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**PORTSMOUTH-KITTERY
16189B**

~~September 18~~ April 20, 2020

SPECIAL PROVISION

SECTION 677 – INTELLIGENT TRANSPORTATION SYSTEMS (ITS) EQUIPMENT

BASE SPECIFICATION

Description

1.1 ITS Devices. This work shall consist of furnishing, installing, relocating, wiring, licensing, testing and providing GPS as-built documentation for Dynamic Message Sign (DMS) Systems, Closed Circuit Television (CCTV) Systems, Roadway Weather Information Systems (RWIS), Variable Speed Limit Sign (VSLS) Systems, Motor Vehicle Detection Sensor (MVDS) Systems, Non-Invasive Pavement Sensor Systems, ITS Device Foundations and Supports, and all ancillary equipment necessary to provide a complete working system.

1.2 ITS Cabinet Equipment and Communications. This work shall consist of furnishing, installing, relocating, wiring, and testing Radio Units (RU), associated Wireless Communication Equipment, ITS Equipment Cabinets, Fiber Optic Cables, Splices, Patch Panels and Distribution Enclosures, Ethernet Switches, Device Servers, Media Converters and all ancillary equipment necessary to provide a complete working system.

1.3 ITS Equipment Power. This work shall consist of furnishing, installing, wiring, and testing Meter and Disconnect Pedestal(s), Uninterruptible Power Supplies (UPS), Service Wires and all ancillary equipment necessary to provide a complete ITS power supply system.

Materials

2.1 General Standards Requirements. Materials provided for this Contract shall comply with the following standards. If no revision date is specified, the most recent revision of the standard applies.

2.1.1 Structural Integrity. Device housings, structures, support poles and foundations shall be designed and constructed to comply with all applicable sections of the current edition of *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* with all published addendums.

2.1.2 Material Certification. All materials and products shall be manufactured in the United States of America, and comply with applicable ASTM, AASHTO and the latest version of the *NHDOT Standard Specifications for Road and Bridge Construction (NHDOT Standard Specifications)* Sections 550 and/or 615. Mill test reports and Certificates of Compliance shall be supplied in compliance with the material specifications.

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2.1.3 Fabricator Qualification. The Fabricator shall have ample experience and shall be qualified and certified in accordance with Section 550.3 of the *NHDOT Standard Specifications*. Proof of qualification will be required.

2.1.4 Steel Welding. All steel welding shall be in accordance with the current edition of *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, AWS D1.1 and Section 550.3 of the *NHDOT Standard Specifications*. All circumferential welded pole and arm splices shall be ultrasonically or radiographically inspected.

2.1.5 Electrical Components. All electrical installations, materials, and grounding shall meet all applicable local and public utility codes and requirements, as well as the National Electrical Code (NEC) and National Electrical Safety Code (NESC). Cabinets and enclosures shall meet the standards herein and the National Electrical Manufacturer's Association (NEMA) requirements.

2.2 Special Provisions for specific ITS devices and required equipment will be included in the Contract as an amendment to this Specification. Refer to the requirements of those specific ITS devices and required equipment Special Provisions, the Contract plans, and the requirements of this Special Provision to complete the Intelligent Transportation System installation.

2.3 Technical Submittal. The Contractor shall provide a complete technical submittal as outlined below, and shall not proceed with manufacture, fabrication or construction until the Engineer has approved the submittals in accordance with Section 105.02. See Special Provisions of individual ITS devices for additional Technical Submittal requirements.

2.3.1 The Contractor shall provide drawings, manufacturer's specifications, and applicable catalog cuts for all materials and components for this work, submitted in accordance with Section 105.02.

2.3.2 The Technical Submittal shall list all proposed equipment to be provided and list project locations and ITS cabinet connection points where the equipment is to be installed and connect to the Owners' ITS network.

2.3.3 The Contractor shall provide cabinet diagrams for all equipment cabinets showing installed hardware and wiring connections.

2.3.4 The Contractor shall provide performance specifications for all devices proposed for use on the project.

2.3.5 The Contractor shall supply electric load calculations required for all power supply equipment to be installed.

2.3.6 All specification documentation shall be clearly marked to identify the exact proposed model and all options to be supplied.

2.3.7 The Owners will give no guarantee as to the completeness of the Plan details and the Contractor shall be required to furnish, install, and test any other equipment and materials required to provide a complete and operational ITS device system.

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2.3.8 The submittal for device support poles shall include the following for approval in accordance with Section 105.02:

2.3.8.1 LRFD design calculations for support structures or poles, for the wind speeds defined in device Special Provisions provided as stated in Section 2.2 above. All calculations shall be signed and stamped by a Professional Engineer licensed in the State where the equipment will be installed. If the same piece of equipment will be installed in both Maine and New Hampshire, the calculations shall be signed and stamped by a Professional Engineer from each state.

2.3.8.2 Manufacturer's specifications and applicable catalog cuts for all materials and components.

2.3.8.3 Complete sets of shop drawings for the pole signed and stamped by a Professional Engineer licensed in the State where the equipment will be installed. If the same pole design will be installed in both Maine and New Hampshire, the shop drawings shall be signed and stamped by a Professional Engineer from each State.

2.3.8.4 Elevations and dimensions.

2.3.8.5 If not provided with the Contract Documents, the Contractor shall submit elevation and plan views showing the device support locations, foundations, and the proposed slopes plotted on cross-sections showing no interference with utilities, drainage pipes or structures and showing cofferdams with sheeting left-in-place if needed for construction of the foundation.

2.3.8.6 Top of foundation reactions from the support pole design (LRFD), in conjunction with Section 2.3.8.1 above, shall be submitted to the Owners for verification and/or modification of the preliminary foundation design for final design, in accordance with the device Special Provisions prior to fabrication.

2.3.8.7 The submittal shall include the foundation system (i.e., drilled shaft or spread footing) that is selected for each pole location, if required.

2.3.8.8 When more than one Engineer is responsible for the design of separate components (i.e. pole, attachment information), the Contractor shall make one submittal containing all of the components unless otherwise allowed by the Owners.

2.4 Flexible Liquid Tight Conduit.

2.4.1 The flexible liquid tight conduit shall be white or light gray in color.

2.4.2 The flexible liquid tight conduit shall have a minimum operating temperature range of -4°F to 140°F.

2.4.3 The flexible liquid tight conduit shall at a minimum be IP-65 rated for watertight applications.

2.4.4 The flexible liquid tight conduit shall be UV resistant and have a flexible PVC outer shell and galvanized steel inner core.

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2.4.5 Mounting hardware for flexible liquid tight conduit shall be stainless steel.

2.4.6 Flexible liquid tight conduit shall include bushings and gaskets where the conduit enters a pole mounted ITS equipment cabinet (if applicable).

2.5 Cellular Communication Equipment.

2.5.1 ITS devices shall be equipped with necessary ancillary equipment to communicate with the Manufacturer's software/hardware, the New England Compass ATMS, and the SwRI-provided PTSU system software.

2.5.2 Modems shall be compatible with all major local cellular communication carrier companies, and shall be capable of changing operator networks to any other major cellular communication carriers at the time of acceptance via SIM.

2.5.3 Cellular modems shall be rugged and suitable for outdoor use.

2.5.4 Modems shall be suitable for solar or battery powered installations, and capable of consuming less than 1 Watt while in idle mode, and less than 60 mW in standby mode. Modems shall enter idle and standby modes, and shall trigger active mode via periodic timers, low-voltage detection or I/O.

2.5.5 Modems shall be capable of operating in the temperature range of -40°F to 158°F. Storage temperature shall be between -40°F to 185°F. Modems shall be capable of operating at 90% relative humidity at 140°F.

2.5.6 The modem case shall be IP64 rated for ingress resistance, conform to MIL-STD-810G standards for shock, vibration, temperature and humidity, and certified in Class I Division 2 hazardous environments.

2.5.7 Modems shall be capable of surviving brownouts and spikes from -600 VDC to 200 VDC.

2.5.8 Modems shall be capable of 4G LTE communications, and shall support the frequency bands in Table 1:

Type	Bands
4G/LTE	2100(B1), 1900(B2), 1800(B3), AWS(B4), 850(B5), 2600(B7), 900(B8), 1800(B9), 700(B12), 700(B13), 700(B14), 850(B18), 850(B19), 800(B20), 850(B26), 700(B29), 2300(B30), 1500(B32), TDD B41, TDD B42, TDD B43, TDD B46, CBRS B48, 1700(B66)

2.5.9 Cellular modems shall provide the following network and routing options.

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2.5.9.1 Network Address Translation (NAT)

2.5.9.2 Port Forwarding

2.5.9.3 Policy Routing

2.5.9.4 Network Mobility (NEMO)/ Dynamic Mobile Network Routing (DMNR)

2.5.9.5 Virtual Router Redundancy Protocol (VRRP)

2.5.9.6 Reliable Static Route

2.5.9.7 Dynamic DNS

2.5.9.8 Verizon Private Network Traffic Management (PNTM)

2.5.9.9 IPV6 Gateway

2.5.10 Modems shall have the following industry approvals: FCC, IC, PTCRB.

2.5.11 Cellular modems shall be supplied with DIN rail mounting brackets from the Manufacturer.

2.5.12 Cellular modems shall provide enough ports and outlets to connect ITS devices and all antennas needed to provide communication to the NHDOT TMC. Modems shall include the following types of ports and connections:

2.5.12.1 10/100/1000 Ethernet ports (RJ45)

2.5.12.2 RS-232 Serial ports (DB-9)

2.5.12.3 USB 2.0 Micro-B

2.5.12.4 SMA antenna connector ports (primary, secondary/diversity antennas)

2.5.12.5 Support for active GPS antenna

2.5.13 Modems shall have a configurable, web-based device interface able to display device status, power usage, device temperature, data usage, and event alerts. The modem shall be configurable with IP addresses and login credentials supplied by the Department.

2.5.14 Cellular modems shall support the following network and router management options

2.5.14.1 Fleet wide firmware upgrade delivery

2.5.14.2 Router configuration and template management

2.5.14.3 Router staging over the air and local Ethernet connection

2.5.14.4 Over-the-air software and radio module firmware updates

2.5.14.5 Device Configuration Templates**2.5.14.6** Configurable Monitoring and Alerting**2.5.14.7** Remote Provisioning and Airtime Activation (where applicable)**2.5.14.8** AirLink Management Service (ALMS)**2.5.14.9** AT Command Line Interface (Telnet/SSH/Serial)**2.5.14.10** SMS Commands**2.5.14.11** Simple Network Management Protocol (SNMP)

2.5.15 Modems shall support up to five concurrent VPN tunnels for secure cellular communications.

2.5.16 Cellular modems shall support the following security features:

2.5.16.1 Remote Authentication (LDAP, RADIUS, TACACS+)**2.5.16.2** DMZ**2.5.16.3** Inbound and Outbound Port filtering**2.5.16.4** Inbound and Outbound Trusted IP**2.5.16.5** MAC Address Filtering**2.5.16.6** PCI Compatibility

2.5.17 Cellular antennas may be of directional or omnidirectional type, manufactured either with ruggedized construction or enclosed in a fiberglass or plastic radome to protect from weather.

2.5.18 Antennas shall be of the tri-band LTE type, capable of operation in the three primary North American LTE frequency bands.

2.5.19 Antennas shall be provided with mounting poles, brackets and hardware to make up full installation of the system.

2.5.20 Radio Frequency (RF) surge suppressors shall be of the in-line coaxial type, with a minimum frequency rating of 3 GHz.

2.5.21 Coaxial cable shall be of the low-loss type, rated for minimum loss at 3 GHz or higher.

2.5.22 Coaxial cable shall be of the RG-8/9913, LMR-400 type, or approved equal with 100% foil shield and no less than 88% copper braid.

Construction Requirements

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3.1 All ITS systems and electrical installations shall comply with the requirements specified herein, local and utility codes, and the National Electrical Code (NEC).

3.1.1 Prior to electrical connection to public utility power, all meters and disconnect pedestals shall be inspected by electrical inspector having jurisdiction at the location.

3.1.2 All electrical wiring and communication cables shall be of diameters and colors as required by the device manufacturers.

3.1.3 Wire connections shall be made without excessively long exposed conductors, or unraveled strands extending beyond connections, to prevent shock hazards.

3.2 A preconstruction meeting with the Contractor, Engineer of Record, Construction Quality Control Manager, Subcontractor (as applicable), Contract Administrator, and a representative of the Owners shall be arranged not less than 7 days prior to the start of the ITS system installations.

3.3 Flexible Liquid Tight Conduit.

3.3.1 Any conduit installed above grade for communications and electrical cabling shall be flexible liquid tight conduit meeting the requirements of these Specifications.

3.3.2 Connections of above grade flexible liquid tight conduit to underground PVC conduit shall be made watertight.

3.3.3 Cabling shall be installed through housings and junction boxes in a manner that provides a watertight installation and prevents moisture damage to the device components.

3.3.4 Insulating materials shall be placed between conduit mounting hardware and any concrete mounting surface to prevent corrosion.

3.3.5 The flexible liquid tight conduit shall be white or light gray in color.

3.3.6 The flexible liquid tight conduit shall have a minimum operating temperature of -4°F to 140°F.

3.3.7 The flexible liquid tight conduit shall at a minimum be IP-65 rated for watertight applications.

3.3.8 The flexible liquid tight conduit shall be UV resistant and have a flexible PVC outer shell and galvanized steel inner core.

3.3.9 Flexible liquid tight conduit shall include bushings and gaskets where the conduit enters a pole mounted cabinet.

3.4 Cellular Communications.

3.4.1 Unless a different communication system is specified, at a minimum, ITS devices shall communicate with the NHDOT TMC, MaineDOT TMC, and the MTA TMCC network wirelessly via a cellular communication system.

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3.4.2 Cellular modems, antennas and any mounting plates, poles, brackets and hardware shall be supplied and mounted by the Contractor.

3.4.3 For locations serviced by commercial AC power, the modem shall include an AC power adapter. Modems provided for solar powered sites shall include a DC power cord.

3.4.4 Cellular Modem shall be installed inside the equipment cabinet. Power shall be supplied through a dedicated power outlet.

3.4.5 Cellular modems shall be provided with data plans from the cellular service carrier suitable for unlimited use. The Department will assume control of the cellular data account at the completion of Final ITS System Acceptance as stated in Section 3.8.

3.4.6 Two antennas shall be installed to provide diversity reception of wireless signal, and a Multiple-Input and Multiple-Output (MIMO) signal link.

3.4.7 The two cellular antennas shall be installed to provide the maximum signal performance possible at the device location. Antenna location shall be determined by best signal strength and physical mounting, but to avoid excessive cable lengths. Antenna mounting height shall be no less than 6-1/2 feet.

3.4.8 Antennas shall be mounted on the control cabinet, as close to the modem as possible to reduce signal loss through the coaxial cables.

3.4.9 Holes drilled into the control cabinet shall be drilled on the sides or underside of the cabinet to allow for mounting and cable entry. Holes shall not be drilled into the top of the control cabinet. Holes shall be sealed to prevent moisture damage to cabinet and equipment.

3.4.10 Coaxial cables shall be installed through the antenna mounts and equipment cabinets in a manner that provides a watertight installation, secures cables to prevent movement, and prevents moisture damage to the antenna and any other part of the ITS device systems.

3.5 ITS Device Documentation Requirements.

3.5.1 A minimum of 15 working days prior to configuration of the IP-addressable equipment, the Contractor shall formally request the assigned IP addresses from the State Project Manager and the Local Authority (Owner who will be responsible for maintaining the equipment).

3.5.2 The Contractor shall fill out a copy of the "IP Address Request Worksheet" found on the NHDOT website (<http://www.nh.gov/dot/business/contractors.htm>), and return it to the State Project Manager. Directions to fill out this worksheet are included in the download file.

3.5.3 All ITS Device documentation shall identify the specific Manufacturer and model number as approved in the technical submittal, Sections 2.3.1 and 2.3.2.

3.5.4 IP addresses and login credentials will be assigned for each device by the Owners and returned to the Contractor.

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3.5.5 The Contractor shall configure all devices with the correct IP addresses and login credentials assigned by the Owners.

3.5.6 The Contractor shall properly label all ports and outlets within device interfaces with the correct component connected to the port or outlet.

3.6 ITS Device and System Testing.

3.6.1 In addition to the requirements of this Specification, all installations of ITS devices and equipment, fiber optic cable, and wireless communication equipment will be subjected to rigorous testing before the work will be accepted by the Owners. The Contractor is directed to review NHDOT's standard testing plans for ITS devices, located on NHDOT's website (<http://www.nh.gov/dot/business/contractors.htm>). Successful completion of device testing, as specified in the applicable standard test plans, shall be considered a requirement of the Contract. The Contractor shall provide all equipment, materials and labor required to perform each test, including laptop computers, internet connections, software, and Maintenance of Traffic.

3.6.1.1 If standard test plans are not available for a specific device or communication method, the Contractor shall propose ITS testing plans and procedures, and submit these plans to the Engineer for approval. Test plans shall be developed to provide a mechanism that ensures that all Contract requirements have been tested successfully and verified. The following separate test plans shall be submitted by the Contractor, when required:

- (a) Fiber optic communications testing
- (b) Wireless Communications Testing
- (c) ITS device standalone testing for RWIS and Non-Invasive Pavement sensor sites
- (d) Central control and nighttime testing for devices stated in Section 3.6.1.1(c)

3.6.1.2 See Special Provisions of specific device or communication method, when standardized test plans are not available for specific testing requirements.

3.6.2 The Contractor shall coordinate with the NHDOT TMC, MaineDOT TMC and MTA TMCC no less than 7 days prior to scheduling any equipment or systems testing.

3.6.3 The Owners reserve the right to examine and test or retest any or all materials furnished by the Contractor for the project to determine if they meet the requirements specified within the Contract Documents.

3.6.4 If the Owners decide that any material used in the construction of this project is defective or otherwise unsuitable, and the workmanship does not conform to the requirements of this contract, the Contractor shall replace such defective parts and material at no cost to the Owners.

3.6.5 The Contractor shall conduct all tests in the presence of the Engineer and a representative of the NHDOT TMC, MaineDOT TMC, MTA TMCC. Testing shall be scheduled only on weekdays, and subject to approval of the Owners.

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3.6.6 Test results shall be packaged and submitted to the Owner within one week of test completion. No test phase shall begin until all prior test phases have been completed, and test results have been approved by the Owners.

3.6.7 The Contractor shall provide any test specific software required to complete the test.

3.6.8 Testing shall be performed after the field installation of all equipment is complete, but before connection with any communications system, network, or the PTSU System. The test shall exercise all functional operations of the ITS device and equipment installed and demonstrate compliance with the functional requirements defined in the Contract Documents and all applicable standards. If an ITS device fails to pass testing, the Contractor shall correct the problem or replace the unit and retest it until satisfactory results are achieved. Testing shall utilize software specific for testing the ITS devices, UPSs, Ethernet switches, and all ancillary equipment, as needed.

3.7 Operational Acceptance Test Period.

3.7.1 A ~~60~~ day Operational Acceptance Test Period will be required for all ITS components installed. This test period shall commence upon successful completion of field tests, communication tests, and central control tests, and will last for ~~60~~ consecutive days. This test period will demonstrate that all the ITS devices, systems and components are properly installed, are free from problems, exhibit stable and reliable performance, communicate reliably with the PTSU System and the New England Compass ATMS and comply with the Contract Documents.

3.7.2 The Contractor shall coordinate with the TSMO Bureau to schedule any exercises and have a representative at the device to provide on-site verification of device functionality if necessary.

3.7.3 In the event of a failure, the problem shall be reported to the Contractor. The failure shall be corrected and the test shall then be restarted for another ~~30~~ days.

3.8 Final ITS System Acceptance. Final ITS System Acceptance of installed devices shall be issued upon satisfactory completion of the Operational Acceptance Test and any required Training. The ITS devices will be inspected and issued Final ITS System Acceptance upon approval and verification by the Engineer and the TMC representative that the project requirements have been met 100 percent. The Contract Guarantee/Warranty period will commence after the Final ITS System Acceptance has been issued by the Owners.

3.9 Training.

3.9.1 The Contractor shall provide a training program consisting of the furnishing of educational training in the installation, operation, and maintenance of the ITS equipment installed. Upon written request by the Contractor and at the sole discretion of the ITS Project Manager, this training requirement may be waived if similar ITS equipment has been installed and Owners personnel have been trained within the previous six months.

3.9.2 The Contractor shall provide qualified instructors, approved in writing by the Engineer, and all training materials necessary for training Owners' and maintenance agency personnel in the

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operation and maintenance of the system components. Training shall consist of classroom lectures as well as hands-on demonstrations.

3.9.3 The Contractor shall develop and submit training course outlines and samples of all training aids and manuals. The training course outlines shall include a list and resumes of individuals who will conduct the training.

3.9.4 The Contractor shall develop and supply all necessary manuals, displays, class notes, visual aids, and other instructional materials as required for the training program. The Contractor shall supply an adequate number of manuals and class notes, individually bound in loose-leaf binders, to provide one copy for each session participant. An additional three copies shall be provided to the Engineer at the completion of the training program.

3.9.5 All training materials and instructors' resumes shall be submitted to the Engineer for approval at least 15 working days prior to the proposed start of the training sessions. The training schedule shall be coordinated with the Owners, and shall be scheduled no later than 30 days after the first field unit is brought online.

3.9.6 Training will be conducted at a classroom facility supplied by the Contractor. This facility shall be within 15 miles of the relevant TMC or within 25 miles of the High Level Bridge at the Owners discretion. The Contractor may request use of NHDOT, MTA, or MaineDOT facilities subject to the approval of the Owners and subject to the COVID-19 restrictions in place at that time.

3.9.7 The training session shall last no longer than 6 hours, and shall accommodate up to 20 people. As a minimum, the training session shall completely cover the following topics:

3.9.7.1 Operational Overview Element. The emphasis in this portion of the training program shall be placed on familiarizing those individuals not accustomed to the ITS equipment, devices, or technology furnished, installed or provided in this project with the abilities and functionality of the system.

3.9.7.2 Maintenance. The emphasis in this portion of the training shall be placed on the manufacturer's recommended maintenance procedures and preventative maintenance schedules.

3.9.7.3 Communications System. This element shall consist of training on the operation, maintenance and theory of the communication systems implemented in the project. The communications portion of this session shall include a discussion of the following components and elements:

- (a) An overview of the communications system as a whole
- (b) Fiber optic communications principles (if the project includes fiber optic equipment and hardware)
- (c) Wireless communication principles (if the project includes wireless equipment and hardware)
- (d) Communication interfaces – Ethernet Switches and Fiber Ethernet Switches

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- (e) Grounding/lightning protection
- (f) All other unique aspects of the particular project

3.9.7.4 Equipment Operation. This element shall consist of training on the operation, calibration and proper use of all installed software, and hardware, such as dynamic sign elements, ITS device controllers, CCTV Camera lowering systems, sensor instrumentation, software systems and device interfaces, utility or solar power systems, UPS backup power supplies, generator hookups, network switches and patch panels, and any other component installed as part of the Intelligent Transportation System.

3.10 Documentation. Complete and accurate as-built global positioning system (GPS) coordinates for the entire system shall be clearly labeled with the project name, number, marked as ITS As-Builts and forwarded to the State Project Manager.

3.10.1 The Contractor shall provide as-built GPS coordinates and information for the following elements:

- (a) Each ITS device location
- (b) Each ITS equipment cabinet location
- (c) Each wireless communication equipment location
- (d) Each ITS equipment power source and any disconnect locations
- (e) Electrical power provider information and electric meter numbers
- (f) All pull boxes associated with the ITS equipment power and communication system
- (g) All electrical and communication conduit associated with the ITS equipment constructed under the project
- (h) All electrical and communication conduit runs in 50 foot intervals and at any point of directional change
- (i) All delineator locations installed along the conduit runs

3.10.2 The GPS coordinates shall be accurate to +/- 2 feet.

3.10.3 The Contractor shall provide a complete set of maintenance and user manuals along with all the wiring and assembly schematics/diagrams, along with any material safety data sheets (MSDS), prepared by the manufacturer, for any toxic substances (coatings, liquids, or other) used.

3.11 Guarantees and Warranties.

3.11.1 Limits of Guaranteed Work. The Contractor shall unconditionally guarantee all system and subsystem modules including all cabinets, equipment, hardware, and software installed to be free of defects. The guarantee shall cover all materials, labor, equipment, transportation, maintenance of traffic, and incidentals required to facilitate responsive maintenance as necessary

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to repair and replace any defective modules, systems or subsystems of the completed ITS installation.

3.11.2 It shall be the Contractor's responsibility to secure all guarantees that are customarily issued by the equipment manufacturers for the specific equipment included in the Contract. The form in which such guarantees are delivered to the Contractor shall include the provision that they are subject to transfer to the Owners, and shall be accompanied by proper validation of such fact. Transfer of guarantees shall coincide with the Guarantee Period specified below.

3.11.3 Guarantee Period. The length of guarantee will be 1 year from the date of Final ITS System Acceptance by the Engineer, as specified in section 3.8 above, for each site. Additionally, the Contractor shall guarantee availability of compatible replacement equipment (to the field replaceable unit level) for a ten-year time period from the same date.

3.11.4 Manufacturer's Warranties. The terms of any equipment warranties stipulated by the equipment manufacturers shall be provided with product data included in the Technical Submittal, specified in Section 2.3 above. The terms of any equipment manufacturer's warranties will not relieve the Contractor from any of the guarantee requirements of this contract.

3.11.5 Guarantee Work (Corrective Action). The Contractor shall be responsible for repairs during the Guarantee Period. Repair is defined as all activities that shall be performed for the system to remain in, or return to, operation as observed at the time of Final ITS System Acceptance. The work consists of the repair of defective devices that fail during the normal course of operation, and does not include repairs or replacements made necessary due to damage resulting from vandalism, traffic accidents, or acts of God. The Contractor shall provide on-site warranty service of the equipment within 24-hours of notification by the Owners. If the Contractor is unable to affect a repair to the system within 7 days of notification, temporary equipment meeting all the original equipment specifications may be requested by the Owners, and shall be provided and installed at no cost to the Owners. The Contractor shall then either fix or replace the broken device or equipment at their discretion.

3.11.6 A log of all guarantee work performed by the Contractor during the Guarantee Period shall be maintained by the Contractor. The log shall include, as a minimum, the following information:

- (a) Date and time defect reported
- (b) Entity reporting the defect
- (c) Description of the reported defect
- (d) Technician responding to reported defect
- (e) Arrival time at the site of the technician
- (f) Technician performing defect repair or replacement
- (g) Description of observed defect
- (h) Corrective actions taken

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- (i) Model and serial number of any module repaired or replaced
- (j) Date and time defect rectified

3.11.7 The Contractor shall maintain records, which show the itemized material, equipment, and labor cost incurred to provide response maintenance during the guarantee period. These records shall be provided to the TMC within 15 working days of the warranty work. These records will not be used as a Basis of Payment to the Contractor. The Contractor shall assure that these cost records are as complete and accurate as practicable. The Owners may perform an audit to verify the accuracy of the cost records.

3.11.8 When a guarantee is available on repaired or replacement components, a written and signed guarantee shall accompany the manufacturer's billing invoice. The Engineer or inspecting agent will sign and retain the original and provide a copy to the maintaining agency and a copy to the manufacturer.

Method of Measurement

4.1 Fiber Optic Cable, Splices, ITS Device and System Components will be measured as specified in the respective special provisions for those items.

4.2 Flexible Liquid Tight Conduit will not be measured for payment but shall be subsidiary to the ITS device items.

4.3 Cellular communication equipment and antennas will not be measured for payment but shall be subsidiary to the ITS device items.

4.4 Guarantees/Warranties will not be measured, but shall be considered subsidiary to the devices and equipment installed.

4.5 Testing and integration of Fiber Optic Cable, ITS Device and/or System installations will not be measured, but shall be considered subsidiary to the Fiber Optic Cable, ITS Device or System being installed. No separate payment shall be made for the monitoring, testing, test equipment, and documentation of test results.

4.6 Training for Fiber Optic Cable, ITS Device and/or System installations will not be measured, but shall be considered subsidiary to the Fiber Optic Cable, ITS Device, or System being installed. No separate payment shall be made for the preparation of training documents, classroom lodging or presentation of training materials.

4.7 Record "As-built" documentation will not be measured, but shall be considered subsidiary to the devices and equipment installed.

Basis of Payment

5.1 Fiber Optic Cable, Splices, ITS Devices, support structures, foundations and all system components and equipment will be paid for as specified in the respective special provisions for those items.

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5.2 Partial payments for ITS device items will be made approximately as follows:

- (a) Up to 50 percent of the contract unit price will be paid after receipt and installation of all equipment
- (b) Remaining 50 percent of the payment will be made after the completion of Acceptance Testing and receipt of the as-built documentation and GPS coordinates in accordance with Section 3.10

5.3 Payment for all items will include all electric service inspections, all electric service charges, cellular communication equipment and cellular service charges, if required, until Final ITS System Acceptance.

5.4 Payment for all items will also include any licensing or integration fees required for adding equipment into the Owners' ATMS software.

5.5 All conduit and pull boxes, except flexible liquid tight conduit, will be paid for under 614.

5.6 Ground wires will be subsidiary to the ITS device or equipment that is grounded.