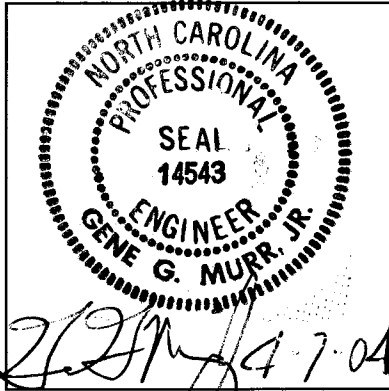


Project Special Provisions (Version 02.13) Traffic Management Systems

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07-Apr-04



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

The 2002 Standard Specifications are revised as follows:

1.1.General Requirements (1098-1)

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

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

1.2.Wood Poles (1098-6)

Page 10-228, Article 1098-6

Replace the entire article with the following:

Provide poles of treated southern pine or treated Douglas fir that meet the requirements of ANSI 05.1. Provide Class 3 or better wood poles that are a minimum length of 35 feet (12.2 meters) unless otherwise shown on the plans and are of a sufficient length to maintain minimum required distances above the roadway, obstructions and affected railroad tracks. Mark each pole in accordance with ANSI 05.01. First roof and bore poles and then give them a full-length preservative treatment.

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

A. METHOD OF MEASUREMENT

Comply with Section 1700 of the 2002 Standard Specifications.

B. BASIS OF PAYMENT

Comply with Section 1700 of the 2002 Standard Specifications.

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

The 2002 Standard Specifications are revised as follows:

2.1.General Requirements (1700)

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

In the event the contractor fails to perform in accordance with the plans and specifications within the time frame specified, the Department reserves the right to perform the maintenance and emergency service necessary to assure continuous traffic signal operation. Further, all expenses incurred by the Department in implementing this option shall be deducted from the payment due the contractor, plus a \$250 liquidated damage per occasion, per day, or any portion thereof, until corrected. The liquidated damages are due to increased public hazard resulting from the malfunction.

2.2.Wood Poles (1720)

Page 17-10, Article 1720-3

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

3. GENERAL REQUIREMENTS

3.1. Description

A. General

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

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

All work shall be performed in the United States of America (USA). No work shall be outsourced outside the USA.

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

The limits of the I-4417 project for the work described below is on I-40 from just west of the exit 66 bridge in Buncombe County east to just west of the exit 73 bridge in McDowell County.

This project is in English units.

Furnish, install, test, integrate and make fully operational five (5) Visibility Sensors that will activate flashing beacons on three (3) static signs when visibility thresholds are reached or crossed.

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

Provide real world coordinates for all field devices (including but not limited to Visibility Sensors, Wireless Data Transceivers, equipment cabinets, static signs, and oversized junction boxes) installed and/or modified under this project. Provide the coordinates in feet units using the North Carolina State Plane coordinate system (1983 North American Datum also known as NAD '83). Furnish coordinates that do not deviate more than 1.7 feet (1/2 meter) in the horizontal plane and 3.3 feet (1 meter) in the vertical plane. Global positioning system (GPS) equipment able to obtain the coordinate data within these tolerances may be used. Submit cut sheets on the GPS unit proposed to collect the data for approval by the Engineer. Provide both a digital copy and hard copy of all information regarding the location (including to but not limited to manufacturer, model number, and NCDOT inventory number) in the Microsoft spreadsheet provided by the Department, shown by example below.

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

B. Domestic Steel and Iron Products

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

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

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

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

3.2.Basis of Payment

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

4. VISIBILITY SENSOR (VS)

4.1.GENERAL

Furnish, install, and integrate Visibility Sensors at field locations shown on the Plans.

4.2.MATERIAL

Furnish Visibility Sensors that meet the following minimum requirements:

- Determines visibility by sensing light scattered from an eye-safe output source
- Contains programmable visibility thresholds
- Provide programmable visibility range between 50 and 2000 feet
- Provide output either continuously or as polled
- Provide programmable averaging intervals of 1, 5, and 10 minutes
- Heated lenses, or other mechanism, to minimize condensation interfering with measurements
- Operate from -10 to +120 degrees F in 0% to 100% humidity
- Operate from 10 VDC to 14 VDC with 6 W power consumption

4.3.CONSTRUCTION METHODS

Perform all work in accordance with the Plans and these Project Special Provisions. Furnish, install, and integrate Visibility Sensor as shown in the Plans. Install and calibrate in accordance with the manufacturer's installation requirements. Integrate connections from the Visibility Sensor with the appropriate Event Processor/Wireless Transceiver.

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

4.4.METHOD OF MEASUREMENT

Actual number of Visibility Sensors furnished, installed, integrated with Event Processor/Wireless Transceivers, and accepted.

No additional measurements will be made for power cords, adapters, connectors, cables and installation materials as these will be considered incidental to the cost of the installation.

4.5.BASIS OF PAYMENT

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

Payment will be made under:

Visibility Sensor Each

5. EVENT PROCESSOR/WIRELESS TRANSCEIVER

5.1.DESCRPTION

The Event Processor/Wireless Transceivers will interface the Visibility Sensors to the wireless data system and will interface the wireless data system to the Beacon Controller Assembly.

The Event Processor/Wireless Transceiver designated as the Master will poll each Event Processor/Wireless Transceiver over the wireless data system to determine if the visibility range of a Visibility Sensor is at, or has passed through, a programmed threshold. When a site's Event Processor/Wireless Transmitter has determined that a threshold has been reached or crossed, the appropriate message will be sent in response to a poll. The Master will receive the message over the wireless data system. The Master will instruct the Event Processor/Wireless Transceiver at the sign sites to turn each Beacon Controller Assembly on or off as appropriate through its contact closure outputs. The Beacon Controller Assemblies will activate the Signal Heads (also known as Flashing Beacons) at the sign locations as appropriate.

When a message is sent over the wireless data system to the Signal Heads, a parallel message will be sent over the Cellular Modem to inform Division 13 Operations of the conditions present.

5.2.MATERIAL

The Event Processor/Wireless Transceiver must meet, as a minimum, all the requirements of the three subsections shown below:

A. Event Processor

The Event Processor must meet the following minimum requirements:

- Communicate seamlessly with the Wireless Transceiver
- Interface with the Visibility Sensor to determine when visibility range thresholds have been crossed and then pass the appropriate messages to the Wireless Transceiver
- Supports hysteresis of visibility thresholds in order to avoid borderline conditions that would otherwise result in cycling of Signal Heads on and off
- Interface with the Cellular Modem to send the appropriate messages to Division 13 operations when visibility range thresholds have been crossed
- Interface with the Beacon Controller Assembly using contact-pair closures to change the state of the Signal Heads after receiving a message from the Wireless Transceiver
- Monitor voltage at event processor and send alarm via the Cellular Modem to Division 13 Operations personnel when the supply voltage is outside the specifications

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- Accept a command from Division 13 Operations personnel via the Cellular Modem to turn off the flashing beacons in the event of accidental activation of the flashing beacons
- Reset itself if an onboard “watchdog timer” expires
- Contact and Relay Ratings:
 - Isolation circuit contact: maximum current = 100ma, maximum voltage = 350VAC
 - Crydom HD4850 relay (or equivalent): Input voltage 3-15 V DC
 - Max. load current, voltage: 50A, 480VAC

B. Wireless Transceiver

The Wireless Transceiver with appropriate antennas must meet the following minimum requirements:

- Communicate seamlessly with the Event Processor
- Compatible and fully interoperable with the Wireless Data Transceivers specified in Section 6 of these Project Special Provisions
- Completely configurable via the same software used with the Wireless Data Transceivers specified in Section 6 of these Project Special Provisions
- Built-in store-and-forward repeater
- Pass messages to and from the Event Processor as required

A lightning arrestor must be furnished and installed in-line between the antenna and the transceiver in the equipment cabinet. Lightning arrestor and its installation method will be approved by the Engineer.

C. Operating Power and Environmental Requirements

The Event Processor/Wireless Transceiver must operate within the following parameters:

- Power Requirements and Consumption: 10-14 VDC and 3.0 Watts
- Temperature range: -20°F to 130°F
- Humidity range: Up to 95% Relative Humidity

5.3.CONSTRUCTION METHODS

Furnish and install Event Processor/Wireless Transceivers as shown on Plans. Install the Event Processor/Wireless Transceivers within an equipment cabinet attached to the appropriate structure in the approximate locations shown in the Plans. Contractor must use the radio spectrum survey

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conducted for the Wireless Data Transceivers as described in Section 6 to determine the signal levels present at each location. The Engineer will approve final locations.

Install the Event Processor/Wireless Transceivers with the appropriate antennas. Integrate the Event Processor/Wireless Transceivers with the Visibility Sensors, the Wireless Data Transceivers, and the Beacon Control Assemblies.

The Event Processor/Wireless Transceiver designated as the Master will be programmed and integrated to poll each Event Processor/Wireless Transceiver at the Visibility Sensors to determine if a visibility threshold has been crossed. When a threshold crossing is detected, the Master Event Processor/Wireless Transceiver will send messages to the Event Processor/Wireless Transceivers at the sign sites to change the state of the Signal Heads. In parallel, the Master Event Processor/Wireless Transceiver will send a message on the Cellular Modem to notify Division 13 Operations personnel through a central server's email as described in Section 6.

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

5.4.METHOD OF MEASUREMENT

Actual number of Event Processor/Wireless Transceivers furnished, installed, integrated, and accepted.

No additional measurements will be made for antennas, power supplies, power cords, adapters, connectors, cables and installation materials necessary to complete this work as these are considered incidental to the cost.

5.5.BASIS OF PAYMENT

The quantity of Event Processor/Wireless Transceivers, measured as provided above, will be paid for at the contract unit price each as "Event Processor/Wireless Transceiver".

Payment will be made under:

Event Processor/Wireless Transceiver.....Each

6. WIRELESS EQUIPMENT

6.1.DESCRPTION

Furnish and install Wireless Data Transceivers at field locations shown on the Plans. The Wireless Data Transceivers provide a bi-directional communication channel for data between the Event Processor/Wireless Transceivers using unlicensed spread-spectrum frequencies.

Integrate Wireless Data Transceivers with the Event Processor/Wireless Transceivers as described in these Special Provisions and as shown on the Plans.

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Furnish and install a Cellular Modem at the field location shown on the Plans. The system provides a communication channel for messages between the Master Event Processor/Wireless Transceivers and Operations personnel using cellular frequencies and email from a central server.

Integrate the Cellular Modem with the Master Event Processor/Wireless Transceiver as described in these Special Provisions and as shown on the Plans.

6.2.MATERIAL

A. Wireless Data Transceivers

The Wireless Data Transceivers with appropriate antennas used for wireless transmission and reception of data must meet the following minimum requirements:

- Operate in the license-free (ISM), spread spectrum band (902-928 MHz), utilizing Frequency Hopping technology
- Utilize 139 user-selectable channels, with 62 available hopping sequences, (2 non-overlapping)
- Completely configurable via included software
- Software features that provide “remote diagnostics, remote maintenance and Spectrum Analyzer” included
- RS232 interface capable of 1200 bps to 115.2 Kbps
- Maximum 8 msec. end-to-end latency
- LED indicators for PWR, TX DATA, RX DATA and a 3 LED Bar graph for RX Signal Strength Indication
- DB9-F connector for RS232 port
- Operating temperature of -40 to +176 degrees F.
- Power supply voltage range between 6 VDC and 30 VDC, with a typical current draw of <100mA
- Programmable for RF output levels of 1mW, 10mW, 100mW or 1 Watt
- Provide 16-bit Cyclic Redundancy Check (CRC) error checking with auto re-transmit
- Available with optional built-in RS485 Interface
- Must not require controller hardware or software modifications
- Built-in store-and-forward repeater
- Function in a wireless network configuration that may include a mix of RS232, RS485
- Come standard with a mounting bracket
- Sleep Mode available with a maximum current draw of <1μA
- Must not exceed 4.38” Depth x 3.65” W x 1.69” H (not including connectors or mounting bracket)
- Reverse Polarity Threaded Normalized Connector-Female (RP TNC-F) antenna connector.
- Must have power cable supplied with radio modem

Complete instructions for hardware installation, programming and system commissioning should be included.

A lightning arrestor must be furnished and installed in-line between the antenna and the transceiver in the equipment cabinet. Lightning arrestor and its installation method will be approved by the Engineer.

B. Cellular Modem

The Cellular Modem will interface with the Master Event Processor/Wireless Transceiver. The Cellular Modem, with an appropriate antenna, will send messages to a central server using cellular technology and frequencies. The server will then email messages to Division 13 Operations personnel. The cellular technology must be compatible with the carriers that hold the State's cellular contracts.

The Cellular Modem will receive a message over the cellular network to turn off the flashing beacons and pass it to the Master Event Processor/Wireless Transmitter.

The Cellular Modem will be powered from 115VAC +/- 10%. Input power that is stepped-down to an appropriate voltage by a contractor/vendor-supplied power adapter is acceptable.

A lightning arrestor must be furnished and installed in-line between the antenna and the transceiver in the equipment cabinet. Lightning arrestor and its installation method will be approved by the Engineer.

6.3.CONSTRUCTION METHODS

A. Wireless Data Transceivers

Furnish, install, and integrate Wireless Data Transceivers as shown on Plans. Install Wireless Data Transceivers within an equipment cabinet attached to the appropriate structure in the approximate locations shown in the Plans. Contractor must conduct a radio path signal strength survey at each location. The survey will evaluate the Signal Strength (dBm), Fade Margin (dB), Signal-to-Noise Ratio (SNR), Data Integrity (poll test), and a frequency scan in the band of interest. As a result of the radio survey, it is possible that some repeaters consisting of Wireless Data Transceivers may not be necessary after the radio survey is completed. The Engineer will approve final locations and number of repeaters.

Install the Transceiver with the appropriate antenna. Integrate the Wireless Data Transceiver with other Wireless Data Transceivers and with the Event Processor/Wireless Transceivers.

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

B. Cellular Modem

Furnish, install, and integrate the Cellular Modem as shown on Plans. Locate the Cellular Modem within an equipment cabinet as shown on the Plans. Contractor must conduct a cellular signal strength survey to determine the appropriate cellular technology's signal levels present at the Master Event Processor/Wireless Transceiver location. The Engineer will approve the cellular technology's signal strength before proceeding with installation. The Engineer will provide the list of message recipients for the delivery of email.

Install the Cellular Modem with the appropriate antenna. Integrate the Cellular Modem with the Master Event Processor/Wireless Transceiver and with a central server providing email delivery.

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

6.4.METHOD OF MEASUREMENT

Actual number of Wireless Data Transceiver Assemblies (including antennas) furnished, installed, integrated, and accepted.

No additional measurements will be made for the radio path signal strength survey, antennas, power supplies, power cords, adapters, connectors, cables and installation materials necessary to complete this work as these are considered incidental to the cost.

Actual number of Cellular Modems (including antenna) furnished, installed, integrated, and accepted.

No additional measurements will be made for a cellular signal strength survey, antenna, power supplies, power cords, adapters, connectors, cables and installation materials necessary to complete this work as these are considered incidental to the cost.

6.5.BASIS OF PAYMENT

The quantity of Wireless Data Transceivers, measured as provided above, will be paid for at the contract unit price each for "Wireless Data Transceiver".

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

Payment will be made under:

Wireless Data Transceiver Each
Cellular Modem Each

7. BEACON CONTROLLER ASSEMBLIES

7.1.DESCRPTION

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

7.2.MATERIAL

Provide, as specified in the plans, a Type F3 beacon controller assembly with cabinet. Furnish all pole mounting hardware, solid state flasher, one Corbin Number 2 cabinet key, surge protection, grounding systems, and all necessary hardware.

- Type F3 - Cabinet [25 inches (625 mm) high x 22 inches (560 mm) wide x 15 inches (375 mm) deep], dual-circuit flasher, a fan and thermostat, and a cabinet light.

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Furnish all cabinets with a solid state flasher meeting the requirements of NEMA Standards Publication TS-2 Section 2 and Section 6.3. Encapsulate flasher components as necessary. Connect the flasher to provide the beacon operation called for in the plans.

Submit drawings showing dimensions, location of required equipment and mechanisms, cabinet electrical diagrams, part numbers and descriptions of required equipment and accessories to the Engineer. Provide certification to the Engineer that materials used in the construction of the cabinet meets these specifications.

Furnish cabinet shells that conform to the requirements of Section 1098-22(A) of the NCDOT Standard Specifications.

Install a vent or vents at or near the bottom to permit the intake of air. On the F3 cabinet, install vents sized for the rated flow of air from the fan. Provide vents no smaller than 20 in² (12900 mm²). Equip the vents with standard-size, replaceable filters or, if located where they can easily be cleaned, permanent filters.

Equip the F3 cabinet with two NEMA standard circuit breakers (20A & 15A) installed to ensure that personnel servicing the cabinet, including the rear of the back panel, cannot inadvertently be exposed to a hazard. Install a terminal block that will accommodate service wire as large as A.W.G. #4, and connect it to the circuit breaker. Install the circuit breakers in addition to any fuses that are a part of the individual control equipment components.

Furnish and install a power line surge protector per Section 1098-22(B) of the NCDOT Standard Specifications in the service power in the F3 cabinet. Install the surge protector in the circuit breaker enclosure in a manner that will permit easy servicing. Ground and electrically bond the surge protector to the cabinet within 2 inches (50 mm) of the surge protector.

Ensure the F3 cabinet has sufficient electrical and electronic noise suppression to enable all equipment in it to function properly. In addition, equip the cabinet with a radio interference filter connected between the stages of the power line surge protector. Ensure the filter minimizes interference generated in the cabinet in both the broadcast and aircraft frequencies. Use a filter that provides attenuation of at least 50 decibels over a frequency range of 200 kilohertz to 75 megahertz. Ensure the filter is hermetically sealed in an insulated metal case. Provide a filter that is designed to operate in a 120-volt, 60 Hertz, single-phase circuit with currents of 15 amperes or more, such as, HESCO LF35 or equivalent.

Connect a metal oxide varistor, type V150LA20, between each field terminal and the ground bus.

Install terminals in the cabinets in conformance with the requirements of Section 1098-22 of the NCDOT Standard Specifications.

Connect each conductor, including unused conductors, within or entering the cabinet to a terminal using crimped spade lugs. Place no more than two conductors on any single terminal screw. Terminations to the back panel may be soldered. Do not use quick connectors or barrel connectors. Make all connections at terminals. Do not make in-line splices.

Ensure that outgoing circuits have the same polarity as the line side of the power supply. Ensure that the common return has the same polarity as the grounded conductor (neutral) of the power supply.

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Neatly package all wiring. Dress the harnesses by lacing, braiding or tying with nylon tie wraps at closely spaced intervals. Attach wires, cables or harnesses to the cabinet walls for support or to prevent undue wear or flexing. Use nylon tie straps or metal clamps with rubber or neoprene insulators. Screw these attachment devices to the cabinet. Do not use stick-on clamps or straps.

Tag AC+, AC-, chassis ground, and flasher circuit conductors with non-fading, permanent sleeve labels at the ends of the conductors at the terminals or use color-coded wire. Ensure that sleeve labels tightly grip the conductors. Alternatively, use hot stamped labels on internal conductor insulation at intervals of no greater than 4 inches (100 mm). Ensure that label legends are permanent.

Ensure that all jumpers are wire conductors or metal plates. Do not use printed circuit back panels or back panels using wire tracks as jumpers.

Lay out all equipment and components for ease of use and servicing. Ensure that equipment controls can be viewed and operated without moving or removing any equipment. Ensure there is access to equipment or components for servicing without removing any other equipment or components. Removal of equipment is acceptable to access the fan or thermostat. Ensure that equipment can be removed using only simple hand tools. Ensure that the layout of equipment and terminals within the various cabinets furnished is identical from cabinet to cabinet, unless otherwise approved by the Department.

Mount equipment using harnesses with suitable multipin (or similar) connectors. Design or key all equipment to make it physically impossible to connect the unit to the wrong connector. Ensure that functionally equivalent equipment is electrically and mechanically interchangeable.

Furnish and install a suitably sized plastic envelope or container in the F3 cabinets for holding the cabinet wiring diagrams and equipment manuals. Locate the envelope or container so that it is convenient for service personnel. Furnish 2 sets of non-fading cabinet wiring diagrams in a paper envelope or container and place them in the plastic envelope or container.

7.3.CONSTRUCTION METHODS

Install new beacon controller assemblies. Provide an external electrical service disconnect at all new and existing cabinet locations unless otherwise shown on the plans.

Install pole mounted cabinets so that the height to the middle of the cabinet is 4 feet (1.2 meters).

Integrate with Signal Heads on static signs.

Ensure that the maximum resistance between the grounding electrode and all points in the grounding system does not exceed 5 ohms.

In addition to the requirements of the NEC, test grounding electrode resistance at the connection point to the electrical service ground bus for a maximum of 20 ohms. Furnish and install additional ground rods to the grounding electrode system as necessary to meet the test requirements.

7.4.METHOD OF MEASUREMENT

Actual number of beacon controller assemblies with cabinets furnished, installed, and accepted.

No additional measurement will be made of surge protectors, external electrical service disconnect, cables, metal conduit, and grounding systems as this is considered incidental to furnishing and installing the beacon controller assemblies.

7.5.BASIS OF PAYMENT

The quantity of beacon controller assemblies with cabinets, measured as provided above, will be paid for at the contract unit price each for "Beacon Controller Assembly and Cabinet (F3)."

Payment will be made under:

Beacon Controller Assembly and Cabinet (F3)Each

8. ELECTRICAL SERVICE

8.1.DESCRPTION

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

8.2.MATERIAL

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

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

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

8.3.CONSTRUCTION METHODS

A. Electrical Service

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

B. External Electrical Service Disconnect

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

8.4.METHOD OF MEASUREMENT

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

New external electrical service disconnects will be measured by the number of external electrical service disconnects furnished, installed, and integrated into an existing service to form a complete electrical service. Any electrical service conductors, remaining hardware and conduit to connect the electrical service to the cabinet will be considered incidental to the service disconnects. No separate payment will be made for extending or replacing electrical service cable and conduits between the disconnect and the cabinet at locations where an existing pole-mounted cabinet is being replaced with a new base-mounted cabinet, or where a base-mounted cabinet is being relocated.

8.5.BASIS OF PAYMENT

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

New Electrical Service..... Each

9. SOLAR POWER ASSEMBLY

9.1.DESCRPTION

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

9.2.MATERIAL

Furnish and install Solar Power Assemblies at the locations shown on the plans. Each assembly should consist of the following:

- solar array
- solar charge regulator
- batteries
- enclosure

A. Solar Array

The solar modules must be made in North America and have a 20 year factory warranty. The solar array should have a minimum peak of 75W. Solar modules must be UL listed, FM Class I, Div II, Group C&D approved. For the solar array, power wiring should be 10-2, stranded copper, double

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insulated, sunlight resistant, 600V 90C rated cable. The array mount will attach to the side of an approved pole with stainless steel fasteners. The array mount must be aluminum alloy or stainless steel. The array must be capable of withstanding 125-MPH winds.

B. Solar Charge Regulator

The solar charge regulator must be UL listed, minimum 10A with solid state, low voltage disconnect. The solar charge regulator must be sealed with internal temperature compensation, lightning protection, reverse polarity protection, and LED indicators. The solar charge regulator should be FM Class I, Div. II, Groups ABCD and have the CE mark.

C. Batteries

Provide 12V gel electrolyte, non-spillable, maintenance free batteries. Batteries should be able to provide power for 7 days without being charged by the Solar Array and Solar Charge Regulator.

D. Enclosure

Enclosures should be 0.125" aluminum with stainless steel hardware. There must be separate compartments for the batteries and the electronics. The enclosures must be NEMA 3R rated and large enough to contain all equipment shown on the Plans at each particular site.

9.3.CONSTRUCTION METHODS

Furnish and install new Solar Power Assemblies. Provide wiring, disconnects, and all other equipment as required by Article 690 of the NEC.

Install pole mounted enclosures so that the height to the middle of the enclosure is 4 feet (1.2 meters).

Ensure that the maximum resistance between the grounding electrode and all points in the grounding system does not exceed 5 ohms.

In addition to the requirements of the NEC, test grounding electrode resistance at the connection point to the electrical service ground bus for a maximum of 20 ohms. Furnish and install additional ground rods to the grounding electrode system as necessary to meet the test requirements.

9.4.METHOD OF MEASUREMENT

Actual number of complete Solar Power Assembly locations furnished, installed and tested.

No additional measurements will be made for riser assemblies, equipment cabinets, service disconnects, conduit runs to the cabinet, electrical service conductors, ground rod, ground wire and any remaining hardware and conduit to provide the Solar Power Assembly as they are considered incidental to the cost.

9.5.BASIS OF PAYMENT

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

Solar Power Assembly.....Each

10. EQUIPMENT CABINETS

10.1. DESCRIPTION

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

10.2. MATERIAL

Furnish pole mounted equipment cabinets (as indicated in the Plans) that meet the requirements of the Standard Specification (with the exception of the Police Panel), NEMA 3R Standards, and the following specifications:

- a. Provide a weatherproof cabinet that is constructed of welded sheet aluminum, 0.125-inch (3.125-mm) minimum thickness. Ensure cabinet mounting attachments are durable, corrosion resistant and of heavy duty construction. Ensure all seams are continuous welds, free from irregularities.
- b. Provide cabinet door that allows full access to the cabinet interior and has neoprene gaskets ensuring weatherproofing. Equip door with a Corbin Number 2 lock. Provide two (2) keys for each lock. Ensure all hinges and handles are stainless steel. Provide cabinet doors with a door stop arrangement that allows it to be firmly positioned at both 90° and 135° ±10°. Provide locking mechanism with a three-point draw roller system with rollers fabricated from nylon with a diameter of at least .75-inch (18.75mm). Ensure the door opening is double flanged on all four sides.
- c. Provide cabinet with slanted top that extends flush with the front of the door.
- d. Furnish equipment in the cabinet that is shelf mounted. Arrange equipment and terminals within the cabinet so that they will not interfere with the entrance, tracing and connection of conductors or communication cable. Ensure all incoming and outgoing conductors has each of its wires connected to terminal blocks. Terminate wiring harnesses from equipment with connectors on the back on panel-mounted terminal blocks easily accessible from the front of the cabinet. Mount those terminal blocks low in the cabinet so that the wiring does not interfere with access to the equipment. Neatly finish, clearly and permanently mark all wiring panels (terminal blocks) with identifications applied by silk screening. Neatly arrange all conductors and communication cable in the cabinet and bundle in groups with cable ties.
- e. Furnish all AC circuit wiring with a minimum Number 14 AWG stranded copper rated at 600 volts. Furnish all DC circuit wiring with a minimum Number 20 AWG stranded copper rated at 600 volts, unless otherwise specified in these Project Special Provisions.
- f. Furnish cabinet with screened and louvered vents, designed to keep out rain and mice. Equip intake vents with a (13 ¾-inch) 350-mm by 20-inch (500-mm) by 1-inch (25-mm) standard furnace type vent filter. Size the filter tray to adequately house and secure the filter in place. Ensure there are no obstructions on the interior face of the door to interfere with easy removal and replacement of the filter.
- g. Furnish spare duplex ground fault interrupt convenience outlet rated at 15 amps.

- h. Furnish removable, clear Plexiglas shield for the incoming power panel equipment. Shield must have an opening to provide for manual operation of the breakers.
- i. Furnish thermostatically controlled vent fan(s) with a screened guard located in the top Section of the cabinet. Furnish thermostat that is adjustable from 79°F to 131°F (26°C to 55°C) with degree markings indicated on the thermostat in five degree increments, minimum. Position fans and vents to ensure that air from the outside actually flows over the electronic equipment in the cabinet. Ensure the fan(s) in each cabinet is capable of exhausting at least twice the volume of air in the cabinet each minute.
- j. Furnish fluorescent lamp, ordering code Number F20T12/d, and an on/off door switch located in the cabinet so that it will provide for the unobstructed illumination of electronic equipment adjustments.
- k. Furnish a circuit breaker panel for incoming power, equipped with enough breakers to supply all the equipment powered from the cabinet. Provide breaker no smaller than 15 amps or larger than 40 amps. Provide a separate breaker for a circuit powering the cabinet fan(s), lights, and convenience outlets. Protect convenience outlets by a ground fault convenience outlet. Sufficiently power convenience outlets for the equipment housed in the cabinet plus one spare. If power is supplied using a step-down transformer, provide the breaker panel on the secondary side of the transformer.
- l. Ground the equipment cabinet in accordance with the plans.

10.3. CONSTRUCTION METHODS

Install pole mounted cabinets so that the height to the middle of the cabinet is 4 feet (1.2 meters).

Ensure that the maximum resistance between the grounding electrode and all points in the grounding system does not exceed 5 ohms.

In addition to the requirements of the NEC, test grounding electrode resistance at the connection point to the electrical service ground bus for a maximum of 20 ohms. Furnish and install additional ground rods to the grounding electrode system as necessary to meet the test requirements.

10.4. METHOD OF MEASUREMENT

Actual number of equipment cabinets furnished, installed, and accepted.

No measurement will be made of surge protectors, external electrical service disconnect, and grounding systems as this is considered incidental to furnishing and installing the equipment cabinets.

10.5. BASIS OF PAYMENT

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

Payment will be made under:

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

11. SIGNAL HEADS

11.1. DESCRIPTION

Furnish and install 12-inch signal heads with yellow LED displays in accordance with Section 1098-2 of the NCDOT Standard Specifications.

11.2. MATERIAL

The NCDOT Standard Specifications are revised as follows:

Page 10-223, Article 1098-2(A), paragraph 5, sentence 4

Revise “1 3/8 inch (32 mm) vertical conduit entrance hubs” to “1 1/4 inch (32 mm) vertical conduit entrance hubs” and revise “1 5/8 inch (40 mm) horizontal hubs” to “1 1/2 inch (40 mm) horizontal hubs.”

Page 10-223, Article 1098-2(A), last paragraph, sentence 2

Revise “2/5 X 3/4 inch (9.5 mm X 19.1 mm) square head bolts” to “3/8 X 3/4 inch (9.5 mm X 19.1 mm) square head bolts.”

Furnish and install all mounting hardware required to mount the 12-inch signal Heads with yellow LED’s as shown in the “Signing Plans”.

All components of the 12-inch signal heads, LED displays, and mounting hardware must be pre-approved on the Department’s Qualified Products List (QPL).

11.3. CONSTRUCTION METHODS

Install 12-inch signal heads with yellow LED displays as shown on the Signing Plans.

11.4. METHOD OF MEASUREMENT

Actual number of 12-Inch Signal Head with yellow LED furnished, installed, and accepted.

No additional measurements will be made for mounting hardware, cabling, and metal conduit required to connect to the flasher relay circuit housed in the equipment cabinet as these will be considered incidental to the cost.

11.5. BASIS OF PAYMENT

The quantity of “Vehicle Signal HD (12”, 1 Sect.)” measured as provided above, will be paid for at the contract unit price each for “Vehicle Signal HD (12”, 1 Sect.)”.

Payment will be made under:

Vehicle Signal HD (12”, 1 Sect.).....Each

12. TESTING

12.1. DESCRIPTION

This section covers the testing requirements of the Visibility Sensors, Event Processor/Wireless Transceivers, Cellular Modem, Wireless Data Transceivers, Beacon Controller Assemblies, and Signal Heads. Testing requirements described in this section do not supersede any of the testing requirements described in any other section of these Project Special Provisions.

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

- Visibility Sensors
- Event Processor/Wireless Transceivers
- Cellular Modem
- Wireless Data Transceivers
- Solar Power Assemblies
- Beacon Controller Assemblies
- Signal Heads

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

12.2. MATERIAL

A. General

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

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

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

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

B. Visibility Sensor Testing

1. General

All Visibility Sensor equipment and materials furnished by the Contractor will be subject to monitoring and testing to determine conformance with all applicable requirements and to ensure proper operation of the Visibility Sensors. The Contractor will supply all required test equipment

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not provided under this contract. No separate payment will be made for the monitoring and testing equipment used during testing, or for the documentation of test results, but should be included in the amount bid for other pay items.

Provide forms to be used for documenting test results as an integral part of the testing procedures submitted to the Department. These forms should specify the acceptable results of the Visibility Sensors' tests and be submitted for review and approval by the Engineer. Provide testing procedures including the necessary documentation and satisfy the testing requirements for the Visibility Sensor.

2. Shop Testing

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

3. Field Visibility Sensor Tests

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

- Verification of installation of specified cables and connections between the Visibility Sensor and the local cabinet.
- Verification of detection of visibility range.
- Verification of programmable visibility ranges.
- Verification of programmable averaging intervals

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

C. Event Processor/Wireless Transceiver Testing

1. General

All Event Processor/Wireless Transceiver equipment and materials furnished by the Contractor will be subject to monitoring and testing to determine conformance with all applicable requirements and to ensure proper operation of the Event Processor/Wireless Transceiver assemblies. The Contractor will supply all required test equipment not provided under this contract. No separate payment will be made for the monitoring and testing equipment used during testing, or for the documentation of test results, but will be included in the amount bid for other pay items.

Provide forms to be used for documenting test results as an integral part of the testing procedures submitted to the Department. These forms will specify the acceptable results of the Event

Processor/Wireless Transceivers' tests and be submitted for review and approval by the Engineer. Provide testing procedures including the necessary documentation and satisfy the testing requirements for the Event Processor/Wireless Transceiver as discussed below.

2. Shop Testing

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

3. Field Event Processor/Wireless Transceiver Tests

Each Event Processor/Wireless Transceiver assembly furnished and installed by the Contractor will be subject to the following tests:

- Verification of installation of specified cables and connections between the Event Processor/Wireless Transceiver and its connected equipment as shown on the Plans.
- Verification of communications capability with its connected equipment as shown on the Plans.
- Verification of Event Processor/Wireless Transceiver address.
- Verification of determining visibility threshold crossings.
- Verification of the ability to detect voltage variations outside the specification.
- Verification of appropriate activation of the connected Beacon Controller Assembly.

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

D. Cellular Modem Testing

1. General

Provide forms to be used for documenting test results as an integral part of the testing procedures submitted to the Department. These forms will specify the acceptable results of the Cellular Modem transmission components and be submitted for review and approval by the Engineer.

2. Shop Testing

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

3. Field Testing

Once the Cellular Modem equipment has been installed to form a complete and operational notification system, test the wireless transmission and data transmission channels.

Determine that messages sent to the Cellular Modem by the Master Event Processor/Wireless Transceiver arrive as valid email to the appropriate recipient.

Determine that the message received to turn off the flashing beacons arrives at the beacons and turns them off.

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

E. Wireless Data Transceiver Testing

1. General

Provide forms to be used for documenting test results as an integral part of the testing procedures submitted to the Department. These forms will specify the acceptable results of the Wireless Data Transceiver components and be submitted for review and approval by the Engineer.

2. Shop Testing

Test Wireless Data Transceiver equipment in accord with manufacturer's procedure in the shop. The purpose of the shop test will be to identify non-operating or deficiently operating equipment prior to its installation in the field.

3. Field Testing

Once the Wireless Data Transceivers have been installed to form a complete and operational system, test the Wireless Data Transceiver transmission channels. Each Wireless Data Transceiver assembly furnished and installed by the Contractor will be subjected to the following tests in the field:

- Verification of Wireless Data Transceiver addresses.
- Verification of Wireless Data Transceiver data transmission.

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

F. Solar Power Assembly Testing

1. General

Provide forms to be used for documenting test results as an integral part of the testing procedures submitted to the Department. These forms will specify the acceptable results of the Solar Power Assembly and be submitted for review and approval by the Engineer.

2. Shop Testing

Test the Solar Power Assemblies in accord with manufacturer's procedure in the shop. The purpose of the shop test will be to identify non-operating or deficiently operating equipment prior to its installation in the field.

3. Field Testing

Once the Solar Power Assemblies have been installed, test each Solar Power Assembly's ability to provide power at the specified voltage to the equipment in its appropriate cabinet. Test the ability of the batteries to hold a charge and to deliver power for a prolonged period in the absence of adequate solar energy for battery charging.

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

G. Beacon Controller Assembly and Signal Heads Testing

1. General

Provide forms to be used for documenting test results as an integral part of the testing procedures submitted to the Department. These forms will specify the acceptable results of the Beacon Controller Assembly and be submitted for review and approval by the Engineer.

2. Shop Testing

Test the Beacon Controller Assemblies and the Signal Heads independently in accord with manufacturer's procedure in the shop. The purpose of the shop test will be to identify non-operating or deficiently operating equipment prior to its installation in the field.

3. Field Testing

Once the Beacon Controller Assemblies have been installed, test each Beacon Controller Assembly's ability to respond to messages from its Event Processor/Wireless Transceiver and to turn the Signal Heads on and off as appropriate.

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

H. System Test

After delivery, installation, and integration of new equipment as required in these Project Special Provision (including all documentation), the Contractor must perform detailed tests on each system component and demonstrate to the Engineer's satisfaction that each equipment item and software

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program is operating correctly and is in conformance with the requirements of these Project Special Provisions.

The System Test requires verification of complete operation of all field locations. The test will include the demonstration of the following:

- Ability to change visibility thresholds at each Visibility Sensor
- Ability to detect and communicate the crossing of a visibility threshold from each Visibility Sensor
- Ability to change the state of the Signal Heads in unison in response to crossing a visibility threshold
- Ability to communicate the crossing of a visibility threshold from each Visibility Sensor via the Cellular Modem and email
- Ability to receive a message from the cellular network to turn off flashing beacons
- Ability to operate the system for a prolonged period in the absence of enough solar energy to provide battery charging.
- Ability to detect and communicate that the voltage on the Event Processor/Wireless Transmitter is outside of its voltage specification.

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

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

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

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

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

I. 90-Day Observation Period

Upon completion of all project work, the successful completion of the component tests and the System Test, the receipt of all system support equipment, and the correction of all deficiencies, including minor construction items, a 90-day Observation Period will commence. This observation consists of a 90-day period of normal operations of the new field equipment without any failure. The 90-day Observation Period will be warranted by the payment and performance bond. The

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purpose of this period is to ensure that all components of the system function in accordance with the Plans and these Special Project Provisions over an extended length of time.

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

Respond to system or component failures (or reported failures) that occur during the 90-day Observation Period within twenty-four (24) hours. Correct said failures within forty-eight (48) hours. Failures that affect any of the major system components defined below for more than forty-eight (48) hours will suspend the timing of the 90-day Observation Period beginning at the time when the failure occurred. After the cause of such failures has been corrected, timing of the 90-day Observation Period will resume. System or component failures that necessitate a redesign of any component or failures in any of the major system components exceeding a total of three (3) occurrences will terminate the 90-day Observation Period and cause the 90-day Observation Period to be restarted from zero when the redesigned components have been installed and/or the failures corrected. The major system components are:

- Visibility Sensors
- Event Processor/Wireless Transceivers
- Cellular Modem
- Wireless Data Transceivers
- Solar Power Assemblies
- Beacon Controller Assemblies
- Signal Heads

12.3. CONSTRUCTION METHODS

Provide test procedures for approval by the Engineer.

After delivery and installation of the project's equipment with appropriate software, perform detailed tests on each system component. Upon the successful completion of all component tests, the system test procedures may commence. Execution of these test procedures will demonstrate that all equipment is fully integrated, operational, and properly controlling the Visibility Sensors, Event Processor/Wireless Transceivers, Cellular Modem, Wireless Data Transceivers, Solar Power Assemblies, Beacon Controller Assemblies, and Signal Heads.

12.4. METHOD OF MEASUREMENT

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

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

12.5. BASIS OF PAYMENT

None specified.

13. TRAINING

13.1. DESCRIPTION

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

- Visibility Sensor operation 4 Hours
- Visibility Sensor troubleshooting and repair 8 Hours
- Event Processor/Wireless Transceiver Operation 4 Hours
- Event Processor/Wireless Transceiver troubleshooting and repair 8 Hours
- Wireless Data Transceiver Operation 1 Hours
- Wireless Data Transceiver troubleshooting and repair 2 Hours
- Cellular Modem operation 2 Hours
- Cellular Modem troubleshooting and repair 4 Hours
- Solar Power Assembly operation 2 Hours
- Solar Power Assembly troubleshooting and repair 4 Hours

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

13.2. MATERIAL

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

The training material generated for each course should contain “hand-outs” for each attendee, which serve not only as subject guidance, but also as quick reference material for future use by the

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students. All course material, in reproducible form, will be delivered to the Engineer immediately following course completion. In addition to on-site training, provide the required training on VHS videotape. All tapes should be labeled, noting at a minimum the date of the course and title of the course.

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

- Visibility Sensors 12 Hours
- Event Processor/Wireless Transceivers 12 Hours
- Wireless Data Transceivers 3 Hours
- Cellular Modem 6 Hours
- Solar Power Assemblies 6 Hours

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

- Theory of operation
- Installation
- Operation procedures
- Preventative maintenance of equipment
- Troubleshooting and equipment diagnostics
- Integration of equipment with wireless transmission systems

13.3. METHOD OF MEASUREMENT

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

13.4. BASIS OF PAYMENT

Payment will be made under:

TrainingLump Sum

14. SYSTEM SUPPORT EQUIPMENT

14.1. DESCRIPTION

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

14.2. MATERIAL

A. General:

Prior to starting the 90-Day Observation Period, furnish all system support equipment.

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

B. System Support Equipment:

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

- One (1) Visibility Sensor as specified in Section 4
- One (1) Event Processor/Wireless Transceiver as specified in Section 5
- One (1) Wireless Data Transceiver as specified in Section 6
- One (1) Cellular Modem as specified in Section 6
- One (1) Solar Power Assembly as specified in Section 9

14.3. METHOD OF MEASUREMENT

Actual number of Visibility Sensors furnished and accepted

Actual number of Event Processor/Wireless Transceivers furnished and accepted

Actual number of Wireless Data Transceivers furnished and accepted

Actual number of Cellular Modems furnished and accepted

Actual number of Solar Power Assemblies furnished and accepted

14.4. BASIS OF PAYMENT

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

The quantity of Event Processor/Wireless Transceivers, measured as provided above, will be paid for at the contract unit price each for "Furnish Event Processor/Wireless Transceiver".

The quantity of Wireless Data Transceivers, measured as provided above, will be paid for at the contract unit price each for "Furnish Wireless Data Transceiver".

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

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

Payment will be made under:

- Furnish Visibility Sensor Each**
- Furnish Event Processor/Wireless Transceiver..... Each**
- Furnish Wireless Data Transceiver..... Each**
- Furnish Cellular Modem Each**
- Furnish Solar Power Assembly Each**

15. DIRECTIONAL DRILLING

15.1. DESCRIPTION

Furnish and install conduit(s) and all necessary hardware by using the horizontal directional drilling method to provide New Electrical Service to several Wireless Data Transceivers on the north side of I-40. Comply with the provisions of Section 1700 of the 2002 Standard Specifications for Roads and Structures.

15.2. MATERIALS

A. General:

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

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

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

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

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

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

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

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

B. Polyethylene Conduit:

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

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

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

15.3. CONSTRUCTION METHODS

A. Pre-Approvals and Minimum Depth Requirements:

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

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

<u>Man-made Structure</u>	<u>Minimum Clearance Requirement</u>
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 has a minimum of one year's experience operating the make and model of drill rig. Submit written documentation of the operators' training and experience at least two weeks prior to commencing directional drilling operations for review by the Engineer.

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

B. Directional Drill Operations:

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

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

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

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

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

Once the drill head has reached its final location, remove the head, and install a reamer of appropriate size (no more than 2" 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" larger than the conduit(s) outer diameter. The 2" larger diameter can be accomplished during the original bore or during the back reaming/conduit installation process.

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

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

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

C. Drilling Fluids:

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

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

D. Splicing of the Conduit:

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

E. Duct Plugs and Mechanical Sealing Devices:

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

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

F. Plan of Record Drawings:

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

15.4. METHOD OF MEASUREMENT

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

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

15.5. BASIS OF PAYMENT

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

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

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

An installation of two (2) 1.25" and four (4) 2" HDPE conduits would be paid as:

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

Payment will be made under:

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