Attachment 18
ITS Technical Requirements

TECHNICAL REQUIREMENTS

ITS Sensors and Equipment

based on

NCDOT ITS and Signals Technical Requirements

Version 12.5

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1. CCTV FIELD EQUIPMENT

1.1. DESCRIPTION

Furnish and install CCTV field equipment and local camera control software described in this Section. Replace existing CCTV equipment as described in this Section. Furnish and install CCTV Camera Assemblies in existing cabinets in accordance with these Technical Requirements (Triangle Expressway cabinets are existing; Complete 540 and Morrisville Parkway cabinets will be furnished by the Constructor).

Provide a system to protect field devices and electronic equipment from lightning and surge protection using UL® listed surge protection devices.

Contractor's proposal shall state the make and model of CCTV camera to be installed.

1.2. MATERIALS

(A) General

1. New CCTV Locations

For new CCTV locations, provide materials as described below:

- CCTV color digital signal processing camera unit integrated encoder, zoom lens, filter, control circuit, and accessories,
- Motorized pan, tilt, and zoom,
- Power supplies,
- Built-in video encoder cable of H.64/MPEG-4 compression for video-over IP transmission,
- All necessary cable, connectors and incidental hardware to make a complete and operable system,
- NEMA Type 4, IP 66 enclosure constructed of aluminum with a clear acrylic dome or approved equal camera unit housing,
- Category 6 cable for power supply and Ethernet communications using Power over Ethernet (POE) technology,
- Surge protection devices, and
- All necessary cable, connectors and incidental hardware to make a complete and operable system.

2. Replacement CCTV Locations

For replacement CCTV locations, provide materials as described below:

- CCTV color digital signal processing camera unit integrated encoder, zoom lens, filter, control circuit, and accessories,
- Motorized pan, tilt, and zoom,
- Power supplies,
- Built-in video encoder cable of H.64/MPEG-4 compression for video-over IP transmission,
- NEMA Type 4, IP 66 enclosure constructed of aluminum with a clear acrylic dome or approved equal camera unit housing,

- Category 6 cable for power supply and Ethernet communications using Power over Ethernet (POE) technology,
- Surge protection devices, and
- All necessary cable, connectors and incidental hardware to make a complete and operable system.

Reuse the following materials:

- CCTV cabinet
- CCTV lowering device or mounting arm (depending on which is present
- Electrical power service,
- CCTV pole,
- Fiber-optic drop cable, patch panel, and fiber-optic jumpers, and
- Ethernet switch and Ethernet patch cords may be reused.

(B) Standards

- ANSI,
- ASTM,
- CE, Class B,
- EIA Standards 170, 232, 422, 250C and 485,
- FCC Rules Part 15, Sub-part J,
- FCC Class A,
- FCC, Class B,
- IEEE,
- ICEA,
- IMSA,
- ISO 9001,
- NEC,
- NEMA 4X, IP 66,
- NEMA Type 1,
- NTSC, and
- UL Listed.

Provide UL listed surge protection devices according to the UL 1449, 2nd edition standard that comply with the NEMA requirements as detailed in the NEMA TS 1 (1992) standard.

Provide a means to ground all equipment as called for in the *Standard Specifications*, and these Technical Requirements.

(C) Camera Assembly

Furnish new CCTV camera assemblies as quantified in Attachment 4B and Attachment 4C. Each assembly consists of one dome CCTV camera that contains, in a single enclosed unit, the following functionality and accessories:

1. Cameras

Provide new 1/3-inch charged-coupled device (CCD) color day/night cameras. The sensors shall use Complementary Metal-Oxide-Semiconductor (CMOS) technology. The camera must meet the following minimum requirements:

- Video signal format: NTSC compatible resolution, user selectable up to a maximum of 1920 x 1080 (1080p)
- White balance: Automatic through the lens with manual override,
- Electronic-shutter: DIP-switch selectable NTSC electronic shutter with speed range from 1/2 of a second (off) to 1/30,000 of a second (NTSC),
- Overexposure protection: Built-in circuitry or a protection device to prevent any damage to the camera when pointed at strong light sources, including the sun,
- Gain control: Automatic and manual,
- Sensitivity: 0.6 lux at 90% scene reflectance, with f/1.6 and 28 dB gain,
- Input/output Connection: Single 10BASE-T/100BASE-T compatible outdoor-rated Category 6 cable for video and control, and IP66-rated RJ45 connector
- Security: Min. 20 users in unicast mode, unlimited in multicast
- Open Application Programming Interface (API): ONVIF Profile S
- Primary supply voltage: 120 VAC,
- Camera voltage: 24 VAC or 24 VDC, and
- Camera power: 73 VA with heater and blower at 24 VAC.

2. Lens

Provide each camera with a motorized zoom lens with automatic iris control with manual override and neutral density spot filter. Provide lenses that meet the following optical specifications:

- Automatic focus: Automatic with manual override, Electronic Image Stabilizations (EIS)
- Horizontal angle of view: 59 degrees at 4.3 mm wide zoom and 2.1 degrees at 129 mm telephoto zoom,
- Focal length: 4.3 mm to 129 mm, 30X optical zoom, 12X electronic zoom,
- Zoom Speed: 2.9, 4.2 and 5.8 seconds,
- Lens aperture: Minimum of f/1.6 to f/4.7,
- Maximum Sensitivity at 35 IRE: .025 lux at ½ second color, .1 lux at 1/60 second black and white, .004 lux at ½ second black and white,
- Preset positioning: Minimum of 128 presets.

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

3. Camera Housing

Provide new dome style enclosure for assemblies with a high performance integrated dome system or approved equal. Provide the dome housing with a 1½" NPT threaded cable entry. Equip each camera housing with a mounting assembly for attachment to the CCTV camera pole. The enclosures must be equipped with a strip heater. Provide a sunshield fabricated from corrosion resistant aluminum and finished in a neutral color of weather resistant enamel. The viewing area of the enclosure must be tempered glass.

Provide surge protectors for all ungrounded conductors that will enter the CCTV enclosure as described below. House the surge protectors within the CCTV housing in a manner approved by NCTA.

A dome-type environmental housing shall have a sustained ambient operating temperature of -50 degrees F to 122 degrees F, with 100 percent non-condensing relative humidity as defined within the NEMA TS-2 (1998) standard. The enclosure shall have a NEMA 4X/IP-66 rating.

4. Pan and Tilt Unit

Equip each new dome style assembly with a pan and tilt unit. The pan and tilt unit must be integral to dome system. The pan and tilt unit must be rated for outdoor operation, provide dynamic braking for instantaneous stopping, prevent drift, and have minimum backlash. The dome must have an auto flip dome rotation to rotate and reposition camera for viewing objects passing below camera. Provide electronic image stabilization. The pan and tilt units must meet or exceed the following specifications:

- Pan: Continuous 360 degrees,
- Tilt: +2 to -92 degrees minimum,
- Presets: Minimum of 128 presets,
- Preset accuracy: 0.1 degree,
- Preset pan speed: 0.1 degrees/second to 200 degrees/second,
- Preset tilt speed: 0.1 degrees/second to 400 degrees/second,
- Privacy zones: Minimum of eight user configurable shapes,
- Input voltage: 24 VDC or 24 VAC, and
- Motors: Two-phase induction type, continuous duty, instantaneous reversing.

5. Power Supplies

Furnish a camera power supply recommended by the manufacturer for use with the camera. Furnish a power supply that is rated for outdoor use, is compatible with the AC electric service source (e.g., traffic signal cabinet), and provides power within the input range of the camera. Furnish camera power cable from the camera manufacturer as follows:

- Three-wire consisting of power conductors and bond wire,
- 8 AWG power conductors,
- 6 AWG bond wire, and
- THWN stranded.

(D) Camera Mounting Bracket

Reuse existing mounting arm bracket or lowering device for Triangle Expressway. Use lowering device provider by the Constructor for Complete 540 and Morrisville Parkway interchange.

(E) Video Encoder

All video encoders must have the following minimum features:

- Network Interface: Ethernet 10/100Base-T (RJ-45 connector)
- Protocols: IPv4, IPv6, HTTP, HTTPS, SSL, QoS, FTP, SMTP, UPnP, SNMP v2c/v3, DNS, NTP, RTSP, RTP, TCP, UDP, IGMP, DHCP
- Security: SSL, SSH, 802.1x, HTTPS encryption with password controlled browser interface
- Video Streams: 2 simultaneous streams, user configurable
- Compression: H.264 (MPEG-4 Part 10/AVC)
- Resolution: Scalable; NTSC-compatible 320x176 to 1920x1080 (HDTV 1080p, 16:9 Aspect Ratio)
- Frame Rate: 1-30 FPS programmable (full motion)
- Bandwidth: 30 kbps – 6 Mbps, configurable depending on resolution
- Edge Storage: SD/SDHC/SDXC slot supporting up to 64GB memory card

Furnish cameras with a built-in digital video Ethernet encoder to allow video-over-IP transmission. The encoder units must be built into the camera housing and require no additional equipment to transmit encoded video over IP networks.

(F) Surge Suppression

Provide surge protection both ahead of and behind the ITS device electronics for the cameras. All surge protection devices shall have an ambient operating temperature of -40 degrees F to 165 degrees F with 95 percent non-condensing relative humidity. All surge protection devices shall comply with the following standards:

- UL 1449 version 3 for electrical power,
- UL 497B for paired data communications, and

Provide surge protection for all four pairs of the Ethernet cable. Data voltage shall be 48 VDC. Surge protector will function with a Maximum Continuous Operating Voltage (MCOV) of 64VDC, and will clamp (on 1000VDC, 1mA, 10/1000 μs waveform) at 72VDC +/- 5V. The maximum continuous current on data lines under normal conditions will be 1.5 A. The peak surge current that can be passed on any pair of data lines can be no more than 30A. Response time on data lines shall be no more than 1 pico-seconds.

(G) Software

Provide Vendor-supplied GUI-based software to setup, configure and operate the cameras in the field. This software shall include features to set communications addresses and protocols, define camera ID lens control, digital signal processing (DSP) settings, azimuth configuration, presets, tours, and privacy zones. The software shall allow the user to control all functions of the camera locally from the CCTV cabinet at the base of the pole with a serial or USB cable.

1.3. CONSTRUCTION METHODS

(A) Electrical and Mechanical Requirements

Ground all equipment as called for in the *Standard Specifications*, and these Technical Requirements.

The air terminal ground wire must not pass through any equipment cabinet or enclosure.

Electrically bond each camera and pan/tilt/zoom mechanism and its housing to the CCTV camera attachment assembly using a number 6 AWG braided copper conductor.

(B) Category 6 Ethernet Cable

Install the Category 6 Ethernet cable between the camera and its respective cabinet. Connect the Category 6 Ethernet cable to the power injector. Connect the power injector to with Category 6 Ethernet cable to the Ethernet edge switch.

(C) Surge Protection

1. Device Line Side Power

Connect the surge protection devices on the CCTV power source on the line side. This device shall provide protection between line-to-neutral, line-to-ground, line-to-line and neutral-to-ground.

2. Device Load Side Power

Connect the surge protection devices in the power line side ahead of all CCTV electronic equipment. This installation technique is designed to restrict earth current transients induced within the ground or directly from the power source from entering the ITS device through the incoming 120/240-volt power circuit. This device shall provide protection between line-to-neutral, line-to-ground, line-to-line and neutral to ground. Install surge protection devices in the CCTV cabinets as called for in the *Standard Specifications*, and these Technical Requirements.

3. Device Data

Connect the Ethernet surge protection device between the POE injector and the CCTV camera. Install surge protection devices in the CCTV as called for in the *Standard Specifications*, and these Technical Requirements.

(D) CCTV Camera Attachments

Install the camera attachment assembly to the mounting bracket or lowering device in a manner that allows for the removal and replacement of the CCTV enclosure as well as providing a weatherproof, weather-tight seal that does not allow moisture to enter the enclosure.

(E) Software

Install the Vendor-supplied GUI-based software to setup, configure and operate the cameras on any laptop supplied by the Constructor’s project.

(F) Remove Existing Equipment

Remove the existing cameras, surge protection, cabling to camera and the PRO-SCP local camera control unit on Triangle Expressway.

1.4. PRICING

The cost of all surge suppression and all supporting hardware and accessories shall not be priced separately but shall be included in the cost per location price in the pricing sheets.

2. MICROWAVE VEHICLE DETECTION SYSTEM

2.1. DESCRIPTION

Furnish and install Microwave Vehicle Detection System (MVDS) field equipment and local software described in this Section. The MVDS radar devices will collect traffic data by lane and direction such as traffic volume, vehicle speed, average speed, lane occupancy, vehicle classification and presence. Supply Wavetronix SmartSensor-HD or NCTA-approved equal.

Contractor's proposal shall state the make and model of MVDS sensor to be installed.

Replace existing MVDS equipment as described in this Section.

2.2. MATERIALS

(A) General

1. New MVDS Locations

For new MVDS locations, provide materials as described below:

- MVDS detector,
- Power supplies,
- Pole-mount attachment hardware,
- 120VAC, 24V, and RS-422/485 surge protection devices.
- Composite MVDS cable between the MVDS cabinet and MVDS unit,
- All necessary cable, connectors and incidental hardware to make a complete and operable system,

2. Replacement MVDS Locations

For replacement MVDS locations, provide materials as described below:

- MVDS detector,
- Power supplies,
- Existing pole-mount MVDS attachment hardware may be reused, otherwise supply,
- Composite MVDS cable for power supply and communications, if existing RS-422 cable is not sufficient,
- Ethernet surge protection devices.
- All necessary cable, connectors and incidental hardware to make a complete and operable system,

Reuse the following materials:

- MVDS cabinet,
- MVDS mounting arm/bracket may be reused,
- Electrical power service,
- MVDS pole,
- Composite MVDS cable between the MVDS cabinet and MVDS unit may be reused,
- Fiber-optic drop cable, patch panel, and fiber-optic jumpers,
- Ethernet edge switch and Ethernet patch cords may be used,
- Terminal server may be reused,
- Ethernet switch and Ethernet patch cords

IMPORTANT NOTE: Replace sensors “in kind”; i.e., where one sensor is deployed, replace with 1 sensor; where 2 sensors are employed, replace with 2 sensors, etc. Furnish new MVD sensors as quantified in Attachment 4A and Attachment 4B.

Furnish and install non-intrusive microwave radar vehicle detectors (MVDS) in existing detection cabinets in accordance with these Technical Requirements (Triangle Expressway cabinets are existing; Complete 540 and Morrisville Parkway cabinets will be furnished by the Constructor). Furnish FCC-certified low-power passive microwave radar detectors that collect by lane and direction: volume, speed, classification and occupancy data. Furnish and install MVDS lead-in cable in accordance with these Technical Requirements (if not re-using cable for existing deployments). Provide MVDS devices with all necessary hardware, mounting brackets and cabling to provide a complete, integrated and fully functional system. The MVDS devices must meet the following minimum functional requirements:

3. Functional Requirements

Provide a (MVDS) that uses a Federal Communications Commission (FCC)-certified, low-power, dual-band microwave radar beam to detect vehicle passage and generate volume, occupancy, length-based classification, and speed data. Ensure that the MVDS is a true-presence microwave radar that uses the frequency modulated continuous wave (FMCW) principle. Ensure that any non-background targets reflect the signal back to the microwave radar detector, where the targets are detected and their range measured.

Ensure that the MVDS provides speed-trap emulation and can detect automatically sensor settings, baud rates, loop spacing, and communication port settings to select an operational mode.

Ensure that the detector can self-tune and allow manual calibration via supplied vendor software. Ensure that the MVDS is capable of auto-calibration and auto-configuration, and that it does not transmit any signals outside its FCC-approved frequency. Provide a setup program that allows the operator to define detection zones within the detector’s field of view. Ensure that the detector automatically configures zones, requiring minimal external tuning. Verify that the unit is not adversely affected by varied weather conditions, such as rain, fog, heat, or wind.

Ensure that the MVDS can compute, store, and provide all required traffic parameter measurements per detection zone in user-selected time intervals from 0 to 60 minutes, including, but not limited to, 10 seconds, 20 seconds, 30 seconds, 60 seconds, 5 minutes, 10 minutes, 15 minutes, 30 minutes, and 60 minutes. The MVDS shall log and store vehicle volume, occupancy, length-based classification and speed data for a minimum of seven days regardless of collection interval. Data storage within the MVDS shall utilize a first in/first out architecture such that the oldest stored data record is overwritten with the newest data record when the storage device is at full capacity.

Provide detectors meeting the following requirements:

- Detection Zone: Twelve traffic lanes (minimum)
- Detection Range: 6 to 250 feet
- Zone Resolution: 1 foot
- Configuration: Automatic
- Management: Supports local and remote management
- Operating Frequency: 10 to 25 GHz

Provide a detector that uses dual radars in a single unit for speed trap data collection in a single unit.

(B) Mechanical Requirements

When the microwave vehicle detection system requires an integrated card rack interface(s), provide only enough interface cards to implement the vehicle detection shown on the signal plans. Provide a means acceptable to NCTA to configure traffic lanes and detection zones. Provide each channel output with a programmable means to delay the output call upon activation of a detection zone that is adjustable in one-second increments (maximum) over the range of 0 to 25 seconds. Provide each channel output with a programmable means to extend the output call that is adjustable in one-second increments (maximum) over the range of 0 to 25 seconds. Ensure both delay and extend timing can be set for the same channel output.

Ensure the advance detection system provides each channel output call of at least 100 ms. in duration.

For units without an integrated card rack interface, provide Form C output relay contacts rated a minimum of 3A, 24VDC.

Provide a detector housing that can be pole-mounted. Supply a universal mounting bracket that is adjustable on two axes for optimum alignment.

Provide detectors that collect and store data by lane. Collect volume, speed, occupancy, direction of travel and classification. Provide detectors that can collect in five, ten and thirty minutes sampling periods.

Provide detectors that store the configuration in non-volatile memory. All detector data shall be downloadable.

(D) Communications Requirements

Ensure that major components of the detection system (such as the sensor and any separate hardware used for contact closures), include a minimum of one serial or Ethernet communications interface. Ensure the system can be configured and monitored via one or more communications interface.

Ensure that the MVDS generates and transmits traffic data either in serial format using an Electronic Industries Alliance (EIA) standard EIA-232 or RS-485 communication port or an Internet Protocol (IP) interface. If the detector does not have Ethernet communications integral to the detector provide data translators to provide for Ethernet communications. Ensure that the MVDS can generate contact closures emulating the output of a pair of 6-foot by 6-foot loops with leading edges placed 16 feet apart.

Verify that the MVDS is IP addressable. Ensure that all device communication addresses are user programmable.

Ensure that the MVDS supports Ethernet protocols. Ensure that wired Ethernet interfaces provide a 10/100 Base TX connection. Verify that all unshielded twisted pair/shielded twisted pair network cables and connectors comply with TIA-568.

Ensure that the setup program assigns an IP address to the detection unit. Ensure that the MVDS responds to a polling request from the STOC for traffic data. Verify that the detection

unit responds with the accumulated traffic parameter measurements from the period since the last request was issued.

Verify that the MVDS stores all system configuration and traffic parameter data within internal nonvolatile memory. Verify that traffic data can be locally and remotely transferred by issuing requests from a personal computer (PC) across the communication network connecting the detector and the STOC operator workstation or another PC.

(E) Configuration and Management

Ensure that the MVDS software application provides PC desktop display of the detection zones and control of any vehicle detector connected to the network. Ensure that the MVDS setup program enables the operator to select whether data is output as contact closures emulating standard loop detector outputs, and/or as accumulated statistical data using detector serial ports.

Verify that the sensor holds a vehicle's presence in the specified detection zone until the vehicle is clear of the zone. Ensure that the sensor does not tune out stationary vehicles within a detection zone and thereby give a false clear status to the lane, even if a vehicle has stopped for a period exceeding 30 minutes. Provide a detector that can resolve closely spaced vehicles.

Provide an assembly manufactured in such a way as to prevent reversed or improper installation. Ensure that the MVDS design provides high-voltage exposure protection to personnel during equipment operation, adjustments, and maintenance.

Ensure that an operator using a locally connected laptop computer can conduct system setup, calibration, diagnosis, and data retrieval operations. Ensure that the MVDS can have its configuration data saved to a laptop computer or server, which can later transfer the data back to the MVDS for reloading.

Ensure that the MVDS operator can use a laptop computer or server to edit previously defined detection configurations to permit adjustments to the detection zone's size, placement, and sensitivity, and to reprogram the detector's parameters.

Ensure that the laptop computer and the MVDS can communicate when connected directly by an EIA-232 cable. Ensure that the laptop computer and MVDS can communicate across the ITS system's communication network using the NTCIP standards described in this Scope of Work. Ensure that the software allows communication between multiple users and multiple field devices concurrently across the same communication network.

Once programmed, ensure that no periodic adjustments are required to the detection zones unless physical roadway conditions change, such as lane shifts or closures.

(F) Electrical Requirements

Ensure that the MVDS field hardware meets the requirements in the FCC's *2005 Code of Federal Regulation (CFR), Title 47, Part 15.* The detector shall not interfere with any known equipment.

Ensure the MVDS operates using a nominal input voltage at the field cabinet of 120 volts of alternating current (V_{AC}). Ensure that the system's power supply will operate with an input voltage ranging from 89 to 135 V_{AC}. For any device requiring a source input other than the standard 120 V_{AC}, supply the appropriate means of conversion. Ensure that the MVDS operator can select and use 12 to 24 volts of direct current (V_{DC}) and 115 V_{AC} at 60 Hz.

Ensure that the power cable running between the MVDS and its electrical service is in a separate conduit. Do not install communication cables in the same conduit as power cables carrying voltage greater than 24 V_{DC}/V_{AC} or current more than 1.5 amps. Do not install the power and communication cables in the same pull boxes.

Provide an assembly manufactured in such a way as to prevent reversed or improper installation. Ensure that the MVDS design provides high-voltage exposure protection to personnel during equipment operation, adjustments, and maintenance.

Furnish all equipment with the appropriate power and communication cables. Install the power cable and the communication cables per the manufacturer's recommendation. Ensure that the cables comply with NEC sizing requirements as presented in NEC Article 210-19(a), Fine Print Note (FPN) No. 4, and meet all other applicable standards, specifications and local code requirements.

Cut all wires to their proper length before assembly. Do not double back any wire to take up slack. Neatly lace wires into cables with nylon lacing or plastic straps. Secure cables with clamps and provide service loops at all connections.

If power to the MVDS or a subcomponent thereof is interrupted, ensure that the equipment automatically recovers after power is restored. Ensure that all programmable system settings return to their previous configurations and the system resumes proper operation.

Ensure that the detector is FCC certified and that the FCC's identification number is displayed on an external label. Ensure that the detector transmits within a frequency band of 10.525 gigahertz, ±25 megahertz, or another FCC approved spectral band.

(G) Environmental Requirements

Provide MVDS that meet all specifications during and after being subjected to an ambient operating temperature range of -30 degrees F to 165 degrees F with a maximum non-condensing relative humidity as defined in the environmental requirements section of the NEMA TS 2 standard.

Verify that the MVDS manufacturer certifies that its device has successfully completed environmental testing as defined in the NEMA TS 2 standard. Verify that vibration and shock resistance meet the requirements of Sections 2.1.9 and 2.1.10, respectively, of NEMA TS 2.

Ensure that no item, component, or subassembly emits a noise level exceeding the peak level of 55 decibels adjusted (dBa) when measured at a distance of 3.3 feet away from its surface.

Ensure that MVDS components comply with the environmental requirements detailed in the NEMA TS 2 standard.

(H) Performance Requirements

The detectors shall operate with per lane volume accuracy of 95% in a side-fire configuration. The per lane volume count accuracy must exceed 95%. The per lane speed average speed and per direction average speed each must be accurate within 2 mph. the per vehicle speed measurement accuracy must be within 3 mph for 90% of the vehicles measured. The per lane occupancy accuracy must be +/- 20% and the per direction occupancy accuracy must be +/- 10%. The classification accuracy shall be minimum of 80%.

To verify performance, collect sample data from the MVDS units against data collected by other means during the same time by human observation or by another method approved by NCTA. Ensure sample data is collected over several time periods under a variety of traffic conditions. Weight each data sample to represent the predominant conditions over the course of a 24-hour period. Samples will consist of 15- and 30-minute data sets collected at various times of the day. Collect count data between the following periods: 12 AM-6 AM (30 minutes), 6:30 AM-8:00 AM (15 minutes), 9:00 AM-11:00 AM (15 minutes), 11:30 AM to 1:30 PM (15 minutes), 2:00 PM-4:00 PM (15 minutes), 4:30 PM-6:30 PM (15 minutes) and 7:30 PM-12 AM (30 minutes).

(I) Composite MVDS Cable

Provide eight-conductor composite cable between the MVDS cabinet and the MVDS detector. Provide keyed connectors to ensure proper alignment of pins and sockets. Provide color coded conductors. Provide the following conductors in the composite MVDS cable:

- Power: (Twisted-pair) DC+ (Red), Grnd/DC- (Black), 20 AWG,
- RS-485: (Twisted-pair) + (Blue/white), - (Blue), 22 AWG,
- RS-232: (Lead wires) CTS (brown), RTS (Orange, TD (Yellow), RD (Violet), 22 AWG, and
- Drain wire: tinned copper.

Provide cable with a grey UV-resistant PVC jacket. Provide aluminum/polyester shielding.

Provide conductors and cable with the following performance requirements:

- RS-232 and RS-485 conductors: DC resistance < 16.7 ohms/1000 ft.
- Power conductors: DC resistance < 11 ohms/1000 ft.

Provide cable with MIL-264823 connectors, minimum of 10 pins. Provide environmentally sealed backshell with strain relief.

2.3. CONSTRUCTION METHODS

(A) General

Refer to manufacturer's recommendations for installation height, alignment and configuration. New MVD locations for Complete 540 and Morrisville Parkway Interchange will be chosen by the Constructor and NCTA.

(B) MVDS Detector

Ensure that the MVDS can be mounted on a MVDS or CCTV poles, in a side-fire configuration. For locations where the minimum setback cannot be met when mounting on front face of pole, provide a mounting bracket to mount on the side of the pole 90 degrees to traffic so the camera and lowering device do not strike the detector. Use this method only if that provides the minimum setback.

In either configuration, mount the detector level with respect to the centerline of the roadway. Tilt the unit downward toward the roadway to ensure detection of all lanes. Install the microwave vehicle detector on new and existing metal poles or structures. Install MVDS lead-in cable inside the new or existing pole and conduit to the respective cabinet. Do not install the detector data cable in a conduit with any cables carrying greater than 24 volts or cables carrying greater than

1.5 amps. Furnish all required mounting brackets, cables, and related hardware. Neatly lace and secure wiring and label all cabling with permanent tags.

Mount the MVDS detector. When installing a detector near metal structures, such as buildings, bridges, or sign supports, mount the sensor and aim it so that the detection zone is not under and does not pass through any structure to avoid distortion and reflection.

Attach the mounting bracket with approved stainless-steel bands that are 0.75-inch-wide and 0.025 inch thick.

Ensure that the MVDS sensor has a 250-foot range, and that the viewing angle is a minimum of 40 degrees vertical and a maximum of 15 degrees horizontal. Verify that all detection zones are contained within the specified elevation angle per the manufacturer's recommendations and that the MVDS is capable of fully detecting all vehicles in a minimum of eight lanes or zones. Ensure that the configuration also provides accurate collection of all data types as detailed in this specification.

Provide a detector housing that can be pole-mounted. Supply a universal mounting bracket that is adjustable on two axes for optimum alignment.

(C) MVDS Cabinet

Install surge protection, power supply, breakers and other serial communication devices. Terminate the field and communications wiring.

Connect the detector to the ITS communications network (by others). Demonstrate the ability to connect, configure and download data. Configure detection zones and settings in accordance with these Technical Requirements, manufacturer's recommendations, and as directed by NCTA. Submit configuration settings (including, but not limited to, detector names, communication settings, and output assignments) and configuration file backups to NCTA.

Ensure that the detector is factory calibrated to comply with all applicable standards, specifications, and requirements.

Crimp or solder the detector connector pins to the cable conductors. Assemble and test the cable prior to onsite installation and pulling. *Cut* all wires to their proper length before installation. Do not double back wire to take up slack. Neatly lace wires into cable with nylon lacing or plastic straps, and secure cables with clamps. Provide service loops at all connections.

Perform continuity tests on the detector's stranded conductors using a meter having a minimum input resistance of 20,000 Ω per volt and show that each conductor has a resistance of not more than 16 Ω per 984.25 feet of conductor.

Measure the insulation resistance between isolated conductors and between each conductor, ground, and shield using a meter designed for measuring insulation resistance. The resistance must be infinity. Perform all resistance testing after final termination and cable installation, but prior to the connection of any electronic or field devices.

(D) Electrical and Mechanical Requirements

Provide an interface to external equipment with a single connector. Ensure that the connector provides power to the unit and allows generation of contact closure output pairs for interface with traffic controller inputs. Ensure that the connector includes serial communication lines for programming, testing, and interfacing with the modem at 9,600 to 115,000 bps baud

rate and that it has at least 26 pins. Ensure that the serial port's data format is standard binary non-return to zero (NRZ) modulation with 8-bit data, 1-stop bit, and no parity.

Ensure that the homerun cable is a polyurethane-jacketed cable approved by NCTA, with polyvinyl chloride (PVC) insulated conductors. The homerun cable shall have a 300-volt rating and a temperature rating of 200° F. Ensure that the cable is equipped with #20 or #22 American Wire Gauge (AWG) conductors.

Install surge protectors on all ungrounded conductors entering the MVDS enclosure as described below. House the surge protectors in the MVDS cabinet on the pole in a manner approved by NCTA. The air terminal ground wire must not pass through this cabinet.

(E) Remove Existing Microwave Vehicle Detector Assembly

Remove existing microwave vehicle detector assemblies on Triangle Expressway. Reuse the mounting bracket if it is compatible with the new unit.

2.4. PRICING

The cost of all surge suppression and all supporting hardware and accessories shall not be priced separately but shall be included in the cost per location price in the pricing sheets.

3. ROAD WEATHER INFORMATION SYSTEM

3.1. GENERAL

Furnish and install new (and replace existing) road weather information systems (RWIS) for detection of certain weather and visibility conditions that would adversely affect traffic. The RWIS shall be capable of measuring wind speed and direction, temperature and humidity, precipitation presence, atmospheric pressure, and the presence of water, ice, slush, snow, and frost on road surfaces.

Contractor's proposal shall state the manufacturer of the RWIS sensors to be installed.

The system shall use Ethernet communications (by others) for monitoring and control from the STOC and monitoring only from the NCTA Executive Offices.

3.2. MATERIALS

(A) General

Provide RWIS sensors as list in these Technical Requirements; consisting of an environmental sensor station (ESS) installed as shown in the ITS Concept Plans and as directed by NCTA. Furnish and install RWIS sensors and RPU in accordance with these Technical Requirements (Triangle Expressway/Morrisville Parkway Interchange RPU and sensors will replace existing RPU and sensors at the RWIS location. The Complete 540 sensors and RPU will be installed at an RWIS site furnished by the Constructor).

Furnish and install a remote processing unit (RPU) at the cabinet at the tower's base. Ensure that the RPU can collect, store, and process sensor data to describe current weather conditions.

Provide any ancillary equipment or incidental items required, including mounting hardware, power supplies, grounding, surge suppression devices, and serial communication equipment, at the ESS location to make a complete and fully operational RWIS. Ensure that the system provides real-time, accurate, reliable data on all system parameters to the degree of precision defined in this Scope of Work.

(B) Sensors

Provide an ESS that can collect, store, and transmit data from the following sensors:

- Ultrasonic anemometer to measure wind speed and direction,
- Infrared road temperature sensor to measure air and pavement temperature,
- Humidity and temperature sensor to measure air temperature and humidity used to calculate dew point and frost point,
- Capacitance sensor to measure presence of precipitation,
- Visibility and present weather capacitive sensor to determine type of precipitation
- Pressure transducer (silicon chip) to measure atmospheric pressure, and
- Non-intrusive laser spectroscopy sensors to detect the presence of water, ice, slush, snow, or frost on road surface. Use near infrared light source.

(C) Sensor Performance

Each environmental sensor and its associated transducers shall record the following attributes to the listed degree of accuracy:

Roadway Data		
Surface Temperature	-40 degrees and 140 degrees F; resolution of 0.1 degree	
Precipitation Type	Dry, wet, ice, slush, snow and frost	
Precipitation Accuracy	±.003 inches for range 0 to .157 inches	
Layer Thickness	Water 0 to .08 inches, ice 0 to .08 inches, snow 0 to .04 inches; resolution .0004 inches	
Atmospheric Data		
Temperature	-80 degrees and 140 degrees F; resolution of 0.1 degree	
Relative Humidity at 68° F	0 to 98%; ±3% between 10 and 00%: 0 to 90%; ±5% between 10 and 00%	
Dew Point	-40 degrees and 140 degrees F	
Barometric Pressure	Accurate to ±0.02 inch of mercury (in. Hg) between 26 and 32 in. Hg; resolution of 0.005 inches Hg	
Precipitation Presence	Presence	
Wind	Direction	±.2 degrees between 0 and 360 degrees
	Speed	±1 mph between 0 and 100 mph, with gusts up to 167 mph

(D) RPU

Use an RPU that supports EIA 232/485 serial protocols, as well as TCP/IP output. Ensure that the RPU is programmable and based on an open architecture.

Provide a unit having a minimum of two EIA-232 and three EIA-485 serial ports and two 10/100 Base T Ethernet ports. Provide four input and four output ports. Ensure that the RPU has a maximum serial data transmission rate of 128 kbps. Ensure that the unit's mean time between failures (MTBF) is 15,000 hours or 625 days.

Furnish 512 MB DDR3 RAM and 2 GB flash memory and a SD/SDHC 32 GB memory card. Use a Linux operating system and a battery backup. Use HTTPS web services.

Ensure that the RPU issues and communicates an alarm whenever a user-defined threshold is exceeded. Ensure that the RPU is also capable of producing an output through contact closure or a digital output that imitates a contact closure.

At minimum, the RPU shall be able to store internally the last 24-hour readings over a user defined time interval of up to 5 minutes.

Ensure that the RPU operates using a nominal input voltage at the cabinet of 110 to 120 AC.,

The RPU must be capable of operating on 12 VDC of solar battery power. The RPU shall issue an alarm to the STOC if the AC power supply is lower than acceptable operating conditions or if there has been a complete power loss. Ensure that the system sends a message when the unit returns to normal conditions.

All components within the RPU shall operate throughout an ambient operating temperature range of -40 degrees to 140 degrees F, with a maximum relative non-condensing humidity of 90%.

(E) Communications

Use an RPU capable of transmitting all collected data to the STOC using the National Transportation Communications for ITS Protocol (NTCIP) over Ethernet communications (by others) over single-mode fiber-optic cable that transfers data at a minimum rate of 10/100 megabits per second (Mbps).

(F) Configuration and Management

Ensure that the RWIS software application provides PC desktop display of the RWIS location on a map. Ensure that the RWIS software enables the system operator to derive environmental measurements, such as the dew point, wind chill, and heat index, from sensor data received. Ensure that the RWIS software can be used to report minimums, maximums, averages, cumulative values, and standard deviations for all data over a prescribed period.

Ensure that the RWIS software provides English-to-metric unit conversions, when applicable, and lets the operator choose which unit of measure to report if more than one unit is common for a particular measurement.

When the software supplied with the RWIS is installed on a laptop computer or a remote workstation, ensure that the operator is able to access, either remotely through the workstation or at the site with the laptop computer, all user-defined parameters, and stored data within the RPU, including the ability to view, download, and delete stored data.

Ensure that the laptop computer and the RWIS can communicate when connected directly by a cable connected to the laptop's USB port. Ensure that the laptop computer and RWIS can communicate across the ITS system's communication network using the NTCIP standards described in this Scope of Work.

(G) Electrical Requirements

Provide RWIS equipment and components installed at the ESS that operate at 110 to 120 VAC from a commercial utility company. Equip the ESS installation with provisions for capable of continuing ESS operations for a minimum of 12 hours.

(H) Cabling

Provide cabling between the sensors and RPU and power management unit as recommended by the RWIS manufacturer.

3.3. CONSTRUCTION METHODS

(A) General

Install all equipment according to the manufacturer's recommendations or as directed by NCTA.

Ensure that all equipment and materials furnished, assembled, fabricated, or installed are commercial off-the-shelf products.

Unless detailed otherwise in the manufacturer's recommendations, mount all atmospheric sensors except anemometers at cabinet-top height, approximately 10 feet above grade. Mount

anemometers at the top of the tower. If local restrictions prevent installing the anemometers at the top, install them no less than 20 feet above the ground.

Install all wiring so that it is either internal to a pole, in conduit attached to truss members, or contained in underground conduit.

(B) Remove Existing Equipment

Remove the existing sensors and RPU at the Triangle expressway/Morrisville Parkway location. Replace existing cabling.

3.4. PRICING

The cost of all surge suppression, the RPU, and all supporting hardware and accessories shall not be priced separately but shall be included in the cost per location price in the pricing sheets.

4. DIGITAL DISPLAY MONITORS

4.1. GENERAL

Furnish digital display monitors for the NCTA Conference Room in the NCDOT Highway Building.

4.2. MATERIALS

Provide two (2) 50-inch LED monitors for the NCTA Conference Room. Provide only new video monitors; do not furnish used or refurbished monitors. Provide power cords for all monitors of at least 20’ in length to plug into duplex wall receptacles.

Provide monitors with a rated life of 50,000 hours.

Provide 50" monitors meeting the following requirements:

- Display Type: LED, widescreen flat panel,
- Mounting: Wall-mount,
- Resolution: 1,920 x 1,080 dpi,
- Pixel Pitch: .265 mm,
- Response Time: 8 ms,
- Colors: Minimum 16.7 million colors,
- Horizontal Scanning Frequency: >85 kHz,
- Vertical Scanning Frequency: 50-86 Hz,
- Contrast Ratio: 1000:1,
- Aspect ratio: 16:9,
- Viewing Angle (Horizontal): 178 degrees,
- Viewing Angle (Vertical): 178 degrees,
- Brightness: 250 cd/m^2,
- HDTV Supported Formats: 720p and 1080p,
- Digital Inputs: DisplayPort, HDMI, and DVI-D
- Analog Inputs: HD-15 VGA and,
- Audio Inputs: RCA Audio, stereo mini-jack, DisplayPort audio, HDMI audio.

Provide two (2) mobile monitor stands, that will accommodate the 50" monitors, meeting the following requirements:

- VESA-compatible monitor mount bracket (sizes 100×100 to 600×400),
- Height-adjustable from at least 47” to 59”,
- Accommodates monitors up to 80lbs and 55” diagonal,
- Top shelf and adjustable device tray are capable of holding up to 10 lbs each,
- Lockable wheels, and
- Provisions for cable management.

Provide HDMI cables (20’ length minimum) and connectors meeting the following requirements:

- Cable: Individually insulated, 26 AWG copper conductors,
- Connectors: 24x1 pin male on both ends,
- Pins: Gold Plated,
- RFI and EMI Noise Reduction: Clip on ferrites,
- Maximum Resolution: 4096 x 2160P at 24Hz,
- Bit Rate: 24-bit, and
- Bandwidth Rating: 14.93 Gbps at 340 MHz.

5. COMPUTER WORKSTATIONS

5.1. GENERAL

Furnish and install computer workstations for NCTA locations described in Attachment 4B.

5.2. MATERIALS

4. Functional

Provide computer workstations as described below.

5. Performance

Provide computer workstations meeting the following requirements:

- Processor: Quad core Intel Xeon E5-1603 v23 processor at 2.8 GHz or greater, 10 MB cache, L2 cache at 1333 MHz,
- Memory: 8 GB DDR3 ECC at 1866 MHz,
- Network: 10/100/1000 Base T Ethernet PCI Express with RJ-45 connector,
- Hard Drive Controller: AHCI chipset SATA, non-RAID, six ports (6 -6 Gbps SW RAID),
- Hard Drive: CI 500 GB SATA, operating at 7200 RPM
- CD-ROM: 16X DVD and 16x DVD+/- RW,
- Keyboard: USB 104-key model,
- Mouse: USB 3-button optical mouse with center scroll,
- Sound: 16-bit integrated high definition audio with external speakers,
- Speakers: Sound bar for use with flat panel monitor,
- Video Card: Two (2) Dual 512 GB DDR3 memory, 64-bit, 14 Gbps, PCIe 2.1 compliant with dual DVI video outputs, maximum digital resolution 2560 x 1600, maximum analog resolution 1920 x 1200, with display port to DVI breakout cables for dual displays,
- Video Output: RGB and DVI connector,
- Desktop Monitor Color: 16.7 million colors,
- Operating System: Windows® 10 Professional, 64-bit, latest version,
- Application software: Enterprise version of Norton antivirus software compatible with City requirements, and DVD burning software, and
- Desktop Monitors: LED, dual 24-inch, digital flat panel display, DVI-D, HDCP Display ports,
    - USB Ports: USB 3.0, one upstream port and three downstream ports,
    - Resolution: 1,920 x 1,080 dpi,
    - Pixel Pitch: 0.275 mm
    - Viewing Angle: 178 degrees vertically and horizontally
    - Contrast Ratio: 1,000:1 (typical) and 10,000:1 (dynamic)
    - Brightness: 250 cd/m^2
    - Colors: 16.7 million colors.

6. Physical Features

Provide computer workstations meeting the minimum power requirements:

- Input voltage: 90-135 V at 50/60 Hz, and
- Output wattage: 825 W.

Provide computer workstations meeting the minimum port requirements:

- Keyboard: One USB connection,
- Mouse: One USB connection,
- Audio: Miniature phono jacks – line out, line in, and microphone,
- Ethernet: 10/100 Base T Ethernet with RJ-45 connector, and
- USB Port: At least 4 rear and 2 front USB 2.0 ports (min. 6 total)

Equip all computer workstations with at least one direct 10/100 Base T Ethernet LAN interface. The network connector shall be RJ-45 for Category 6 STP or 6 UTP for interfacing with the Ethernet core switch.

5.3. CONSTRUCTION METHODS

Install the computer workstations in building location as directed by NCTA.

Connect the workstations to the local area network by installing Ethernet patch cords to the existing wall outlets. Perform the following operational tests for each computer component in accordance with the test plans. After the equipment has been installed, perform the following:

- Connect all components (monitors, mice, keyboards, existing printers, network cables, power supplies),
- Install all software required in this cope of work
- Configure network communications,
- Map network drives and existing printers,
- Run diagnostic utilities on the hardware, and
- Print test pages for each workstation on each existing printer to verify printer configuration.

6. TESTING AND ACCEPTANCE

6.1. GENERAL

Conduct and complete successfully the following progressive series of tests before acceptance: field demonstration test prior to installation, installed standalone tests, system test of the network hardware, network management software and an operational test. Develop a comprehensive series of test plans for each device to determine the equipment was correctly installed and meets the requirements of materials, workmanship, performance, and functionality required in the Technical Requirements. The test plans shall describe the functions to be tested, purpose of test, setup requirements, procedures to be followed, any inputs and expected outputs for each test, criteria for pass/fail and any required tools or test equipment. Any software testers shall be pre-approved by NCTA.

Develop as part of the Test Plan a Traceability Matrix of all the individual subsystem functional requirements to be used to cross-reference each planned test to a specific contract requirement to be verified. This Test Evaluation/Traceability Matrix shall be used by NCTA to crosscheck the functional requirements and the results.

A key element of test plans, where appropriate, is the introduction of forced errors into the functional test. The test plan shall check the actual result of the forced error against the anticipated result. Tests will be performed by the Contractor and witnessed by NCTA. No deviation from the written test procedure shall be permitted without approval from NCTA. Any changes to the approved test procedure to accommodate unforeseen events during the time of testing shall be documented in a copy of the master test procedure. Immediately following the conclusion of each test, NCTA and the Contractor shall meet to agree on the results observed and recorded during the testing. This will form the basis for the conclusions reported in the test plan. All test results, notes, and observations shall be maintained in both electronic and hard copy. Maintain complete records of all test results during all stages of testing.

6.2. INSTALLED SITE TESTS

Conduct an approved, standalone equipment installation test at the field site. Test all standalone functions of the field equipment using equipment installed as directed by NCTA.

Complete approved test plan forms and turn them over to NCTA for review as a basis for rejection or acceptance. Provide a minimum notice of 30 calendar days prior to all tests to permit NCTA or his representative to observe each test.

If any unit fails to pass its stand-alone test, correct the unit or substitute another unit in its place, then repeat the test.

If a unit has been modified as a result of a standalone test failure, prepare a report describing the nature of the failure and the corrective action taken and deliver it to NCTA prior to re-testing the unit. If a failure pattern develops, NCTA may direct that design and construction modifications be made to all units without additional cost to NCTA or an extension of the contract period.

Utilize vendor supplied device software to perform diagnostic tests of each device. The vendor supplied diagnostic software shall be provided to NCTA before final acceptance. Test the following features of each competent as described below.

(A) CCTV Subsystem

Develop an operational test plan that demonstrates all requirements of the equipment and software. Submit for approval before conducting tests.

Notify NCTA at least 14 calendar days prior to the proposed date for the tests. NCTA shall have the right to witness such tests, or to designate an individual or entity to witness such tests.

Perform the following local field operational tests at the camera assembly field site in accordance with the test plans. A laptop computer shall provide camera control and positioning. After completing the installation of the camera assembly, including the camera hardware, power supply, and connecting cables, the Contractor shall:

- Furnish all equipment, appliances, and labor necessary to test the installed cable and to perform the following tests before any connections are made,
- Verify that physical construction has been completed,
- Inspect the quality and tightness of ground and surge protector connections,
- Check the power supply voltages and outputs,
- Connect devices to the power sources,
- Perform continuity tests on the surveillance camera's stranded conductor element using a meter having a minimum input resistance of 20,000 ohms per volt and show that each conductor has a resistance of not more than 16 ohms per 984.3 feet of conductor;
- Measure the insulation resistance between the conductors, and between each conductor, ground, and shield using a megger. The resistance must be infinity. Perform all resistance testing after final termination and cable installation, but prior to the connection of any electronics or field devices; and
- Replace any cable that fails to meet these parameters, or if any testing reveals defects in the cable, and retest new cable as specified; and
- Verify installation of specified cables and connections between the camera, PTZ, camera control receiver, and control cabinet,
- Perform the CCTV assembly manufacturer's initial power-on test in accordance with the manufacturer's recommendation,
- Set the camera control address,
- Verify the presence and quality of the video image in the field cabinet with a portable NTSC-approved monitor or laptop computer
- Exercise the pan, tilt, zoom, focus, iris opening, and manual iris control selections, and the operation, preset positioning, and power on/off functions,
- Demonstrate the pan and tilt speeds and extent of movement to meet all applicable standards, specifications, and requirements,
- Verify proper voltage of all power supplies, and
- Interconnect the communication interface device with the communication network's assigned fiber-optic trunk cable and verify that there is a transmission LED illuminated.

Test the grounding system per ANSI/IEEE C62.41 and ANSI/IEEE C62.45 as applicable. Measure the ground impedance utilizing an instrument designed specifically to measure and document the ground impedance. Provide written test results of the ground impedance for each location to NCTA prior to backfilling the grounding electrode. The test results shall include the

instrument model, date of instrument calibration, and local environmental conditions at the time of testing. Certify and sign the test results by the Contractor.

Repair or replace defective or failed equipment and retest.

(B) Microwave Vehicle Detection Subsystem

Inspect the MVDS field components to ensure proper installation and cable termination.

Adjust and verify the detector settings by comparing each sensor's recorded traffic volumes and speed with those actually observed. Remotely repeat this test from the STOC. Verify the accuracy of traffic parameters using permanent or temporary traffic detection methods or devices of known accuracy.

Conduct the installed field tests detailed below. Furnish all equipment, appliances, and labor necessary to test the installed MVDS and the network communication device, and to perform the following tests before any connections are made:

- Perform a continuity test on the detector cables to ensure that anomalies, such as openings, shorts, crimps or defects, are not present,
- Perform continuity tests on the detector's stranded conductors using a meter having a minimum input resistance of 20,000 Ω per volt and show that each conductor has a resistance of not more than that specified by the wire/cable manufacturer,
- Measure the insulation resistance between isolated conductors and between each conductor, ground, and shield using a meter designed for measuring insulation resistance. The resistance must be greater than 100 MΩ. Perform all resistance testing after final termination and cable installation, but prior to the connection of any electronic or field devices, and
- Replace any cable that fails to meet these parameters, or if any testing reveals defects in the cable, and retest new cable as specified in this section.

Furnish and calibrate all test equipment. Demonstrate the following after installation of the MVDS, other hardware, power supplies, and connecting cables:

- Verify that physical construction has been completed,
- Inspect the quality and tightness of ground and surge protector connections,
- Check power supply voltages and outputs,
- Verify that device connections to power sources,
- Verify that the installation of specified cables and connections between all detectors and the field cabinet,
- Demonstrate that the remote system is fully operational and performing all specified types of detection, including data storage functions, with a laptop computer, and
- Verify detector accuracy by conducting sample ground counts using test intervals as described in "Performance Requirements" section of the MVDS. Accuracy tests for Complete 540 may be conducted following the opening of the facility. If the existing traffic does not provide the minimum number of vehicles required for testing, the Contractor shall provide test vehicles.

(C) Road Weather Information Subsystem

The testing process shall include the completion of a remote field sensor and RPU test, a remote-to-central communication test, and a systems operational test. NCTA shall be notified 14 calendar days prior to installation of the RWIS assembly so that NCTA, or his representative(s), can be present to witness procedures.

NCTA shall be notified at least 14 calendar days in advance of the proposed date for the RWIS remote field sensor and RPU test, and the remote-to-central communication test. NCTA shall have the right to witness such tests or to designate a representative or entity to witness such tests on NCTA's behalf.

The Contractor shall:

- Perform and document laboratory tests verifying proper sensor calibration;
- Calibrate instrument alignment with true north;
- Furnish sensor calibration protocols and adjustment procedures;
- Verify and ensure that sensors are reporting proper field data;
- Detail regular site maintenance procedures and calibration training;
- Provide block diagrams, schematics, catalogs, and line drawings;
- Program source codes in both printed and digital form;
- Verify proper orientation of wiring and cabling;
- Ensure that the conduit is straight, neat, and properly secured; and
- Verify that the grounding component is installed, and produces a voltage standing wave ratio (VSWR) of 1.5 or less.

The RWIS shall undergo a 30-day observation period, during which time the Contractor shall perform all maintenance, recalibration, and data verification required by NCTA.

Wind sensors shall be certified by wind tunnel tests. The Contractor shall submit test results to NCTA for review and approval. The Contractor shall, upon request, furnish independent laboratory testing documentation certifying adherence to the stated wind force criteria using a minimum effective projected area (EPA), the actual EPA, or an EPA greater than that of the system to be attached.

Local field operational testing shall be performed at each RWIS field site according to the test plans. After the environmental sensor and RPUs, and other RWIS hardware, power supplies, and connecting cables have been installed, the Contractor shall:

- Verify that physical construction has been completed;
- Inspect the quality and tightness of ground and surge protector connections;
- Check power supply voltages and outputs;
- Connect devices to the power sources;
- Verify installation of specified cables and connections between the environmental sensor and RPUs, and the control cabinet; and
- Test local operation of all environmental sensor and RPU components.

Within three calendar days of successful test completion, the Contractor shall deliver to NCTA a written completion notice and a copy of all test results. The completion notice shall include documentation of any discrepancies found during testing, along with environmental

sensor and RPU serial numbers. The notice shall also include assembly installation locations and successful test completion dates;

Within 10 calendar days of receipt of the completion notice and all test results, NCTA shall either accept or reject the work. If rejected, NCTA shall specify the defect or failure in the work. Notification of acceptance or rejection of the work shall be by delivery of written notice to the Contractor; and

If NCTA rejects the work, the Contractor shall promptly remedy the defect or failure specified in NCTA's notice. Upon completion of the remedy for the failure specified in NCTA's notice, the Contractor shall again provide NCTA with a completion notice. NCTA may identify an independent third party to specify what defects must be addressed in order for the work to meet the minimum technical requirements.

6.3. INTEGRATION AND OVERALL SYSTEM TESTING

The Contractor shall not be responsible for integrating the CCTV cameras, the MVD sensors and the RWIS sensors into existing NCDOT ITS management systems, the existing analog video distribution system, or a potential future ATMS. Such integration will be addressed following this project, when more details are known of the integration needs and constraints.

6.4. PRICING

The cost of all testing shall not be priced separately but shall be included in the cost per location price in the pricing sheets.