractor and approved by the Engineer, for mounting the equipment inside the cabinet. To store documentation, provide a minimum 12 x 14 inch plastic envelope or container located in the cabinet so that it is convenient for service personnel.

21.3 CONSTRUCTION METHODS.

Install equipment cabinets at locations identified in the Plans. Install the cabinets on foundations as identified in the Plans and the Standard Specifications.

21.4 METHOD OF MEASUREMENT.

Actual number of base mounted cabinets furnished, installed, and accepted.

21.5 BASIS OF PAYMENT.

The quantity of base mounted cabinets, measured as provided in above, will be paid for at the contract unit price each for "Base Mounted Cabinet."

Base Mounted Cabinet ..... Each

22. CABINET FOUNDATIONS

22.1 DESCRIPTION.

Furnish and install cabinet foundations and all necessary hardware in accordance with the Plans and Project Special Provisions.

22.2 MATERIALS.

Furnish either poured concrete foundations or preformed cabinet pad foundations and all necessary hardware. Selection of the type of foundation will be the Contractor's option.

Provide pads with a minimum pad area that extends 24 inches from each side of the cabinet that has a door, and 3 inches from the sides that do not have doors.

Furnish poured cabinet foundations with chamfered top edges. Provide Class B concrete or better. Refer to Division 10:

Portland Cement Concrete.....Article 1000-4

Where field conditions permit, preformed cabinet pad foundations may be furnished. Ensure preformed cabinet pad foundations provide chamfered top edges and a 7 (l) x 18 (w) inch minimum opening for the entrance of conduits. Ensure that no more than four 3/4 inch holes are cast or drilled in each pad for the purposes of handling or placing. Provide preformed cabinet pad foundations constructed of Class A concrete or better.

22.3 CONSTRUCTION METHODS.

Comply with the following:

Incidental Concrete Construction ..... Article 825

Obtain approval for final cabinet foundation locations before pouring the concrete base. Do not install foundations over uncompacted fill or muck.

Use procedures, equipment, and hardware as follows:

Hand tamp the soil on which the concrete is to be placed before placing the concrete.

Maintain a minimum distance of 12 inches from the service pole to the closest point on the cabinet foundation unless approved.

Use a minimum of four 1/2 inch diameter expanding type anchor bolts to secure the cabinet.

Install foundations a minimum of 4 inches above the finished grade and 4 inches below the finished grade.

Install conduits no more than 4 inches above the foundation. Locate external stubbed out conduit at the cabinet foundation so that the conduit is in the middle of the cabinet. Provide a service conduit as the rightmost conduit coming into the cabinet. Provide two spare conduits stubbed out; one pointed toward

the service pole and the other toward the direction of the lead-in cable. Inscribe an identification arrow in the cabinet foundation indicating the direction of spare conduits.

Give the cabinet foundation a broom finish.

Seal the space between the base of the cabinet and the foundation with a permanent, flexible, waterproof sealing material.

22.4 METHOD OF MEASUREMENT.

Actual number of cabinet foundations furnished, installed, and accepted.

22.5 BASIS OF PAYMENT.

The quantity of cabinet foundations, measured as provided in above, will be paid for at the contract unit price each for "Cabinet Foundation."

Payment will be made under:

Cabinet Foundation ..... Each

23. CCTV POLE

23.1 DESCRIPTION.

Furnish and install galvanized steel poles for the full motion video camera equipment, with grounding systems and all necessary hardware in accordance with the Plans and Project Special Provisions.

23.2 MATERIALS.

A. General:

Furnish metal poles with grounding systems and all necessary hardware.

Furnish metal poles and support systems that contain no guy assemblies, struts, rods, stay braces, clamps or U-bolts, except where noted. Provide metal poles and support systems with hardware that equals or exceeds AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (AASHTO Specifications) in effect on the date of advertisement (assume ice and average winds for a 25-Year Mean Recurrence Interval with a 1.3 gust factor when loaded). Provide assemblies with a round or near-round cross-sectional design consisting of no less than six sides. The sides may be straight, convex, or concave.

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

Ensure metal poles permit cables to be installed inside poles and any required mounting arms. For holes in the poles and arms used to accommodate cables, provide full-circumference grommets.

After fabrication, have steel poles and all parts used in the assembly (except the standard length galvanizing on the anchor bolts) hot-dip galvanized. Provide hot-dip galvanizing on structures that meets or exceeds ASTM Standard A-123. Provide galvanizing on hardware that meets or exceeds ASTM Standard A-153. Ensure threaded material is brushed and retapped as necessary after galvanizing. Perform repair of damaged galvanizing that complies with the following:

Repair of Galvanizing ..... Article 1076-6

B. Metal Poles:

Provide steel poles as indicated on the Plans. Comply with the following requirements for steel poles:

- Have shafts of the tapered tubular type and fabricated of steel conforming to ASTM A-595 Grade A or an approved equivalent,
- Have galvanization in accordance with ASTM A-123,
- Have shafts that are continuously welded for the entire length by the submerged arc process, and with exposed welds ground or rolled smooth and flush with the base metal. Provide welding that conforms to Article 1072-20 except that no field welding on any part of the pole will be permitted,

- Have anchor bases for steel poles fabricated from plate steel meeting the requirements of ASTM A 36M or cast steel meeting the requirements of ASTM A 27M Grade 485-250 or an approved equivalent,
- Have poles permanently stamped above the hand holes with the manufacturer's name or logo,
- Provide tapers for all shafts that begin at base and that have diameters which decrease uniformly at the rate of not more than 0.14 inch per foot of length, and
- Ensure allowable pole deflection does not exceed that allowed by AASHTO specifications.

Provide anchor bolts with two anchor nuts and two washers for each pole. Have anchor bolts fabricated from steel with minimum yield strength of 55,000 psi and minimum ultimate tensile strength of 70,000 psi. Ensure anchor bolts have required diameters, lengths, and positions, and will develop strengths comparable to their respective poles. Provide anchor bolts with a 6 x 6 x 3/4 inches plate at the embedded end secured with a washer and nut.

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

23.3 CONSTRUCTION METHODS.

Furnish shop drawings for approval. Provide triplicate copies of detailed shop drawings for each type of structure. Ensure shop drawings show materials specifications for each component and identifies welds by type and size. Do not furnish structures until approval is received.

Install metal poles, hardware, and fittings as shown on the manufacturer's installation drawings. Install metal poles so that when the pole is fully loaded it is within 2 degrees of vertical. Do not use shims or other types of leveling devices.

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

Connect poles to grounding systems.

23.4 METHOD OF MEASUREMENT.

Actual number of CCTV metal poles without regard to height furnished, installed and accepted.

23.5 BASIS OF PAYMENT.

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

Payment will be made under:

CCTV Metal Pole ..... Each

24. METAL POLES WITH FOLDING MAST ARMS

24.1 DESCRIPTION.

Furnish and install metal poles with folding mast arms and all necessary hardware in accordance with the Plans and Project Special Provisions.

Design and construct the metal poles with a hinge plate assembly as shown on the Plans. The hinge assembly shall allow maintenance crews to fold the mast arm for servicing of equipment attached to the mast arm, from the shoulder. A metal pole with folding mast arm of this type can be purchased from:

Union Metal Corporation
1432 Maple Ave., NE
PO Box 9920
Canton, OH 44705
(330) 456-7653
(330) 456-0628 fax

Atlantic Technical Sales
14522 – K Lee Road
Chantilly, VA 20151-1639
Tel: 703-631-6661

24.2 MATERIALS.

A. General:

Furnish metal poles with folding mast arms, grounding systems, and all necessary hardware. Provide steel arms as indicated on the Plans.

Furnish metal poles and support systems that contain no guy assemblies, struts, rods, stay braces, clamps or U-bolts, except where noted. Provide metal poles and support systems with hardware that equals or exceeds AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (AASHTO Specifications) in effect on the date of advertisement (assume ice and average winds for a 25-Year Mean Recurrence Interval with a 1.3 gust factor when loaded). Provide assemblies with a round or near-round cross-sectional design consisting of no less than six sides. The sides may be straight, convex, or concave.

Heights of the metal poles shown on the Plans are estimated from available data for bid purposes. Prior to furnishing metal poles, use manufacturer's specifications for equipment and field measurements and adjusted cross-sections to determine if pole heights are sufficient for equipment functionality and State required clearances. If pole heights are not sufficient, immediately notify the Engineer of the required revised pole heights.

Ensure metal poles permit cables to be installed inside poles and mast arms. For holes in the poles and arms used to accommodate cables, provide full-circumference grommets.

After fabrication, have steel poles, required mast arms, and all parts used in the assembly (except the standard length galvanizing on the anchor bolts) hot-dip galvanized. Provide hot-dip galvanizing on structures that meets or exceeds ASTM Standard A-123. Provide galvanizing on hardware that meets or exceeds ASTM Standard A-153. Ensure threaded material is brushed and retapped as necessary after galvanizing. Perform repair of damaged galvanizing that complies with the following:

Repair of Galvanizing .....Article 1076-6

B. Metal Poles:

Have shafts of the tapered tubular type and fabricated of steel conforming to ASTM A-595 Grade A or an approved equivalent. Have galvanization in accordance with ASTM A-123.

Have shafts that are continuously welded for the entire length by the submerged arc process, and with exposed welds ground or rolled smooth and flush with the base metal. Provide welding that conforms to Article 1072-20 except that no field welding on any part of the pole will be permitted.

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

Have poles permanently stamped above the hand holes with the manufacturer's name or logo.

Provide tapers for all shafts that begin at base and that have diameters that decrease uniformly at the rate of not more than 0.14 inch per foot of length.

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

Provide anchor bolts with two anchor nuts and two washers for each pole. Have anchor bolts fabricated from steel with minimum yield strength of 55,000 psi and minimum ultimate tensile strength of 70,000 psi. Ensure anchor bolts have required diameters, lengths, and positions, and will develop strengths comparable to their respective poles. Provide anchor bolts with a 6 x 6 x 3/4 inch plate at the embedded end secured with a washer and nut.

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

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

C. Mast Arms:

Provide hinged mast arm assemblies.

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

Ensure allowable mast arm deflection does not exceed that allowed by AASHTO Specifications.

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

Provide 50 percent spare bolts for each arm.

Provide grommeted holes on the arms to accommodate cables for the equipment.

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

Provide hardware that is galvanized steel or stainless steel.

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

Comply with the following for Steel Arms:

- Have standard weight black steel pipe conforming to ASTM A 53-90a, Type E or Type S, Grade B or an approved equivalent,
- For the arms, conform to the welding requirements of the steel poles, and
- After all fabricating, cutting, punching, and welding is completed, be hot-dipped galvanized inside and outside.

24.3 CONSTRUCTION METHODS.

Furnish shop drawings and loading diagrams for approval. Provide triplicate copies of detailed shop drawings for each type of structure. Ensure shop drawings show materials specifications for each component and identifies welds by type and size. Do not furnish structures until approval is received.

Install metal poles with folding mast arms, hardware, and fittings as shown on the manufacturer's installation drawings. Install metal poles so that when the pole is fully loaded it is within 2 degrees of vertical. If horizontal-type arms are furnished, install arms within 2 degrees of horizontal when loaded with hardware as identified on the Plans. Install poles with the manufacturer's recommended "rake." Use threaded leveling nuts to establish rake. Do not use shims or other types of leveling devices.

Bond poles arms to grounding electrodes.

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

24.4 METHOD OF MEASUREMENT.

Actual number of metal poles with folding mast arm assemblies, furnished, installed, and accepted.

24.5 BASIS OF PAYMENT.

The quantity of metal poles with folding mast arms, measured as provided above, will be paid for at the contract unit price each for "Metal Pole with Folding Mast Arm (Location)"

Payment will be made under:

Metal Pole with Folding Mast Arm (Location)..... Each

25. METAL POLE FOUNDATIONS

25.1 DESCRIPTION.

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

Metal Pole Standards have been developed and implemented by NCDOT for use in North Carolina. Design the foundation to conform to the applicable provisions in the NCDOT Metal Pole Standards. Comply with the provisions of Section 1700 of the Standard Specifications.

25.2 SOIL TEST AND FOUNDATION DETERMINATION

A. General:

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

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

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

B. Soil Test:

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

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

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

Describe each boring location by the station number and offset. For each boring, submit a legible (hand written or typed) boring log signed and sealed by a licensed geologist or professional engineer registered in North Carolina. Include on each boring the SPT blow counts and N-values at each depth, depth of the boring, and a general description of the soil types encountered.

C. Foundation Design:

Use the following method for determining the Design N-value for each pole location:

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

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

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

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

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

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

Or

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

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

Determine a drilled pier length, "L," for each pole from the Foundation Selection Table based on the Design N-value and the predominant soil type. Submit a completed "Metal Pole Standard Foundation Selection Form" signed by the contractor's representative for each pole location. Include the design N-value calculation only. These forms are to be used by the contractor-selected pole fabricator to assist in the pole and foundation design.

The "Metal Pole Standard Foundation Selection Form" may be found as follows:

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

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

25.3 DRILLED PIER CONSTRUCTION

A. Excavation:

Perform excavations for drilled piers to the required dimensions and lengths including all miscellaneous grading and excavation necessary to install the drilled pier. Depending on the

subsurface conditions encountered, excavation in weathered rock or removal of boulders may be required.

Dispose of drilling spoils as directed and in accordance with Section 802 of the 2002 Standard Specifications for Roads and Structures. Drilling spoils consist of all material excavated including water removed from the excavation either by pumping or with augers.

Construct drilled piers within the tolerances specified herein. If tolerances are exceeded, provide additional construction as approved by the Engineer to bring the piers within the tolerances specified. Construct drilled piers such that the axis at the top of the piers is no more than 3 inches in any direction from the specified position. Build drilled piers within 1% of the plumb deviation for the total length of the piers. Construct the finished top of pier elevation between 5 inches above and 2 inches above the finished grade elevation. Form the top of the pier such that the concrete is smooth and level.

If unstable, caving or sloughing soils are anticipated or encountered, stabilize drilled pier excavations with temporary steel casing during drilling through concrete placement. For each excavation, provide one continuous piece of steel casing that is clean smooth non-corrugated watertight steel of ample strength to withstand handling and driving stresses and the pressures imposed by concrete, earth or backfill. Use temporary steel casings with an outside diameter equal to the specified size of the pier and a minimum wall thickness of 1/4 inches. Extract all temporary casings during concrete placement in accordance with this special provision unless the Contractor chooses to leave the casing in place in accordance with the requirements below.

Any steel casing left in place will be considered permanent casing and must be installed before excavating or drilling such that the permanent casing is against undisturbed soil. Permanent steel casings are only allowed for strain poles and prohibited for mast arm poles. No additional compensation will be paid for permanent casing. If the Contractor chooses to use permanent steel casing, include all costs for permanent casing in the cost of the contract unit price bid for the "Drilled Pier Foundation" pay item.

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

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

B. Reinforcing Steel:

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

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

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

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

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

C. Concrete:

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

1. Concrete Mix:

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

Designate the concrete as Drilled Pier Concrete with a minimum compressive strength of 4500 psi at 28 days. Make certain the cementitious material content complies with one of the following options:

- Provide a minimum cement content of 640 lbs/yd^3 and a maximum cement content of 800 lbs/yd^3; however, if the alkali content of the cement exceeds 0.4%, reduce the cement content by 20% and replace it with fly ash at the rate of 1.2 lb of fly ash per pound of cement removed, or
- If Type IP blended cement is used, use a minimum of 665 lbs/yd^3 Type IP blended cement and a maximum of 833 lbs/yd^3 Type IP blended cement in the mix.

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

Produce a workable mix so that vibrating or prodding is not required to consolidate the concrete. When placing the concrete, make certain the slump is between 5 and 7 inches for dry placement of concrete or 7 and 9 inches for wet placement of concrete.

Use Type I or Type II cement or Type IP blended cement and either No. 67 or No. 78M coarse aggregate in the mix. Use an approved water-reducer, water-reducing retarder, high-range water-reducer or high-range water-reducing retarder to facilitate placement of the concrete if necessary. Do not use a stabilizing admixture as a retarder in Drilled Pier Concrete without approval of the

Engineer. Use admixtures that satisfy AASHTO M194 and add admixtures at the concrete plant when the mixing water is introduced into the concrete. Redosing of admixtures is not permitted.

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

2. Concrete Placement:

Place concrete such that the drilled pier is a monolithic structure. Vibration is only permitted, if needed, in the top 10 feet of the drilled pier or as approved by the Engineer. Remove any contaminated concrete from the top of the drilled pier and wasted concrete from the area surrounding the drilled pier.

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

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

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

- **Dry Placement:** Prior to placing concrete, make certain the drilled pier excavation is dry so the flow of concrete completely around the reinforcing steel can be certified by visual inspection. Place the concrete by free fall with a central drop method where the concrete is chuted directly down the center of the excavation.
- **Wet Placement:** Maintain a static water level in the excavation prior to placing concrete. Place concrete with a tremie or a pump in accordance with the applicable parts of Sections 420-6 and 420-8 of the Standard Specifications. Use a tremie tube or pump pipe made of steel with watertight joints. Passing concrete through a hopper at the tube end or through side openings as the tremie is retrieved during concrete placement is permitted. Use a discharge control to prevent concrete contamination when the tremie tube or pump pipe is initially placed in the excavation. Extend the tremie tube or pump pipe into the concrete a minimum of 5 feet at all times except when the concrete is initially introduced into the pier excavation. If the tremie tube or pump pipe pulls out of the concrete for any reason after the initial concrete is placed, restart concrete placement with a steel capped tremie tube or pump pipe.

Once the concrete in the excavation reaches the same elevation as the static water level, placing concrete with the dry method is permitted. Before changing to the dry method of concrete

placement, remove the water above the concrete and clean the concrete surface of all scum and sediment to expose clean, uncontaminated concrete.

D. Concrete Placement Time:

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

E. Scheduling and Restrictions:

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

During the first 16 hours after a drilled pier has achieved its initial concrete set as determined by the Engineer, do not drill adjacent piers, do not install adjacent piles and do not allow any equipment wheel loads or "excessive" vibrations to occur at any point within a 20 foot radius of the drilled pier.

In the event that the procedures described herein are performed unsatisfactorily, the Engineer reserves the right to shut down the construction operations or reject the drilled piers. If the integrity of a drilled pier is in question, use core drilling, sonic or other approved methods at no additional cost to the Department and under the direction of the Engineer. Dewater and backfill core drill holes with an approved high strength grout with a minimum compressive strength of 4500 psi. Propose remedial measures for any defective drilled piers and obtain approval of all proposals from the Engineer prior to implementation. No additional compensation will be paid for losses or damage due to remedial work or any investigation of drilled piers found defective or not in accordance with these special provision or the plans.

25.4 DRILLED PIER FOUNDATIONS WITH WING WALLS

A. General:

Wing walls are reinforced concrete sections, rectangular in shape that protrude horizontally out from two sides of a drill pier shaft. They are cast-in-place together with a drilled pier in a monolithic pour. They are used to eliminate torsional rotation of a foundation designed for supporting poles with mast arms.

NCDOT Metal Pole Standards provide design details for two types of wing walls based on their size and concrete volume:

- TYPE 1: 1'-6" long by 1'-0" wide by 3'-0" deep (.4 cubic yards), and
- TYPE 2: 3'-0" long by 1"-0" wide by 5'-0" deep (1.2 cubic yards).

The type of wing wall to be used, if required, is determined when a standard foundation is selected from the Foundation Selection Table shown on the plans. For non-standard site-specific pole designs, the contractor-selected pole fabricator will determine whether wings are needed for the pole foundation.

Contact the Engineer for assistance in resolving constructibility issues if wing walls for a foundation are required, but can not be installed because:

- of unforeseen difficulties such as underground utility obstructions,
- the construction of the wings may compromise a roadway base,
- the soil conditions are so unstable that construction of the wings may compromise the integrity of the drill pier shaft, or
- underground rock formations make excavation impractical.

B. Excavation:

Excavate for wing walls after boring of the drill pier shaft is complete. If unstable, caving or sloughing soils are anticipated or encountered, stabilize excavation for wings using temporary shoring during excavation and through concrete placement. In wet pour conditions, advise and gain approval from the Engineer as to the planned construction method intended for the complete installation of the drilled pier prior to performing any excavation of the drill pier or its wings.

C. Reinforcing Steel:

Completely assemble the wing wall cage along with the drill pier cage. Install horizontal bars in one continuous length so they extend completely through the drill shaft cage, out to each wing tip. If a drilled pier casing has been installed to construct the drill shaft to stabilize the shaft walls, installation of the wing wall reinforcing steel may not be possible until the drill shaft casing has been extracted. Constructibility issues must be resolved and construction methods approved to the satisfaction of the Engineer prior to assembly of the reinforcing cage.

D. Concrete Placement:

Place concrete such that the drilled pier and wing walls are a monolithic structure. No construction joints or keys will be allowed.

25.5 METHOD OF MEASUREMENT.

Actual number of CCTV metal pole foundations furnished, installed and accepted.

Actual number of metal pole foundations for metal poles with mast arms furnished, installed and accepted.

No measurement will be made for soil borings and structural design analysis as these will be considered incidental to the metal pole foundation.

25.6 BASIS OF PAYMENT.

The quantity of CCTV metal pole foundations for metal poles without mast arms, measured as provided above, will be paid for at the contract unit price each for "CCTV Metal Pole Foundation."

The quantity of metal pole foundations for metal poles with mast arms, measured as provided above, will be paid for at the contract unit price each for "Metal Pole Foundation (Location)."

Payment will be made under:

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

Metal Pole Foundation (Location) ..... **Each**

26. TESTING AND ACCEPTANCE

26.1 DESCRIPTION.

A. General:

Test all equipment, cable and software furnished and installed under this Contract and conduct all testing in the presence of the Engineer. The Engineer reserves the right to perform any inspections deemed necessary to assure that the equipment conforms to the requirements specified in the Project Special Provisions and Plans.

B. Tabletop Test:

To minimize the time that the weigh station will be closed while new equipment and software are installed and to minimize the risk of operational problems, the Contractor must conduct an exhaustive test of the new equipment and software at the vendor's facility. No equipment is to be shipped to the project site until this test demonstrates that all the equipment and software are working together in full compliance with the Contract Documents and until the Department's representative agrees that the system is ready for routine use.

During the test, interconnect all the electronics and some of the sensors just as they will be interconnected at the weigh station, except that all the devices will be in the same room. Use jumpers rather than cable for fiber optic communication. Load all microprocessors with all of the software and configuration parameters that they will use at the weigh station.

As a minimum, test the following items:

- AVI equipment, including readers, transponders and both makes of antenna,
- WIM electronics including all new scale house equipment,
- Freeze-frame camera equipment, including frame grabber,
- Overheight detector,
- Fiber optic data and sync transceivers,
- Media converters, and
- Ethernet hub, patch panels, and patch cords.

Simulate testing of the following items with devices supplied by the Contractor and connected to the equipment under test:

- All existing and proposed scales and off-scale sensors,
- All loops,
- All piezoelectric sensors,
- The lane control signals, and
- The blankout sign.

The following items need not be included in the test:

- All equipment related to full motion video,

- All items related to the open/closed sign, and
- All items related to the highway advisory radio sign.

Develop a detailed test procedure and obtain the Engineer's approved before the tests are conducted. The Department's review period will not exceed forty days from receipt of the test procedure. Demonstrate through the test procedure that all requirements defined in these Contract Documents, including but not limited to, functional/system performance requirements, electrical requirements, data transmission/communication requirements, safety/password requirements, and interface requirements with other components of the system have been satisfied. Environmental testing of equipment is not required if the manufacturer certifies that the equipment meets the project environmental specifications. Rewrite the proposed demonstration tests at no additional cost to the project to correct deficiencies noted in the original version. During the testing, perform such additional tests as the Department's representative may request to confirm proper operation.

Conduct the tabletop tests at the vendor's facility. Compare the results of each test with the requirements specified in the Contract Documents, and with the approved test procedures. Failure to conform to the requirements of any test shall be counted as a complete failure and the equipment and software will be rejected. Make any corrections deemed necessary at no additional cost to the Department. Assume total responsibility for documenting the results of such tests and furnishing the documented test results to the Department.

The approval of test procedures and witness of such test will not relieve the Contractor of his responsibility to provide a completely acceptable and operating system that meets the requirements of these Contract Documents.

The cost of visiting the vendor's facility to witness the test will be borne entirely by the Department. If retests are necessary, the Contractor shall bear all reasonable expenses for four people to visit the vendor's facility to witness each retest.

C. Cable Tests:

Perform fiber optic cable tests after installation, splicing and termination. All of the fibers shall pass these tests.

Test the entire length of each fiber in each cable using an optical time domain reflectometer (OTDR) at both 1310 nm and 850 nm. The Engineer or his representative will witness all OTDR tests. Provide the Engineer with durable, labeled plots of the results for each fiber. Also provide these plots on electronic media. Submit calculations demonstrating that the OTDR results for each fiber meet the attenuation requirements of these Project Special Provisions, and that the optical properties of the cable have not been impaired by the installation process.

If the OTDR results indicate that the cable, splices, or terminations do not meet the attenuation specifications, or if they indicate that the optical properties of the cable have been impaired during installation, then, at the Contractor's expense, take such action as the Engineer may approve to correct the problem. This may entail complete replacement of the fiber optic cable.

At a minimum, include the following in the fiber optic cable test documentation:

- List of test equipment,
- Cable attenuation measurements in both directions, including average link losses, for every fiber in every segment of every cable,

- Loss for each splice and connection, and
- OTDR trace for each fiber with every event annotated.

D. Operational Tests:

Conduct approved tests on all installed equipment and software, both central and field. Perform these tests in the presence of the Engineer. Three separate tests are required.

1. Mainline Weigh-in-Motion Scale:

The testing requirements are outlined in the WIM Scale section of these Project Special Provisions.

2. Truck Regulatory Enforcement System:

Repeat the tabletop test where practical, but with all equipment installed and connected. Use real vehicles to test the system.

3. Full Motion Video System:

Perform tests of full motion video system to demonstrate satisfactory picture and proper operation of all system features and functions, both from the cabinet and from the scale house.

Detailed test plans, prepared by the Contractor, must be approved by the Engineer before the tests begin. The Department review period will not exceed forty calendar days from receipt of the test procedures. Advise the Engineer a minimum of thirty calendar days before the start of tests. Make arrangements for the witnessing of tests as requested by the Engineer. Submit full documentation of test results, including problems experienced, to the Engineer. Replace or repair and retest any equipment failing the tests at no additional cost to the Department.

E. Observation Period:

After all equipment and software comprising the system has been accepted, satisfactory completion of the system acceptance test, and after the training is complete, a 60-day observation period begins. This observation period shall serve to evaluate full-scale operation of the system under normal conditions. The Department will be responsible for operating the system during this period. The goal of the observation period is to demonstrate that the system has been properly installed and integrated, performs properly, and complies with the Contract Documents.

The following conditions apply to the observation period

- During the entire observation period, the system shall monitor all the system detectors (both mainline and ramp devices) and CCTV cameras, and perform all the functions described in these Project Special Provisions,
- If any hardware item provided under this Contract fails (with the exception of expendable items such as printer cartridges), repair the item at the Contractor's expense, and then the observation period for the failed item begins again for the full 60-day duration,
- During the observation period, have personnel responding to the problem within two (2) hours after being notified of a problem by the Engineer. Within one day, have personnel on-site, with replacement equipment, addressing problems encountered with the central computers, operator computers, field devices, and communications network at the earliest possible time,

- If any other problem is discovered, such as intermittent communication or erroneous computations, the observation period will be suspended until the Contractor fixes the problem at his expense. Once the problem has been eliminated, the observation period will resume. If the problem was one that affected the entire system, rather than just one field device, the observation period will not resume until the system has performed properly for at least 72 hours. During this 72-hour period, demonstrate that any corrections or modifications made are valid, that the problems which restricted system operation have been corrected, and no new problems have resulted from the changes,
- Total system "down time" may not exceed 30 hours during the entire period. Down time includes the time of suspension of the observation period as described in the previous paragraph. Down time is a condition caused by failure of the central equipment, system software, field equipment or communication system, which causes the system to cease normal operation. If total system "down time" exceeds 30 hours, a full duration of the observation period shall begin again, and
- Terminate the observation period if 10% or more of the total quantity of any individual hardware item fails. Commence a full observation period for that hardware item upon the repair of all failed hardware items.

Upon successful completion of the observation period, the Department will accept the system, providing that all errors and omissions in Contractor-supplied documentation have been fixed and all other requirements of the Contract Documents have been met. Final acceptance will be in writing from the Department.

26.2 METHOD OF MEASUREMENT.

This work is incidental to the items being tested and will not be measured for separate payment.

26.3 BASIS OF PAYMENT.

Incorporate the cost of the work described above into the bid prices for the items tested. Testing costs will not be paid for separately.

27. TRAINING

27.1 DESCRIPTION.

Provide four training courses covering operation and maintenance of the equipment and software being supplied as part of this project. One of the courses shall train weigh station personnel to properly operate the truck regulation enforcement system. The remaining courses shall train maintenance technicians in maintaining and repairing the sensor equipment, modifying and/or fine tuning of the system thresholds, the communication system, and the CCTV equipment. Manufacturer's representatives or personnel approved by the Engineer shall conduct the training courses.

At least 40 days prior to commencement of each training course, submit detailed course curriculums, draft manuals and handouts, and resumes of the instructors. The Engineer will review and request modifications of that material as appropriate.

Limit training courses to no more than six hours of training in any one day; i.e., 24 hours of training would be conducted over at least a four-day period. Conduct all courses on weekdays at times to be specified by the Engineer.

Conduct operator training courses in the scale house. Conduct the classroom portion of the technician training courses in a meeting room at NCDOT Division 7 Headquarters in Greensboro and the field portions at the relevant cabinets at the weigh station.

The training material generated for each course shall contain manuals and other handouts for each attendee who shall serve not only as subject guidance, but also as quick reference material for future use by the students. The courses must utilize, to the greatest extent possible, the documentation described in these Project Special Provisions. Use the training courses to familiarize the students with all documentation that has been provided as part of this project. Deliver all course material, in reproducible form, to the Engineer immediately following course completion.

Videotape every session of each training course, using VHS cassettes, and deliver the cassettes to the Department at the conclusion of the training.

27.2 WEIGH STATION OPERATOR TRAINING.

This training course shall train weigh station personnel to use all features and functions of the software and new hardware. Divide the training course into two parts. Conduct each part of the course twice. Provide each part of the course for up to fifteen (15) people.

The training course shall be a minimum of 12 hours duration. Include both classroom instruction and practical experience on the central equipment. Design the first part of the course to provide students with an introduction to the system and the theory of its operation. At a minimum, the first part of the course must include the components of the system, central software operation, and the configuration of the central and field equipment. The second part of the course shall provide each trainee with hand-on experience with the computer system and the video surveillance system. The course shall cover the operation of all software provided in this project. The course shall also cover the proper operating techniques and user maintenance procedures for each piece of equipment, including modification and/or fine tuning of the system thresholds. Particular attention shall be paid to precautions that should be observed in operating or handling the equipment or materials.

27.3 TECHNICIAN TRAINING.

Design the technician training courses to train technician-level personnel in the maintenance of Contractor-installed equipment. Extend the courses from the basic equipment operating theory to the detection and identification of malfunctions in the equipment through use of diagnostic programs and the Contractor-supplied test equipment. Include field level troubleshooting, as well as bench repair. Also include the proper use of all test and maintenance equipment supplied in this Contract.

Provide each course for up to 15 people.

The training shall cover all Department serviceable equipment with a separate course on each of the following categories of equipment:

- New sensors, including the mainline scale, piezoelectric sensors, and overheight sensors. This course shall run at least 12 hours,
- Communication system, including fiber optic cable and transceivers, Ethernet equipment, and AVI equipment. The emphasis shall be on troubleshooting. This course shall run at least 12 hours,
- CCTV system, including camera and housing maintenance, communication equipment, surge suppression, and the central equipment. This course shall run at least 4 hours, and
- Threshold modification and fine tuning. This course shall run at least 4 hours.

Each training course shall consist of a presentation of the functional operation and programming of the equipment, followed by a "hands-on" workshop. A second presentation shall cover routine maintenance and troubleshooting procedures. This shall be followed by a "hands-on" workshop wherein personnel troubleshoot simulated faults to the component level. Finally, the trainees will be taken to the weigh station and given a tour, in which every cabinet (indoor and outdoor) will be opened and every component identified.

27.4 METHOD OF MEASUREMENT.

Training shall be paid for as a lump sum. The price includes providing instructors, materials, and other items required for the training.

27.5 BASIS OF PAYMENT.

The quantity of training, measured as provided above, will be paid for at the contract lump sum price for "Training."

Payment will be made under:

Training.....Lump Sum

28. SYSTEM WARRANTY

28.1 DESCRIPTION.

A. General:

Unconditionally warrant the performance of all systems and subsystems installed under this contract, including all equipment, hardware, and software for a period of two (2) years from the successful completion of the 60-day observation period.

Provide the necessary labor, parts, materials, tools, test equipment and facilities required to address any warranty issues related to the system after it is installed. Consider this warranty period to be part of the work required to be completed by the final completion date of the project.

B. Period of Performance:

The period of performance for the Warranty shall be two (2) years from the successful completion of the 60-day observation period.

The warranty coverage shall be renewable on an annual basis for an additional five (5) years by mutual consent of both parties. Develop the cost for the renewable option through mutual agreement of both parties.

C. Scope of Warranty:

Ensure the components of all systems are in good working condition, and take appropriate action to remedy performance issues. Good working condition is defined under this project as equipment meeting the system specifications for acceptance, accuracy, and tolerances as defined in these Project Special Provisions.

Provide scheduled diagnosis and repair service and/or respond to repair malfunctioning equipment as outlined below:

- Complete scheduled preventative maintenance, diagnostic testing and repair (if needed) at three (3) month intervals. Preventative maintenance shall be completed in accordance with equipment manufacturer's recommendations and standard practices. Provide routine checks on all major systems, system components and ancillary equipment and take any corrective action to ensure proper long-term operation. The maintenance shall include, but not be limited to the following activities:
  - Test signal level and lead cable of WIM scales, piezoelectric sensors, and loops. Repair or replace as required,
  - Verify WIM, loop, and piezoelectric sensor performance and reliability. Adjust calibration on devices to meet the specifications defined herein for each device. Repair or replace equipment as required to meet specifications,
  - Check installation of grout and sealant for loops and piezoelectric sensors. Repair or replace as required,
  - Perform visual inspection of detector housings and repair or replace as required,
  - Check the calibration of and clean (if needed) the AVI antenna,

- Check the calibration of and clean the overheight detector,
- Clean the interior and exterior of WIM electronics, power supplies, computers and communications equipment in all equipment cabinets and in the scale house. Repair or replace as required,
- Check condition of all WIM cables and connectors, terminal strips, and back-up batteries. Repair or replace as required,
- Check all electrical connectors, cables and components. Test and visually inspect utility pole, AC disconnect box, main AC circuit breakers, cabinet AC circuit breakers, and AC outlets,
- Perform visual inspection of equipment cabinets. Repair or replace as required,
- Test and visually inspect equipment cabinet ventilation fan and filter, thermostat, light and fused switch. Repair or replace as required, and
- Test and verify control and sequence of operation of interface components;

- Calibrate the WIM scales every six (6) months. The calibration shall verify system and interface operations. Vehicles to be used for calibrating the WIM scales will be provided by the Department,
- Provide up to one (1) system operations refresher course either before or after each scheduled preventative maintenance service. The decision to have a refresher course shall be at the discretion of the Engineer. Contact the Engineer four (4) weeks prior to preventative maintenance to determine the need for the refresher course. The refresher courses shall have a maximum duration of four (4) hours scheduled immediately before or after the scheduled preventative maintenance. Include in the refresher courses a hands-on demonstration of system functionality. The Department will provide facilities for the refresher courses,
- Provide emergency repair services, on an as needed basis. The response time for emergency repair service shall be as follows:
  - 24 hours to acknowledge request,
  - 48 hours to respond to request, and
  - 7 days to repair equipment and return system functionality. The repaired system shall function to the specifications defined in these Project Special Provisions for acceptance, accuracy, and tolerances;
- Document all activities performed under the warranty agreement, both preventative and emergency maintenance, in an electronic form that facilitates sorting the records by time period and/or device type. Submit a proposed format for this database for the Engineer's approval. Include, as a minimum:
  - Date and time of scheduled preventative maintenance,
  - All preventative maintenance activities completed,
  - All parts repaired or replaced during preventative maintenance,
  - Technician completing preventative maintenance work,
  - Repair history for all systems and subsystems,
  - Date and time of emergency maintenance request,

- Date and time of technician on site to respond to emergency maintenance request,
- Description of defective equipment or malfunctioning operations during emergency maintenance request,
- Technician responding to emergency maintenance request,
- Corrective actions taken during emergency maintenance request,
- Date and time that operations restored after emergency maintenance request, and
- Model and serial number of any equipment repaired and replaced during emergency maintenance request.

Provide both electronic and hardcopy records of the updated database within ten (10) days of each maintenance activity.

Document all itemized material, equipment, and labor costs incurred to maintain the Hillsborough Weigh Station during the warranty period. The cost records shall differentiate between preventative and emergency maintenance costs. Provide these records to the Department on a semi-annual basis within fifteen (15) days after the end of the six-month period. The purpose of this requirement is to provide the Department with information to estimate the maintenance budget needed for the system after the warranty period. These records will not be used as a basis of payments to the Contractor. Ensure that these cost records are as complete and accurate as practicable. The Department may perform an audit to verify the accuracy of the cost records.

Provide software upgrades for all new software revisions completed during the warranty period at no additional cost to the Department. Provide these software upgrades for the WIM systems at both the eastbound and westbound weigh stations. Identify a cutover procedure for all software upgrades, which shall ensure that there is no interruption of service or failure of any operation as a result of upgrading the software. Also develop a contingency plan to re-install older versions of software, by the Contractor, if any operation fails or any system degradation is encountered as a result of a software upgrade.

D. Warranty Evaluation:

Two (2) months prior to the end of the warranty period, the Engineer will inspect the system thoroughly for potential system defects. The Department's personnel or representative will do this inspection. Assist the Department's personnel or representative during this inspection. One (1) week prior to the inspection, provide a summary report of all preventative and emergency maintenance records. This report shall document and certify that all components have been maintained fully in accordance with the Project Special Provisions and manufacturer recommendations and that all manufacturer warranties that extend beyond the Contractor's warranty have been in no way compromised.

Following the inspection, the Engineer will determine if there are any unresolved defects with equipment hardware or software. The Department will provide a punch list to the Contractor for the replacement or repair of defective components or repairs to system software. Replace or repair equipment and software identified in the punch list within one (1) month of receipt of the punch list. Also replace any components whose manufacturer warranty has been voided or compromised by any action/inaction on the part of the Contractor. Document all repairs or replacements completed, providing the documentation to the Department within two (2) months of receipt of the punch list.

E. Correction of Work:

Re-execute any work that fails to conform to the requirements of the Contract and that appears during the process of the work. Remedy any defects due to faulty materials or workmanship that appear within the warranty period. The provisions of this article apply to work done by subcontractors as well as direct employees of the Contractor.

F. Traffic Control:

Provide traffic control for all maintenance activities requiring lane closures. Traffic control activities shall be in accordance with NCDOT standards. When lane closures are required for preventative maintenance, document the proposed traffic control plan and coordinate lane closure activities with the Department thirty (30) days prior to the preventative maintenance activities. When lane closures are required for emergency maintenance, coordinate lane closure activities with the Department as soon as practicable. Schedule work requiring lane closure during normal work days and during daylight hours.

28.2 MATERIALS.

All replacement materials and equipment provided under the warranty shall meet or exceed the requirements as defined in the Plans and the Project Special Provisions. If during the warranty period a part or component of a system or subsystem is no longer available to the Contractor, obtain equipment which ensures that the systems and subsystems meet or exceed the specifications and functionality as defined in these Project Special Provisions.

Provide all tools, test equipment and other equipment necessary in the maintenance, repair and replacement of all components furnished under this contract during the warranty period.

28.3 CONSTRUCTION METHODS.

In replacing equipment under the maintenance agreement, meet or exceed the construction requirements for each component as defined in the Plans and Project Special Provisions.

28.4 METHOD OF MEASUREMENT.

System Warranty shall be priced as a lump sum. Payment shall be made on a quarterly basis (every 3 months) during the warranty period in which measurement is made by the Department on the completion of preventative maintenance and any emergency maintenance during the quarter. The first payment will be made after the completion of the first quarter of warranty service. The Department will make the final payment after the final quarter of the warranty period after the Contractor completes all punch list items identified during the Warranty Evaluation. The price includes providing labor, parts, materials, shipping, vehicles, tools, test equipment, documentation and facilities.

28.5 BASIS OF PAYMENT.

System Warranty, as describe above, will be priced at the contract lump sum price as "System Warranty" with 1/8th payments of the lump sum made on a quarterly basis during the warranty period.

Payment will be made under:

System Warranty .....Lump Sum

29. EMERGENCY RESTORATION EQUIPMENT

29.1 DESCRIPTION.

Furnish emergency restoration equipment and parts as described herein to the Department, and unless otherwise indicated by the Engineer, deliver the emergency restoration equipment and parts to the Engineer between the hours of 8:00 AM and 3:00 PM.

29.2 MATERIALS.

All equipment shall be furnished new thirty (30) days prior to the end of the two (2) year Warranty Period. All equipment shall be new, fully operational and calibrated (except where calibration requires on-site installation) when provided to the Department. The emergency restoration equipment and parts shall be the same make and model as the original equipment installed under this Contract. If a part is no longer manufactured or available from the manufacturer, provide recommendations to the Department on suitable replacements. The replacement part shall meet the specifications defined in these Project Special Provisions for the component. Provide, at no additional expense to the Department, operations manuals, maintenance manuals and equipment specifications for all replacement components. Provided computer software pre-loaded and ready for operation. At the option of the Engineer, test certain items of emergency restoration equipment and parts by installing them in place of a similar item of equipment in a field or central location which has already passed acceptance testing.

Provide the following emergency restoration equipment and parts:

Parts and Equipment	Quantity
Single Load Cells	2 units
Off-scale Detector	2 units
Piezoelectric Sensor	1 unit
AVI Reader	1 unit
AVI Antenna (Sinclair)	1 unit
AVI Antenna (Scala)	1 unit
Multimode Field Transceiver	1 unit
Multimode Control Center Transceiver	1 unit
Media Converter	1 unit
Data and Sync Transceiver	1 unit

A. Single Load Cells:

Provide single load cells, with pressure transducers, as defined in the section "Weigh-In-Motion Scale" of the Project Special Provisions.

B. Off-scale detector:

Provide off-scale detectors as defined in the section "Weigh-In-Motion Scale" of the Project Special Provisions. The off-scale detectors shall include replacement mounting hardware for installation.

C. Piezoelectric Sensor:

Provide a piezoelectric sensor with lead-in cable as defined in the section "Piezoelectric Sensors" of the Project Special Provisions.

D. AVI Reader:

Provide an AVI reader meeting the specifications defined in the section "Automatic Vehicle Identification Equipment" of the Project Special Provisions, capable of replacing the readers at the Advance, Notification and Compliance Locations. The AVI reader shall include the reader unit, communications and power cables.

E. AVI Antenna (Sinclair):

Provide a Sinclair AVI antenna, including communications cables, as defined in the section "Automatic Vehicle Identification Equipment" of the Project Special Provisions.

F. AVI Antenna (Scala):

Provide a Scala AVI antenna, including communications cables, as defined in the section "Automatic Vehicle Identification Equipment" of the Project Special Provisions.

G. Multimode Field Transceiver:

Provide a multimode field transceiver as defined in the section "Fiber Optic Transceivers" of the Project Special Provisions.

H. Multimode Control Center Transceiver:

Provide a multimode control center transceiver as defined in the section "Fiber Optic Transceivers" of the Project Special Provisions.

I. Media Converter:

Provide a media converter as defined in the section "Fiber Optic Transceivers" of the Project Special Provisions.

J. Data and Sync Transceiver:

Provide a data and sync transceiver as defined in the section "Fiber Optic Transceivers" of the Project Special Provisions.

29.3 METHOD OF MEASUREMENT.

Emergency restoration equipment will be paid for as a lump sum, which shall include delivery of all parts and equipment identified herein, at the quantities listed herein.

29.4 BASIS OF PAYMENT.

Emergency restoration equipment, as measured above, will be paid for at the contract lump sum price for "Emergency Restoration Equipment".

Payment will be made under:

Emergency Restoration Equipment.....Lump Sum

30. DYNAMIC MESSAGE SIGNS

30.1 DESCRIPTION.

Furnish and install dynamic message signs (DMSs) and all necessary hardware in accordance with the plans, Standard Specifications and these Project Special Provisions. Ensure DMS signs automatically interface with the operator workstations. Comply with the provisions of Sections 1098 and 1700 of the Standard Specifications.

A. Contractor Qualifications:

In order to be considered for award of the contract to accomplish the work as defined by this these Project Special Provisions, the successful bidder or his designated electrical sub-contractor must possess a valid North Carolina Electrical Contractor's License as prescribed in Article 4, Chapter 87 of the General Statutes. The license must have been issued on or before the date of the scheduled bid opening. This license must be of a class to accomplish the total dollar value of the work.

Assume responsibility for the complete installation, inter-connection, and operation of all DMS system components and electrical facilities described in the plans and these Project Special Provisions.

B. DMS Manufacturer Qualifications:

The DMS manufacturer must have a minimum of three (3) years experience in outdoor traffic control-type DMS systems of the type and size described in the plans and these Project Special Provisions.

Provide at least three references from customers who have purchased and installed permanent outdoor traffic sign systems of 8" (203mm) or larger characters that use LED technology. Only provide references from outdoor traffic systems that have been in full operation at least three (3) calendar years by this project bid-letting date. Include a contact name, organization, phone number, address, date of installation, photographs and a description of the DMSs purchased for each reference.

C. Approved Submittals & Compliance To Requirements of This Document:

Approval of any submittals such as drawings, product specifications, functional specifications, catalog cut sheets, training manuals, software source codes, and other DMS system related submittals shall not relieve the Contractor of the responsibility to provide a DMS system that meets all the requirements as stated herein.

D. References Used:

These Project Special Provisions reference the following:

- Latest edition of the Department's Standard Specifications for Roads and Structures referred to as Standard Specifications,
- Latest edition of the National Electrical Manufacturers Association (NEMA) Standards for Traffic Control Systems,
- Latest edition of the National Electrical Code (NEC).

- Underwriters Laboratories (UL) 6 Rigid Metal Conduit, 489 Circuit Breakers and Panels, 514B Fittings for Conduit and Outlet Boxes,
- Latest edition of National Transportation Communications for ITS Protocol (NTCIP) Joint Standards Committee Recommended Standards applicable to DMS systems and requirements of these Project Special Provisions, and
- AASHTO 2001, 4th edition and 2002 Interim to Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

30.2 MATERIALS.

A. General:

Furnish an operating DMS system consisting of, but not limited to, the following:

- LED display elements (pixels),
- DMS controller, uninterruptible power supply (UPS), cabinet and accessories with interconnect, power cabling and conduit,
- IBM compatible PC with dedicated software,
- Interface cable for fiber optic data transceiver,
- 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 the latest NEC requirements and all applicable local and state codes.

Provide products that perform date and/or time data recognition functions, calculations or sequencing using a four-digit year format. These products include, but are not limited to any piece or component of equipment, hardware, firmware, middleware, custom or commercial software, or internal components or subroutines therein.

B. DMS Enclosure:

1. General:

The DMS enclosures furnished on the project will be attached to existing overhead sign assemblies; therefore, furnish DMS enclosures that are of equal or smaller size and weight as the existing DMS enclosures. The existing DMS enclosures are each 108" (2.743 m) wide, 63" (1.60 m) high, 12" (305 mm) deep and weigh approximately 800 pounds (363 kg). Character height of the existing DMSs is 8" nominal. The existing DMS enclosures were manufactured by Lake Technology Products, Inc. under Job # NC9413.

Furnish a DMS with maximum overall dimensions of 144" wide, 40" high and 12" deep, including the border. Construct the DMS to display one line of text that, when installed, is clearly visible and legible to a person with 20/20 corrected vision from a distance of 300' (91m) in advance of the DMS at an eye height of 3.5' (1.1 m) along the axis.

The DMSs' single line must display at least twenty (20) proportionally sized and spaced individual alphanumeric characters. Each character must be at least 8" (203 mm) in height and composed from a luminous dot matrix of LEDs.

2. Enclosure Fabrication:

Construct the enclosure of welded aluminum type 6061-T6, 5052-H38, 5052-H34, or of an Engineer approved alternate at least 1/8" (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).

Furnish exterior and interior DMS enclosure surfaces made of natural, mill-finish aluminum. Remove all grind marks and discoloration from the surfaces. Cover the sign face, excluding the front panel, with a flat black, UV treated, colorfast material such as 3M™ Scotchcal™ non-reflective sheeting. Prior to the application of the sheeting, prepare all surfaces for application per the sheeting manufacturer's recommendations.

Seal all nuts, bolts, washer, and other mounting and bonding parts and components used on the exterior of the DMS enclosure against water intrusion.

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

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

3. External Features:

Surround the DMS face with a flat black aluminum border to provide contrast and enhance readability, with no light visible between the two. UV-treat the border and make it colorfast. Construct the border with a minimum width of 6" (152mm).

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

4. Internal Features:

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.

5. Environmental Requirements:

Construct the DMS enclosure and DMS controller cabinet so the equipment within is protected against moisture, dust, corrosion, and vandalism.

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

Design the DMS, controller, cabinet, and accessories for a nominal performance through an ambient temperature range of -30° F to 165° F 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 within these Project Special Provisions. Provide equipment that does not suffer any damage when temporarily operating at 10° F 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.

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 utility companies to determine if any special design is needed. Include any extra cost, if required, in the contract lump sum price for the DMS.

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 DMSs on the system.

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

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 of the outdoor ambient temperature. Provide the DMS environmental control system with four primary subsystems as follows:

a. 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 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. 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 restart temperature thresholds to be user-programmable. Design the field controller to report sensor temperatures and DMS shutdown/restart events to the DMS Control Software.

b. Housing Cooling System:

Provide the DMS housing with a cooling system that 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.

c. LED Display Cooling System:

Provide the DMS with an LED display cooling system that 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.

d. 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).

6. 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 anti-reflection coating, and are a minimum of 1/4" (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.

7. Photo-Electric Sensors:

Install three photoelectric sensors with 1/2" (13mm) 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.

C. DMS Display:

1. 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 T-1 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 degrees 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.

Provide 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 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.

2. 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.

Construct pixels consisting of two strings of LEDs. The manufacturer is to determine the number of LEDs in each string required to produce the candela requirement as stated herein. 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.

Furnish pixels that produce a luminous intensity of 28 Cd when driven with an LED drive current of 20 mA per string.

Drive LED pixels with direct-drive pulse width modulation. Do not exceed a maximum pulse amplitude of 30 mA.

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 and maintenance.

3. Display Modules:

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). 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. Furnish all power and communication cables connected to a display module as plug-in type to

allow easy removal for maintenance and repair. Position cooling fans so they do not prevent removal of an LED pixel board or driver board.

4. 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° to 140° F (-30° to +60° C). Power supply output at 140° F must not derate to less than 65% of its specified output at 70° F. 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 0.95, 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.

5. Display Dimming:

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 as measured by the three photoelectric sensors mounted on the DMS and/or DMS support structure.

6. Display Capabilities:

Design the DMS to display:

- All upper case letters,
- All punctuation marks,
- All numerals 0 to 9, and
- 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.

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)

D. Interconnect Between DMS Enclosure and DMS Controller:

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 plans.

E. DMS Controller:

Provide the DMS controller as a software-oriented microprocessor and with resident software stored in non-volatile memory. The Control Software and DMS controller must comply with the NTCIP Standards identified in Table 1 within this section of these Project Special Provisions. Design communications to comply with latest available edition of the applicable NTCIP standards identified in Table 1 within this section of these Project Special Provisions. Provide sufficient EEPROM to allow storage of at least 500 multi-page messages and a test pattern program.

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.

1. 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.

2. 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.

3. Controller Functions:

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.

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 the EEPROM remotely,
- Display one of three message types: static, flashing, or a multi-page message of at least two pages,
- Display any message stored in the EEPROM,
- Change existing messages in the EEPROM, and
- Enter new messages into the EEPROM.

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.

a. Error and Failure Reports:

- Power failure,
- Data transmission error,
- Receipt of invalid data,
- Communications failure recovery,
- DMS controller failure,
- Power recovery, and
- 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, and 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.

4. DMS Controller Commands:

Include these commands at a minimum in the controller:

- Displays the last command from Control Software,
- 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,
  - Message display command: Shows text and display parameters of the message currently displayed on the DMS.
- Light level switching command: Selects Dim, Normal, or Bright Light level control in two modes: automatic (photoelectric sensor control), Control Software override,
- Program command: Programs the display of a message in memory at a selected date and time,
- Abort and / or Sign off command.

5. DMS Controller Memory:

Design each DMS controller with its own local memory (EEPROM). Use the EEPROM 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 EEPROM. The Control Software can upload messages into and download messages from each controller EEPROM remotely.

Messages uploaded and stored in the controller EEPROM may be erased or edited using the Control Software or the controller. New message may be uploaded to and stored in the controller EEPROM using the Control Software or the controller. Accomplish these actions without removing the EEPROM from the controller or installing another EEPROM in the controller.

6. Communications Interface:

The controller will have the following interface ports:

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

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

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

a. Modem:

If required for the DMS installation, furnish an external industrial-grade modem. 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. Furnish a modem that will automatically reset itself in the event of a hardware or software problem. The unit must meet the following minimum specifications:

Modem Specifications:

Telephone Line	
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	11.52 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 (half duplex)
Signal Rate	Standard Rates unto 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 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	-30° C to 70° C
Storage Temperature	-40° C to 85° C
Humidity	Up to 95%RH
Flammability	UL94V-0 materials
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

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

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.

F. DMS Controller Cabinet:

1. General:

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

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,
- UPS system and local disconnect,
- Microprocessor-based controller,
- Lamp driver and control system (unless integral to the DMS),
- Industrial-grade dial-up modem and/or fiber optic transceiver 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 (refer to the section "Environmental Requirements"),
- All interconnect harnesses, connectors, and terminal blocks, and
- All necessary installation and mounting hardware.

2. Cabinet Fabrication:

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 controller components as described in the section titled "DMS Controller Cabinet," and sized to fit space restrictions, if any. 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, with air filters as described in the paragraph above.

3. Cabinet Features:

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 materials. 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" (50 mm) 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.

Design the cabinet so that no resident equipment utilizes the GFI receptacle. Provide one spare non-GFI receptacle for future addition of equipment.

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

4. Cabinet Wiring:

Apply the requirements stated herein 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.

Individually and uniquely label all conductors with labels that are clearly visible without moving the conductor. Connect all terminal conductors to the terminal strip at right angles. Remove excess conductor before termination of the conductor. Mold the conductor in such a fashion as to retain its relative position to the terminal strip if removed from the strip. Do not run conductors 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. Install all connectors, devices and conductors in accordance with manufacture's guidelines. During installation, comply with the latest NEC guideline in effect for all wiring. No conductor or conductor bundle may hang

loose or create a snag hazard. Protect all conductors from damage. Complete all solder joints using industry accepted practices designed not to fail due to vibration and movement. All welds must be in a manner that will not fail due to vibration. Protect lamps and control boards from damage.

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

Route and bundle all wiring containing 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.

a. Backpanel 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.

b. 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.

c. Circuit Breakers:

Protect the DMS controller, accessories, and cabinet utilities with thermal magnetic circuit breakers (refer to the section titled "Circuit Breakers and Panels"). 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.

d. 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

e. 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 1/4" (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.

f. 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

g. Lighting Arrester:

Protect the system with a UL-approved lightning arrester installed at the main service disconnect, which meets the following requirements:

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

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

5. Uninterruptible Power Supply (UPS):

Provide the cabinet with a 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 long enough for the controller to initiate and report the power loss to the Control Software if 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 a UPS with at least three outlets for supplying conditioned AC voltage to the DMS controller, an industrial-grade dial-up modem, and a fiber optic transceiver. 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 1/2" (15 mm) thick plywood to separate them from concrete floor and aluminum cabinet structure. Provide a UPS capable of operating within an ambient temperature range from -40 to +185 degrees F (-40 to +85 degrees 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.

6. 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 EEPROM messages stored in the DMS controller when in the Local Control Mode. Furnish a LCD display allowing EEPROM messages to be previewed prior to activation. While a message is being previewed, flash any failed pixel within the message or outside the message area to notify of needed repairs 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

7. Cabinet Installation:

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.

Avoid installation of the cabinet near ditches and low lying areas. Build a 10' x 10' (3 m x 3 m) work zone around the cabinet pad. Compact the soil around the cabinet base as required by Section 410. Cover the work zone with a layer of Department-approved weed or vegetation barrier and a 2" (50 mm) layer of 2" (50 mm) gravel.

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 stainless steel corrosion resistant enclosures that meet UL Standard for Safety for Cabinets and Boxes, and UL Standard for Safety for Industrial Control Equipment.

Use only molded case, thermal magnetic trip type breakers, which meet material requirements of Sections 1098 and 1700 of the Standard Specifications. 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. Conduit, Boxes, and Fittings:

Use conduit of the rigid metal type manufactured of mild steel, wrought iron, or a silicon-bronze alloy containing at least 1.25 percent silicon that conform to UL Standard UL-6 for Rigid Metallic Conduit. Use hot-dip galvanized conduit conforming to ASTM A 123. Use couplings of the same manufacture as above to form all joints.

Use lengths of conduit that are plainly marked with the UL seal of approval and that are true to size and form, free from warps, kinks and bends, except the bends provided for in the plans and specifications. Install conduit as shown in the plans, and in accordance with NEC requirements for an approved watertight raceway.

Use watertight galvanized steel conduit bodies, boxes, and fittings meeting the requirements of UL Standard 514 B "Fittings for Conduit and Outlet Boxes".

I. Grounding and Bonding Equipment:

Provide ground clamps, grounding and bonding bushings, lock nuts, and grounding electrodes that comply with UL Standard 467 "Electric Grounding and Bonding Equipment". Use 5/8" (15mm) diameter, 10' (3 m) long, copper-clad steel ground rods. Please refer to the section titled "Cabinet and System Grounding."

J. Service Poles:

If required, 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.

Provide a mill finish aluminum electrical service meter base.

K. DMS Bench Test Unit:

Provide a fully operational DMS comprised of three (3) character modules of the size and type specified elsewhere in these Project Special Provisions.

Provide the unit with controller, drivers, power supply(s) and all other devices and equipment installed within the Unit's enclosure.

Design all the electronics and electrical devices and equipment within the DMS enclosure to be accessible from the back. Design the character modules to be accessible from the front of the DMS.

Provide all materials and electrical/electronic devices, components, and equipment used to build the test unit in conformance to the applicable specifications and requirements outlined elsewhere in these Project Special Provisions and other documents and standards referred to by these Project Special Provisions.

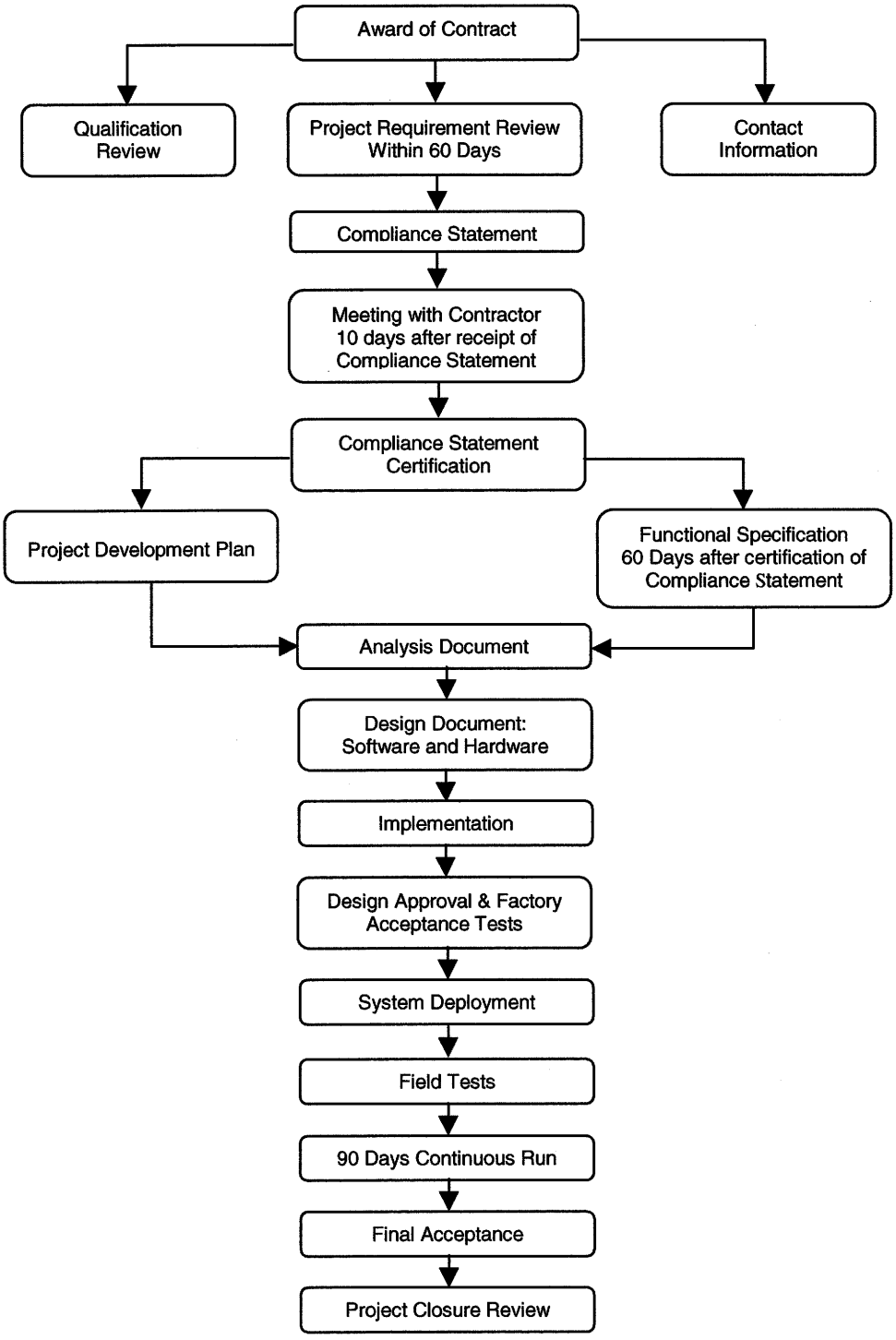
Provide an electrical cord (hot, neutral, and ground) for power connection to a standard receptacle and an on/off switch mounted in a convenient location on the outside of the DMS enclosure.

Design the unit with appropriate ventilation system installed. No heating elements are required for this unit. This unit does not require provision of remote communications devices and power backup or conditioning equipment typically found in a roadside cabinet.

30.3 CONSTRUCTION METHODS.

A. DMS System Development and Installation Process:

Comply with the flowchart below depicting the DMS system development and installation process. The process is described in greater detail in the following subsections.



1. Project Contacts Information:

Provide the name, phone number (office and mobile), fax number, email address, and mailing address for the following persons thirty (30) calendar days after the award of the contract:

- Project Engineer, General Contractor and his/her Subs
- Project Engineer, Electrical Contractor(s)
- Project Engineer, DMS Manufacturer

During the project development life cycle, the Engineer may contact the above person(s) for project related issues.

2. Qualifications Review:

Submit to the Engineer the followings for review and approval as described in these Project Special Provisions thirty (30) calendar days after the award of the contract:

- North Carolina Electrical Contractor's License
- DMS Manufacturer's experience history
- DMS Enclosure Manufacturer experience history
- Three (3) references (DMS system/Enclosure) including name of organization, contact name, phone number, and email address
- Quantity of DMSs installed for each reference, date of installation, date of operation, and photographs

The Engineer will review and respond as "approved, disapproved, or incomplete" within ten (10) business days of the receipt of the information.

3. Project Requirements Review:

Sixty (60) calendar days after the award of the contract, submit a Compliance Statement bearing the signature of all the persons identified in the Project Contacts Information above. If no "exception(s)" are noted, this will be considered certification that the Contractor fully understands the requirements of this document in its entirety as "intended" by the Department and not by his/her interpretation of these requirements.

Develop, manufacture, deliver, and install a system that meets all the hardware, software, testing, operational, functional, and warranty (as outlined in Observation Period) requirements of the system as described in this document and as "intended" by the Department.

Note any "exception(s)" to certain requirements of the Project Special Provisions within the Compliance Statement in the following format:

1. Note each "exception" on a separate page.
2. Identify each "exception" as a hardware, software, functional, operational exception, etc.
3. Refer to the page and section of the Project special provisions where the requirement is stated.

4. Provide a detailed reason and explanation as to why the "exception" is taken.

5. Provide the signature of the Contractor Project Engineer, DMS Manufacturer Project Engineer, and DMS Enclosure Manufacturer Project Engineer if applicable and dated.

6. Provide check boxes for "Approved, Rejected, and More Information."

7. Provide signature and date fields for two Engineer signatures from the Department.

Note any "ambiguity" or "concern" with any requirement of the Project Special Provisions within the Compliance Statement in the following format:

1. Note each "concern" on a separate page.

2. Identify each "concern" as a hardware, software, functional, operational concern, etc.

3. Refer to the page and section of the Project Special Provisions where the requirement is stated.

4. Provide a statement as to what is not clear or concerns the Contractor.

5. Provide the signature of the Contractor Project Engineer, DMS Manufacturer Project Engineer, and DMS Enclosure Manufacturer Project Engineer if applicable and dated.

6. Provide a field for explanation/clarification by a Department Engineer of the "ambiguous" requirement.

7. Provide signature and date fields for two Engineer signatures from the Department.

Ten (10) business days after the receipt of the Compliance Statement, the Engineer will setup a meeting, in North Carolina, with the Contractor and his/her concerned parties to discuss "exceptions", "concerns", and certification of the Compliance Statement. "Ambiguities" will be clarified by the Department as initially "intended" and not as perceived by the Contractor and shall remain a contract requirement. After the clarification is made, the Contractor may take "exception" to the clarified requirement. Comply with any "exception" the Department finds to be unacceptable.

At the conclusion of the meeting or a subsequent meeting, the Compliance Statement that may include approved "exception(s)" will be certified. No other "exception(s)" will be considered or allowed past the date of certification.

4. Functional Specification:

Sixty (60) days after the certification of the Compliance Statement, submit a detailed DMS system functional specification that includes the following at the minimum:

- High level description and architecture of systems needed to support the Project Special Provisions. Use cases, state diagrams (life cycle diagrams), and process and data flow diagrams for describing high-level system structure.
- Requirements, Constraints, and Trade-offs

- Performance - defined by concrete measurements such as number of seconds and actions required to edit and/or display a message
- Scalability - concurrent users, number of accounts, storage capacity, network throughput, etc.
- Recovery - does the system have to have one or more "hot" back up systems
- Redundancy - related to performance, does the system need to be redundant in order to support distribution of load as well as recovery situations
- Archiving - what needs to be archived and are there constraints, such as geographic diversity of storage or vulnerability of backup media to corrosion
- Reliability - what percentage down time can be tolerated, what is the worse responsiveness that can be tolerated
- Reuse - is the system expected to be a "one-off" or should reusability be a goal in the development effort

- Standards:
  - Quality standards - are there industry standards for quality that must be followed
  - Auditing - will the system be internally and/or externally audited, what are the auditing requirements
  - Tools - should build tools or methodologies adhere to standards. For example, should all C/C++ compilers meet a particular ANSI standard
  - Libraries - are standard libraries a concern
    - Protocols - should the system use pre-defined protocols or define new protocols
    - Hardware - what hardware and network platforms are required for deployment
    - Operating system - what operating systems on which hardware platforms are required for development and deployment
    - Portability - should the systems to be developed have built in portability, to what platforms
    - Software - what software must the system coexist with or have compatibility with
    - Security - what security standards must the system adhere to, what additional security measures are necessary both in the deployed system as well as for internal processes and controls
    - Testing - what types of testing and reviews will be performed, who is responsible for those tests, and how will they be managed

- Testing tools - what types of testing tools will be needed for each phase of the project
- Documentation - what kind of documentation is needed for the system (also part of the methodology and how will it be managed)
- Installation - what type of tools are necessary for building installation utilities
- What internal and external support is needed for the deployment of the system
- Help system - what type of on-line help is needed, are separate, printed user and administrative manuals needed
- Administration utilities - what are the expected administrative activities from both the user and administrator point of view
- Audit trails/logging - what sophistication of system audit trails are needed, are audit trails necessary only for error detection or for other purposes such as fraud detection, performance tracking, or legal purposes

- Risk Analysis
- Issues

5. Project Development Plan:

Sixty (60) calendar days after the certification of the Compliance Statement, submit a DMS system development plan. The plan should focus on the software and hardware engineering of the system. The system development plan should identify tasks, resource needs, and major milestones. Details should be added to the plan where specifics can be anticipated. In developing the plan and schedule, the Contractor should account for the delivery and review time of his/her submittals that would affect start of the next phase. As stated in the Project Special Provisions, allow 40 to 50 days for the review and approval process of most submittals.

Include timelines for the design and development of DMS hardware and software in the plan, plus all required DMS testing and training, deliveries, installations and etc. including drawings and documentation. The plan should contain at the minimum the following:

a. Schedule :

Timeline indicating milestones within the development group and showing dependencies and inputs and outputs with other groups. For example, at the milestone, Analysis Complete, the Project Special Provisions, functional specification and analysis document should be shown as inputs to the training and documentation groups that then uses that material to plan and develop training materials and user documentation.

This timeline should show parallel tasks both within the development group and with other groups that have a direct input/output relationship with the development group. For example, the task of developing training materials and user documentation would be occurring in parallel with the development group continuing on with design and implementation.

Development tasks should be given priorities and placed within the timeline so that work that multiple groups will be dependent on is done first. For example, if a means for distributing load between processes is needed, the distribution framework should be designed and

developed before the specific applications that need the load-balancing functionality. Separate, broken-out schedules may be necessary to show this level of detail.

b. Resource Allocation:

Teams and individuals will be referred to in the schedule. Details of those teams and individuals should be specified in a separate section. Skills, expertise, and leadership abilities should be specified for each participant in the development effort. This information can be summarized in a roles document, then those role names can be used to specify the members of each team. However, even with role definitions, specific skills will need to be determined for each group. For example, a team that is assigned to develop a system framework may need a team leader, a system architect, two developers at level 3, and two developers at level 1 or 2. Within the team, expertise in C++, Smalltalk, distributed objects, NTCIP, and network protocols may be required.

c. Methodologies:

The methodologies that will be used throughout the remainder of the development life cycle should also be specified at this time. For each task in the schedule, a methodology should be specified. If there are unknowns, this points out the need for a group to investigate the methodologies in parallel with the analysis effort. For example, if integration or validation testing methodologies are an unknown, a team or individual should be tasked with investigating existing methodologies as soon as possible.

A methodology should be defined before formal activity can begin. This is necessary so that clear communications will be possible within and across development teams. For example, an analysis methodology should be determined before full-scale analysis is begun.

d. Training:

An internal training plan must be defined so that internal resources can be scheduled to deliver the required training.

Training requirements will also impact the development effort and must be factored into the schedule

6. Analysis Document:

After the review and approval of the Functional Specification and Project Development Plan by the Department, submit an Analysis Document. The Analysis Documentation should completely define what needs to be implemented, but not how it is implemented. The Analysis Document should contain the following:

- Use cases and prose
- Scenarios
- Analysis object model
- Class dictionary, includes detailed information on each class defined in the analysis object model. Also provides helpful documentation defining the meaning of the relationships and interdependencies of clusters of classes and frameworks.
- Life cycle model

- Operation model (shows details of system operations that were shown in the scenarios)
- Additional notations that may be useful include the data flow diagrams. These diagrams should allow for showing how data flows through the system.

7. Design Document:

Following the review and approval of Analysis Document, submit a Design Document that defines a blueprint for the development of the project. The Analysis Document specifies the functionality of the system and serves as a starting point for the Design Document. The Design Document expands and adds to the Analysis Document and will identify frameworks and tools needed to implement the design and the "how to." The Design Document should contain the following:

- User interface appearance and behavior design: design screens, menus, reports, and supporting tools in great detail from a user's point of view
- User interface implementation design: plans the implementation of the required behavior of the each interface, report, etc.
- System operation design: plans the implementation of the system's response to incoming events, exceptions, and other functionality of the system. It is how the system responds to commands from the user interfaces or from messages coming from network connections
- Persistence design: incorporates the purchased, or built, database frameworks into the design, requires additional detail in the design object model and dynamic diagrams (life cycle models, state transition diagrams, etc.).
- Distributed design: breaks out distributed components from the monolithic view of the system and incorporates the distributed frameworks
- Test plans for class and module tests
- Help system design
- Installation design
- Administration, user options, and supporting tools design

The following tools maybe used to create the Design Document:

- Object interaction graphs
- Visibility graphs
- Class dictionary (must define individual classes, purpose of hierarchies of classes, clusters of classes, and frameworks)
- Design object model
- State transition diagrams
- Data flow diagrams
- Use case diagrams

8. Implementation:

Using the approved documents, develop an Implementation Plan and submit it to the Department for review. Prepare the implementation plan to contain at the minimum the following:

- Detailed implementation plan,
- Design Approval Test Plan,
- Factory Acceptance Test Plan,
- Operational Test plan,
- Systems Test Plan,
- Integration Test Plan,
- User Test Plan, and
- NTCIP compliance test plan acquired from the selected Testing firm

During the implementation phase, prior to actual coding, pseudo code must be generated. Pseudo code and programming code must be periodically submitted to the Department for reviews and commenting and to enforce code development standards.

Periodically perform an audit to ensure that documentation is being kept up to date and that the schedules are on track. Submit updated, modified, and/or changed documents to the Department for review.

9. Hardware Development Documents:

a. General:

The submittals listed below complement submittal requirements stated throughout the Project Special Provisions and therefore do not replace them.

Furnish all drawings on 24"X36" sheet of paper. Fill the entire sheet of paper with the drawing excluding a 2" border all around.

Supplement each drawing with catalog cut sheets and parts list. Furnish parts lists in the following format:

Drawing Title and Number (on all pages)

Part ID	Source	Part Number	Alternate Source	Alternate Part Number	Description

b. Drawings and Documents' Certification:

Prepare the following drawings, documents, plans, and calculations approved by a Professional Engineer registered in the state of North Carolina, which bears his/her signature, seal, and date of acceptance:

- Plans for the DMS enclosure, mounting description, and shop drawings
- Plans for overhead sign assembly, footings, design computations and shop drawings
- Electrical power distribution drawings and power consumption calculations

c. Mechanical:

Include, but do not limit to, in this set of submittals material specification, catalog cut sheets, parts list, and fabrication drawings for DMS controller cabinet(s), DMS enclosure, character assemblies, DMS overhead assembly, DMS to DMS overhead assembly mounting, etc. Accompany drawings with Engineering calculations as needed and applicable. Show compliance with space requirements within the DMS controller cabinet, air flow/exchange inside the DMS enclosure, etc. through these calculations.

d. Electrical:

Include, but do not limit to, in this set of submittals material specification, catalog cut sheets, parts list, and wiring diagrams within the DMS controller cabinet, DMS enclosure, DMS controller cabinet/enclosure, service entrance cabinet/panels, and etc. Include power consumption calculations, wire and conduit size calculations, voltage drop calculation, etc. in this set of submittals. Prepare design for the DMS electrical system, wires, conduits, breakers, panel-boards, etc. in accordance with the latest edition of NEC and have them sealed and signed by a professional engineer registered in the state of North Carolina.

e. Electronics:

Include, but do not limit to, in this set of submittals material specification, catalog cut sheets, parts list, and schematic diagrams for all electronics assemblies and sub assemblies used in the system.

f. Block Diagrams:

Provide a block diagram for the following:

- DMS System,
- DMS Controller Cabinet,
- DMS Enclosure,
- DMS Controller,
- DMS Display Boards,
- DMS Driver Board(s),
- DMS Lighting Control Board(s),
- Interface Board(s), and

- Other system boards/assemblies that help in understanding, troubleshooting, and repairing the system and/or system's components.

g. LEDs:

Include in this set of submittals LED data/specification sheets and LED selection procedures as required by this section of the Project Special Provisions.

10. System Deployment:

Do not deliver the system (DMSs, Cabinets, Computers) to the job site without written permission from the Engineer. System delivery shall be contingent upon successful completion and delivery of the following:

- Factory Tests and certified results
- Retest and certified results if applicable
- On site test plans and Inspection form
- Training, Maintenance, and Repair manuals
- Drawings and diagrams: block, mechanical, electrical, electronics, and etc.
- Software related documents
- Computer submittals
- Source code for all DMS system components
- User's and operation manuals
- Catalog cut sheets, parts list, material specifications, and data sheets
- All OEM warranty documents
- All other submittals required by the Project Special Provisions and/or relevant to the system's operation, maintenance and repair

Missing or incomplete submittals shall prevent a ready-to-ship DMS/system from being delivered to the job-site.

Once the system is delivered to the job site, Department personnel(s) will conduct a thorough inspection to ensure that the system is not damaged during shipping and handling. Repair any noted damage on the inspection form supplied by the Contractor directed by the Engineer prior to installation. Do not install a system without an approved and signed inspection form by the Engineer.

At the conclusion of the installation, the system will be inspected. An approved and signed inspection form by the Engineer will allow progression to the next phase that is the Field Test.

a. Field Tests:

Supply field test plans and forms that were previously approved by the Department. Every DMS system on the project shall successfully pass all field tests. The contract will not be allowed to proceed to the next phase until the results are reviewed and approved by the Engineer.

b. Training:

Conduct the System operational, maintenance, and repair training prior to the start of the Observation Period. The system must be brought to a stable status prior to the start of the training sessions. Obtain written approval from the Engineer to conduct the required training.

11. Final Acceptance Requirements:

At the end of the project, provide the following:

- Updated versions of the hardware/software, drawings, and documents,
- Updated source code on all objects used in the project with internal and external documentation. The Department can request further documentation if the Contractor doesn't provide a clear understanding of the functions,
- Supply all updated libraries, Objects, and third party files with full development packages and rights,
- All updated third party development packages used for OEM boards, devices or components must be supplied with full development packages and rights.

Forward copies of the final documentation and other project files to the Engineer for Project Closure Review.

12. Project Closure Review:

The final project documents, bug reports and other documentation from the project will provide valuable feedback to the Department allowing them to prevent similar issues from occurring in future projects. The Project Closure Review can be conducted using email or an informal conference. The purpose is to give Engineers the chance to address any issues that caused difficulties during the process and to take steps in preventing delays in future projects.

B. Submittals:

Submit a list of all material and equipment, specifications, shop drawings, and catalog cut sheets, as well as the names and phone numbers of all key personnel and subcontractors to the Engineer for review and approval in advance of any fabrication, shipment, or purchase. The Department is not liable for any equipment or materials furnished or labor performed prior to such approval.

Include in the list the name of the manufacturer, catalog number, and brief description of each item, and supplement it with detailed drawings and wiring diagrams of DMS system components. Submit one (1) reproducible and nine (9) copies of each drawing. Include in each drawing comprehensive information and details to permit the Engineer to evaluate compliance with the specifications and special provisions. Provide each submittal sheet with a drawing number and the package with a title sheet listing the title and number of all sheets in the submittal.

Allow forty (40) days for the Engineer's review of these submittals. The Engineer is responsible for evaluation and final acceptance of all DMS System, software, testing, and training submittals. The Engineer may have other units of the Department analyze information in the submittals.

The Engineer will mark each submittal as follows:

"**APPROVED**" - The Engineer accepts the submittal, and fabrication or purchase may proceed.

"**APPROVED AS NOTED**" - The Engineer accepts the submittal provided the Contractor incorporates the attached notations into the system or component and gives the Engineer written notice of compliance before proceeding.

"**REJECTED**" - The Engineer does not accept the submittal or finds it insufficient for proper evaluation. Replace with alternate items or redesign and resubmit for review.

Do not deviate from submittals marked either "APPROVED", "APPROVED AS NOTED", or "REJECTED". The time required to resubmit new or redesigned items for review is not considered justification for extending the completion date of the project.

1. 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.

2. Physical Description:

Provide a detailed physical description of size, weight, center of gravity, special mounting requirements, electrical connections, and all other pertinent information necessary for proper installation and operation of the equipment.

3. Parts List:

Provide a parts list that contains all information needed to describe the characteristics of the individual parts, as required for identification. Include a list of all equipment within a group and a list of all assemblies, sub-assemblies, and replacement parts of all units. Arrange this data in a table, in alpha-numerical order of the schematic reference symbols, which gives the associated description, manufacturer's name, and part number, as well as alternate manufacturers and part numbers. Provide a table of contents or other appropriate grouping to identify major components, assemblies, etc.

4. 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, and 270 degrees.

5. 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.

Provide complete and detailed schematic diagrams to component level for all DMS assemblies and subassemblies such as driver boards, control boards, DMS controller, power supplies, 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.

6. Routine of Operation:

Describe the operational routine, from necessary preparations for placing the equipment into operation to securing the equipment after operation. Show appropriate illustrations with the sequence of operations presented in tabular form wherever applicable. Include in this section a total list of the test instruments, aids and tools required to perform necessary measurements and measurement techniques for each component, as well as set-up, test, and calibration procedures.

7. Field Trial:

At the request of the Engineer, supply within thirty working days a three character demonstration module with characters of the size and type specified for the project, and an appropriate control device and power supply to allow character display. Perform a field trial on this module at a time and location selected by the Engineer.

This trial will allow the Engineer or his selected representatives to test the readability of the DMS at the maximum distance required for that size character. Test the module with the sun directly above the DMS, and near the horizon in front of and behind the DMS (washout and back-lit conditions).

The Engineer must accept the functional readability of the module for the DMS product to receive further evaluation.

8. DMS Bench Repair Unit Documentation:

After approval of any equipment or equipment component parts and prior to installation of the equipment, supply all schematics drawings, board layout information, equipment manuals, software, and firmware required to perform bench repair to the component level and testing of electronic equipment and equipment circuit boards. Provide above documentation to the Department's Traffic Electronics Center at the address below. Failure to supply the documentation required by this section of the Project Special Provisions shall be grounds for rejection of the submitted item due to incomplete information. Provide schematic drawings as well as the board layout drawings that identify all components in the equipment or circuit board including but not limited to all digital and analog integrated circuits devices (ICs), all discrete

electronic components, transformers, relays, switches and other electronic devices and components used in the circuits. Provide schematic drawings that show pin to pin interconnection between components. Provide a complete parts list for each circuit board's components to the Traffic Electronics Center. Provide a copy of all software required to operate any equipment or circuit boards for the purposes of test or system software to test operation of equipment used as a system component.

a. Proprietary Parts:

Provide a list of all proprietary electronic component parts along with a price at which the vendor shall supply non-warranty parts for a two year period. Failure to supply this required proprietary part and price information may be grounds for rejection of the submitted item due to incomplete information. A part is considered to be a proprietary part if it is designed and manufactured exclusively for a specific application and is not commercially available for sale to the general public. In addition, any item that is sole source (e.g. available only from the vendor or from a single known manufacturer) is considered to be proprietary and should be identified along with the sole source. Identify and quote a price for parts that are no longer being manufactured and identify the item as one that is no longer manufactured.

b. Limits On Use and Protection of Manufacturer's Proprietary Information:

The Department's Traffic Electronics Center electronics technicians will use the above documentation (schematics, drawings, software, firmware, manuals, etc.) exclusively for the following purposes: diagnosing and performing repairs on malfunctioning equipment, equipment circuit boards, and malfunctioning systems; operational test of repaired equipment, circuit boards, systems; and performing authorized upgrades to equipment, circuit boards, and software supplied under this contract. The Department's Traffic Electronics Center electronics technicians will not use or copy devices or software for any purpose other than diagnosis, repair, and testing or to perform authorized firmware or software upgrades.

Upon notification by the manufacturer, the Department agrees not to divulge any proprietary or otherwise confidential information contained in the above required documentation. The Traffic Engineering and Safety Systems Branch of the Department agrees to protect and secure any proprietary documentation identified by the manufacturer as proprietary or confidential. Upon request by the manufacturer, the Traffic Engineering and Safety Systems Branch of the Department agrees to sign a binding non-disclosure agreement with the manufacturer or other business that is providing documentation it considers proprietary or otherwise confidential.

c. Destination:

Pre-configure the Bench test unit to the system requirement. Submit a list of the additional components for approval by the Engineer.

Deliver the DMS Bench Test Unit, all associated manuals, equipment, and repair documentation listed above to:

North Carolina Department of Transportation
Traffic Electronics Center
2580 Trenton Road
Raleigh, NC 27607
ATTN: Mr. Kenneth Morge Phone #: (919) 233-1521

C. Summary of Submittals:

This section lists DMS submittals and DMS submission timing required by these Project Special Provisions. See the referenced paragraphs for a full description of the required DMS submittal contents.

Description	Reference	Due
Names and Phone Numbers of Key Personnel	30.3.A.1	30 days after award
Three Customer References from DMS Manufacturer	30.3.A.2	30 days after award
Plans for DMS, structure, mounting description and calculations	30.3.A.9.b	With Catalog Cuts
Sample Paint Finish (if required)	30.2.B.2	With Catalog Cuts
Front Face Panel Sample (if required)	30.3.B.7	With Catalog Cuts
LED Sort Procedures	30.3.C.1	With Catalog Cuts
LED Manufacturer Technical Specifications	30.3.C.1	With Catalog Cuts
LED Power and Driver Circuit Schematic	30.3.C.2	With Catalog Cuts
Controller Cabinet Layout	30.2.F.2	With Catalog Cuts
Controller Backpanel Layout	30.2.F.4.a	With Catalog Cuts
Equipment List	30.3.B.1	With Catalog Cuts
Power Consumption Table for Major Equipment	30.3.A.9.d	With Catalog Cuts
Parts List	30.3.B.3	With Catalog Cuts
Character Set	30.3.B.4	With Catalog Cuts
Wiring Diagram of DMS system	30.3.B.5	With Catalog Cuts
Theory of Operation	30.3.B.5	With Catalog Cuts
Routine of Operation	30.3.B.6	With Catalog Cuts
Maintenance Procedures	30.4.B	With Catalog Cuts
Repair Procedures	30.4.C	With Catalog Cuts
Field Trial Demo Module	30.3.B.7	30 days after request
Drawing of Underground Conduit/Cable	30.3.D.2	With Catalog Cuts
Construction Submittal (As Built Plans)	30.3.D.3	Prior to Final Acceptance
Spare Parts	30.3.D.10	Prior to Final Acceptance
Certification of Electrical Inspection	30.3.D.12	Prior to Final Acceptance
Failure Log & Corrective Actions during Observation Period	30.3.D.13	After Final Acceptance
List of Material, Specs, Drawings, Catalog Cuts	30.3.B	Before Fabrication, Shipment, or Purchase
Outline of all Training	30.1.A	60 days before Training
Video Tapes of Training	30.1.A	After Training is Complete
Test Procedures and Requirements	30.3.F	40 days before Test date
Notification of Test Date	30.3.F	30 days before Test date
Quantitative Test Results	30.3.F	ASAP after Test Completion
Certified Design Approval Tests Results by ITA	30.3.F.1	40 days before Test date
Project-Specific NTCIP Manual	30.3.F.2.d.7	40 days before Test date
NTCIP testing submittals	30.3.F.2.d.5	40 days before Test Date
Description of computers hardware and software, Comm. Protocol/Timing Diagrams	30.3.B.1	With Catalog Cuts
Computer Manuals, Circuit Card Doc., Licenses, Source Programs	30.3.A.10	With Delivery of Computers
Designs, Plans, Shop Drawings and Computations for Attachment to Overhead DMS Assembly	31.3.B	Prior to Fabrication (50 day review)

D. Construction Requirements:

1. 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.

2. 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.

3. 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.

4. Removal of Existing DMS Enclosures, Controllers and Cabinets:

Remove the existing DMS enclosure, controller and controller cabinet prior to installation of a new DMS enclosure, controller and controller cabinet. Do not take the existing DMS out of service until all equipment and materials are on site to install the new DMS in the minimum time possible. Obtain the Engineer's approval before removing an existing DMS.

Transport and deliver the existing DMS enclosure, controller and cabinet to a location designated by the Engineer.

The foregoing requirements for removal of existing DMSs apply individually to each DMS.

5. Conduit:

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

Make bends in the conduit so that do not 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' (1.2m) for conduit 1.5" (40 mm) and larger, or 6' (1.8 m) for conduit 1.25" (30 mm) and smaller. Place fasteners no more than 3' (900 mm) from the center of bends, fittings, boxes, switches, and devices.

Locate underground conduit as shown in the plans in a trench with essentially vertical walls no wider than necessary for easy installation of the conduit and at a minimum depth of 24" (600 mm).

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" (150 mm) upward and at least 3' (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 with oakum. 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 a 40% fill rate on all cable installed in conduit as specified in the NEC.

6. 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.

7. 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. Construct concrete in conformance with Section 1750 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.

8. Cabinet and System Grounding:

Ground the controller cabinet, DMS enclosure, DMS structure, and service entrance equipment per Sections 1098 and 1700 of the Standard Specification and Roadway Standard Drawings. 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 buss. 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' (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.

9. Excavating and Backfilling:

Excavate and backfill according to the requirements of Section 1715 of the Standard Specifications.

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.

10. 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.

11. Spare Parts:

Provide the following spare parts package to the Engineer upon successful completion of the system "Observation Period."

- One complete character module
- One DMS face panel
- One DMS controller and power supply
- One LED power supply and LED driver
- One interface board for each piece of equipment, if applicable

Pre-configure all spare DMS equipment to the system requirement. Submit a list of spare parts for approval by the Engineer.

12. Technical Assistance:

Ensure that an authorized representative from the manufacturer is available, unless otherwise authorized by the Engineer, to assist the technical personnel at each installation site and during installation of the Client/Server Computer and up-link with the DMS system. The representative will provide technical assistance in the following areas:

- DMS to structure installation
- DMS Controller cabinet installation

- DMS to DMS Controller cabling

Server, Client, Laptop Computers' software installation and configuration, up-link and initial operation with the DMS system.

13. Inspection:

Comply with all local ordinances and regulations. Prior to the start of any electrical work apply for and obtain all permits and / or licenses required by local registration. Have each system inspected and approved by the licensed city, county, or state electrical inspector having jurisdiction where the system(s) are located.

Inspection by the local electrical inspectors does not eliminate, nor take the place of, inspection by the Engineer. Furnish written certification to the Engineer that the system(s) have been approved by the local electrical inspector having jurisdiction. Provide this approved electrical inspection certificate to the Engineer prior to final acceptance of the project.

14. Observation Period:

Comply with the same observation period requirements for the DMSs as specified in the section titled "Testing and Acceptance", subsection "Observation Period."

E. Integration:

Furnish NTCIP compliant DMSs. Integrate the new DMS systems into the existing eastbound and proposed westbound weigh station computer systems to operate in a manner equivalent to the existing DMSs and compatible with operation of a state-of-the-art commercial vehicle weigh station. Assure through demonstration that all functions and features required by the weigh station control software fully operate on the new DMSs. Assume responsibility for all damages that may be inflicted on the new or existing system as a result of the integration process.

The integrated system as defined above is subject to the requirement of these Project Special Provisions. The requirements of "Continuous Run Evaluation Period" and "Observation Period" shall fully apply to the integrated system.

F. Testing:

The Department requires physical and functional testing of all material and equipment not previously tested and approved.

Test the DMS system in a series of design approval 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 8 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 test procedures for the tests. Include the7 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 NIST standards. Provide calibration documentation upon request.

Notify the Engineer thirty days in advance of factory tests.

The Engineer will consider a failure to conform to the requirements of any test and these specifications as a complete failure, and the equipment will 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. Provide the documentation to the Engineer of all tests 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 5 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.

1. Design Approval Tests:

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.

Manufacture a prototype Dynamic Message Sign and controller of the type and size described in the 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 pixel on and half off, alternating pixels on each page. Display this pattern for 1 hour.

The Design Approval Tests consists of the following:

a. Temperature:

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.

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

b. Humidity:

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.

c. Primary Power Variation:

1. 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.

2. 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.

3. High Frequency:

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.

d. 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.

e. 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.

f. LED Pixel Light Output Test:

Perform a test to confirm that the light output intensity conforms to the requirements in the section titled "LED Pixels" of these Project Special Provisions.

Approval of the Design Approval Test results does not relieve the Contractor of the requirement to conform to the specifications in these Project Special Provisions.

2. Operational Factory Tests:

Conduct Operational Factory Tests as described below. Perform Operational Factory Test on the assembled DMS system at the manufacturer's facility prior to shipping. Each piece of equipment must pass the following tests:

a. 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.

b. Continuity Test:

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

c. 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 identified in Table 1 and the requirements of 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
- EEPROM 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.

d. NTCIP Testing:

This portion of the specification defines the detailed NTCIP requirements for the DMSs covered by the procurement package.

1. Definitions:

The following terms 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

Full, Standardized Object Range Support – 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 ASCs and 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.

2. 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)*	

Abbreviated Number	Full Number	Title	Known Amendments
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	

3. ***General Requirements:***

(a) 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.

(b) 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.

(c) 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.

(d) 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:

Object	Reference	Project Requirement
		Local
		External central
		CentralOverride

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

Blank the sign 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.

(1) Time Management, as defined in NTCIP 1201

(2) 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

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

(4) PMPP

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

(5) 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 font. The second font shall be a double-stroke font. The third and fourth fonts 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 [# & * +< >]

(6) VMS Configuration, as defined in NTCIP 1203.

(7) 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

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

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

(10) Multi Error Control, as defined in NTCIP 1203

(11) 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

(12) Auxiliary I/O

(13) 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

(14) Sign Status, as defined in NTCIP 1203

(15) Status Error, as defined in NTCIP 1203

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

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

(18) Power Status, as defined in NTCIP 1203

(19) Temperature Status, as defined in NTCIP 1203

Install necessary hardware for the support of items 17, 18, and 19 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.

4. Documentation:

Supply software with full documentation, including 3.5" (89 mm) floppy disk(s) and 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.

5. NTCIP Acceptance Testing:

Secure the services of one of the following firms to perform NTCIP compliance tests outlined in the section titled "Testing" of 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

Unless otherwise stated in these Project Special Provisions, perform all work in compliance with the applicable requirements of the above references.

Submit to the Engineer for approval a portfolio of the selected firm, including the name, address, and a history of the selected firm in performing NTCIP testing along with references. Also provide a contact person's name and phone number. Submit a detailed NTCIP testing plan 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. Have these test documents 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. Have the tests conducted by the firm in North Carolina on the installed system in the presence of the Engineer. Document and certify the results of the test by the Firm and submit to the Engineer for review and approval. In case of failures, remedy the problem and have 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.

6. Interpretation Resolution:

If the Project Engineer or NTCIP Component developer discovers an ambiguous statement in the standards referenced by this procurement specification, submit the issue to the relevant NTCIP Working Group for resolution. If the Working Group fails to respond within 90 days, the Project Engineer will provide an interpretation of the specification for use on the project.

7. NTCIP Submittal:

Include a project-specific NTCIP manual in the list of deliverables that thoroughly documents the details associated with the various NTCIP options and features in the system.

3. Operational Field Tests:

Conduct Operational Field Tests as described below. Perform Operational Field Tests on each system after it is shipped, installed, and operational. Each piece of equipment must pass the following tests:

a. Physical Examination:

Test per section titled "Physical Examination" above.

b. Continuity Tests:

Test per section titled "Continuity Tests" above.

c. 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.

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

G. DMS Enclosure Structure Mounting:

Mount the DMS enclosure and interconnect system securely to the existing support structure.

Submit plans for the DMS and existing structure, mounting description, and calculations to the Engineer for approval. A Professional Engineer registered in the state of North Carolina must approve these calculations and drawings and they must bear his signature, seal, and date of acceptance.

30.4 MAINTENANCE.

Maintain the system throughout the Observation Period. During this time, the Engineer will run the system in normal operational mode.

A. Maintenance Training:

Provide System Assembly, Operations, and Maintenance Training, unless the Engineer authorizes otherwise, to key personnel prior to the start of the Observation Period. Limit training to a maximum of 15 people and provide it at a time and place in North Carolina that the Engineer approves. Provide a minimum of 40 hours of demonstrations and seminars that include, but are not limited to, the following:

- Hands on training with all system hardware and software,
- Explanation of software capabilities,
- Data entry and message editing procedures,
- Preventative maintenance and servicing procedures,
- System diagnostic and repair procedures.

Provide an outline of the training sessions 60 days in advance for the Engineer's review and approval.

Videotape the entire training on VHS tapes and provide the tapes to the Engineer for approval and later use. If the Engineer determines the quality or contents of the training session inadequate, or the quality of the videotape unacceptable, repeat and provide adequate training and/or videotapes.

B. Maintenance Procedures:

Specify the recommended preventative maintenance procedures and checks at pre-operation, monthly, quarterly, semi-annual, annual, and "as required" periods to assure equipment operates reliably. List specifications, including tolerances, for all electrical, mechanical, and other applicable measurements and / or adjustments.

C. Repair Procedures:

Include in this section all data and step-by-step procedures necessary to isolate and repair failures or malfunctions, assuming the maintenance technicians are capable of analytical reasoning using the information provided in the section of these Project Special Provisions titled "Wiring Diagrams and Theory of Operation."

Describe accuracy, limits, and tolerances for all electrical, physical, or other applicable measurements. Include instructions for disassembly, overhaul, and re-assembly, with shop specifications and performance requirements.

Give detailed instructions only where failure to follow special procedures would result in damage to equipment, improper operation, danger to operating or maintenance personnel, etc. Include such instructions and specifications only for maintenance that specialized technicians and engineers in a modern electromechanical shop would perform. Describe special test set-up, component fabrication, and the use of special tools, jigs, and test equipment.

30.5 METHOD OF MEASUREMENT.

Lump sum for each DMS with controller and cabinet furnished, installed and accepted.

Lump sum for each DMS Bench Test Unit furnished and accepted.

Lump sum for DMS Maintenance Training with training packages completed and accepted.

No measurement will be made of communications equipment; spare parts; strapping hardware; UPS; cabinet base, conduit and conduit bodies; wire; connectors; circuit protection equipment; photo-electric sensors; electrical and telephone service acquisition; and related service equipment; tools; materials; documentation; computers; software; testing; integration; attachment to overhead assembly; cost of labor; cost of transportation; incidentals; removal of existing DMSs cabinets and controllers; and all other equipment necessary to furnish and install a DMS as these will be considered incidental to furnishing and installing DMS with controllers and cabinets.

No measurement will be made of character modules, controller, drivers, power supply, components, electrical cord, switches, ventilation, documentation, delivery and setup costs as these will be considered incidental to furnishing the DMS Bench Test Unit.

30.6 BASIS OF PAYMENT.

Payment will be made at the contract lump sum price for "Dynamic Message Sign System "DMS-__"" for the equipment and work described within this Section.

Payment will be made at the contract lump sum price for "Dynamic Message Sign Bench Test Unit" for the equipment and work described within this Section.

Payment will be made at the contract lump sum price for "Dynamic Message Sign Maintenance Training" for the work described within this Section.

Payment will be made under:

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

Dynamic Message Sign Bench Test Unit .....Lump Sum

Dynamic Message Sign Maintenance Training .....Lump Sum

31. ATTACH DMS TO EXISTING OVERHEAD SIGN ASSEMBLY

31.1 DESCRIPTION.

Furnish all work and materials to attach new DMS enclosures to existing overhead dynamic message sign (DMS) assemblies with all necessary hardware in accordance with the plans, Standard Specifications and these Project Special Provisions. Comply with the provisions of Section 900.

31.2 MATERIALS.

Refer to Division 10 of the Standard Specifications:

Structural steel..... Section 1072 and 1096

Steel bar reinforcement ..... Section 1070

Zinc-rich paint.....Article 1080-9

High strength bolts, nuts, and washers.....Sub-article 1094-1 (A)

31.3 CONSTRUCTION METHODS.

A. General:

Design the attachment to the existing overhead DMS assembly and submit shop drawings for approval. 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*. Have a Professional Engineer registered in the state of North Carolina prepare such computations and drawings, which shall bear the signature, seal, and date of acceptance of said Professional Engineer.

Fabricate the attachment to the existing 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 a complete design for attachment to each existing overhead DMS assembly to the Engineer for approval, sign assembly hardware, and brackets for supporting the signs.

To ensure the correct attachment of the DMS enclosure, submit plans and designs for the DMS enclosure and the overhead DMS assembly to the Engineer to transmit to the Engineer and Structures Engineer for approval and acceptance. Resolve discrepancies and conflicts arising from

non-compatibility of the DMS enclosure through coordination between the structure designers and the sign designers.

Coordinate work of the DMS enclosure manufacturer to ensure that the sign and the sign structure are totally compatible, operational, and functional as a working unit.

Submit 13 copies of completely detailed shop drawings and one copy of the design computations for attachment of the new DMS enclosure to the existing overhead DMS assembly to the Engineer for review and approval by the Structures Engineer prior to fabrication. Show in the shop drawings complete design and fabrication details including provisions for attaching the DMS, applicable material specifications, and any other information necessary for review and approval of the design.

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, and for the fit of all shop and field connections and anchors.

C. Design and Fabrication:

Fabricate the attachment hardware in accordance with the details shown in the approved shop drawings and with the requirements of these Project Special Provisions.

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

31.4 METHOD OF MEASUREMENT.

No measurement will be made for attachment design, shop drawings, documentation, fabrication, construction, transportation, and installation of the DMS enclosure, hardware, direct tension indicators, additional incidentals, and all other equipment and features necessary to attach the DMS enclosure to the existing overhead sign support assembly as all work and materials are considered incidental to furnishing and installing the DMS.

31.5 BASIS OF PAYMENT.

No separate payment will be made for the work associated with attaching a new DMS to an existing overhead sign support assembly.