DEPARTMENT OF TRANSPORTATION

STATE OF GEORGIA

SUPPLEMENTAL SPECIFICATION

Section 937—Detection Systems

937.1 General Description

This work includes the procurement and installation of a detection system as shown in the plans. Ensure the detection system is capable of traffic data collection meeting the general and specific requirements of this specification. Ensure the firmware and software furnished and installed as part of an Intelligent Transportation System (ITS) or traffic signal project are the most current and approved releases or versions, unless otherwise requested by the Department. Provide all equipment, materials, and work in accordance with all manufacturers’ recommendations. All equipment, cables, and hardware must be part of an engineered system that is designed by the manufacturer to fully interoperate with all other system components.

A. Video Detection System (VDS)

Provide an IP/Ethernet video detection system which provides presence detection, vehicle counts, roadway occupancy, vehicle classification, and speed information to the Department’s central ITS management software. The video detection system shall be able to provide a minimum of three programmable vehicle classifications. The video detection system shall be able to detect in both high speed freeway and intersection presence modes. The video detection system includes, but is not limited to, camera image sensor(s), including the detector housing, mounting hardware, an application programming interface (API) and protocol for system communications, a video detection system processor, central and local system management software, cabling between the detector and the cabinet, surge suppressors, terminations, output expansion modules which mount in the traffic signal controller cabinet input files, vertical conduit, weather heads and related equipment. The video detection system processors shall communicate through an Ethernet interface and TCP/IP (transmission control protocol/Internet protocol) connection to multiple Transportation Management Center (TMC) computers. The detection video shall be encoded within the VDS processor to MPEG4 digital video format and be able to be viewed at the TMC without the use of external encoders.

B. Microwave Vehicle Detection System (MVDS) – ITS Applications

Provide a high resolution microwave radar detection system which provides presence detection, vehicle counts, classification, occupancy, and speed information to the Department’s central ITS management software. The microwave radar detection system includes, but is not limited to, microwave/ radar detectors, including detector housing, mounting hardware, an application programming interface (API) and protocol for system communications, system management software, cabling between the microwave detector(s) and the cabinet, surge suppressors, terminations, and related equipment. The high resolution Microwave Vehicle Detection System shall be able to emulate single or dual zone loop detectors and be able to detect a minimum of 10 lanes with a range of up to 250 feet away. These microwave detection systems are typically used for gathering near real-time information about the flow of traffic on freeways, highways, or other designated roadway types. The MVDS shall be provided with all necessary cabling, surge protection devices and modules for local serial and IP/Ethernet communications.

C. Wireless Magnetometer Vehicle Detection (WMVD)

Provide a wireless in-pavement magnetometer system for use in both freeway and intersection applications. The detection system shall provide accurate vehicle count, occupancy and speed information, as well as presence/stop bar applications, as needed. The battery-powered wireless sensor shall consist of a magnetometer capable of low-power
radio communications to a roadside transceiver, packaged in a small, hardened plastic case, suitable for in-pavement mounting. The sensors shall detect changes in the earth’s magnetic field to determine the presence or absence of vehicles, relative to the detection zone. Detection ‘events’ are transmitted via wireless radio communications to a wired access point connected to the control cabinet. The wired access point shall utilize IP/Ethernet communication. The system includes, but is not limited to battery operated wireless sensors, battery operated wireless repeaters, antennas, wired access points with respective radios, mounting hardware, cabling, surge protection devices, jumper cables and all items necessary for a complete WMVD installation.

D. Short-Range Radio Device Detection System

Provide a Short-Range Radio Device detection system in which a roadside monitoring unit continually and passively listens for Short-Range Radio enabled devices that broadcast their BDADDR (or BADDR), also referred to as the MAC address. The addresses shall be passively collected in order to get vehicle probe data for use in determining travel time along a route. These devices shall not have the ability to correlate a MAC address with personal information, such as subscriber names and/or vehicle ownership information. This type of detection system shall not be used to collect highly accurate volume and occupancy of a roadway, but rather collect a sampling of vehicles in order to derive approximate speeds and travel time for a corridor. Provide separate, powered and surge protected enclosures for Short-Range Radio Device modules so that they may be installed in various cabinet types. All modules shall utilize IP/Ethernet communications, or cell modem by Type. The system includes, but is not limited to the Short-Range Radio Device processor, antenna, power supplies, mounting hardware, cabling, surge protection devices, jumper cables and all items necessary for a complete installation.

E. Microwave Vehicle Detection System (MVDS) – Intersection Applications

Provide a high resolution microwave radar detection system which provides presence detection, vehicle counts, classification, occupancy, and speed information. The microwave radar detection system includes, but is not limited to, microwave / radar detectors, including detector housing, mounting hardware, an application programming interface (API) and protocol for system communications, system management software, cabling between the microwave detector(s) and the cabinet, surge suppressors, terminations, and related equipment. The high resolution Microwave Vehicle Detection System shall be able to emulate single or dual zone loop detectors and be able to detect a minimum of 8 lanes with a minimum range of 100 feet. These microwave detection systems are typically used for detecting vehicles at signalized intersections and inputting service calls to the signal controller. The MVDS shall be provided with all necessary cabling, surge protection devices and modules for local serial and IP/Ethernet communications.

937.1.01 Definitions

General Provisions 101 through 150

937.1.02 Related References

A. Standard Specifications

Section 150 – Traffic Control
Section 639 – Strain Poles for Overhead Sign and Signal Assemblies
Section 647 – Traffic Signal Installation
Section 922 – Electrical Wire and Cable
Section 925 – Traffic Signal Equipment
Section 939 – Communication and Electronics Equipment
Section 940 – NaviGAtor Advanced Transportation Management System Integration

B. Referenced Documents

American National Standards Institute (ANSI)
937.1.03 Submittals

Use only equipment and components that meet the requirements of these minimum specifications and the Department’s Qualified Products List (QPL).

Provide submittal data for all equipment, materials, test procedures, and routine maintenance procedures required for these items as required in these Specifications.

For training, submit to the Engineer for consideration and approval a training schedule and all training materials within 60 calendar days from the NTP.

For each applicable vehicle detection system, submit to the Engineer for approval, two (2) hard copies and one (1) electronic copy of the manufacturer’s descriptive literature (catalog cuts), technical data, operational documentation, service and maintenance documentation and all other materials required within these specifications. Electronic documents shall be placed on a CD as Adobe® pdf documents and delivered to the Engineer.

Provide as-built documentation of all detector installations after the completion of acceptance testing.

937.2 Materials

937.2.01 Video Detection System

Use a video camera sensor that is compatible with the video detection system processor and meets the following technical and functional requirements:

A. Requirements

1. Video Camera Sensor Type A

Furnish and install a video camera sensor that is compatible with both freeway and arterial video applications, and compatible with the required detection processor type. Send a video signal from the video camera sensor to the processor, using high resolution, video camera sensors as the primary video source for real-time vehicle detection. Utilize high-sensitivity optics in the video camera sensor to compensate for variations in lighting conditions, including blooming at night caused by headlights and minor vibration caused by wind. Include a heater at the front of the enclosure, or alternate method, to prevent the formation of ice and condensation in cold weather. Ensure that the heater does not interfere with the operation of the video camera sensor electronics, or cause interference with the video signal, where applicable. As a minimum, meet the following requirements for each video camera sensor assembly installation:

   a. Use a 1/4" to 1" color interline or frame transfer charge coupled device (CCD) or CMOS sensor.

   b. Signal to Noise Ratio shall be greater than 47 dB
c. If using analog video, the video standard should be compliant with National Television System Committee (NTSC) Standard, RS-170A Compliant (available as EIA-170A specification)

d. If using digital video, the video standard should be compliant with ATSC Standard H.264

e. Provide a lens with a minimum 18X digital or optical zoom. Zoom and camera controls shall be over the camera coaxial video connector

f. A minimum resolution of 380 Horizontal Television Lines (TVL), 350 Vertical TVL

g. For Electromagnetic interference, ensure compliance with FCC Part 15, Subpart J, Class A device requirements, which apply to the video camera sensor and associated connected equipment in their installed condition

h. Power the video camera sensors with 115 VAC +/- 10%, 60 Hz nominal +/- 3 Hz. Size the power conductors from the power source to the camera input so that no more than a 3% voltage drop is experienced (NEC 210-19 a., FPN No. 4). Include a provision at the rear of the camera enclosure for a waterproof connection of power and video signal cables over a single weather-tight MilSpec connector. Provide power from the cabinet power source through a surge suppressor and then to the video camera sensor.

i. The Video camera sensor enclosure shall be installed in a light colored enclosure to limit solar heating. Meet NEMA 250 Type 4 enclosure standards for the enclosure and seal the enclosure to prevent sand, dirt, dust, salt and water from entering. Affix a sun shield visor to the front of the enclosure which is sufficiently adjustable to divert water away from the video camera sensor lens and also prevent direct sunlight from entering the iris when mounted in its installed location.

j. Provide a single run of non-spliced outdoor-rated power and coaxial video cabling from the sensor enclosure to the cabinet in accordance with the manufacturer’s recommendations. Interruptions in cable runs shall only be allowable for interfacing necessary surge protection devices. All connectors shall be professionally sealed to manufacturer recommendations.

k. Environmental: Ensure that temperature and humidity limits of the sensor adhere to NEMA TS2-2003 requirements.

l. Shock and Vibration: Ensure that shock and vibration of the sensor adheres to NEMA TS2-2003 requirements

2. Video Camera Sensor Type B

Furnish and install a thermal video camera sensor that is compatible with both freeway and arterial video applications, and compatible with the required detection processor type. Send a thermal video image from the thermal video camera sensor to the processor for real-time vehicle detection. Utilize thermal imaging to compensate for variations in lighting conditions, including blooming at night caused by headlights, rain and ice glare, and daytime cloud and sun position shadowing where a normal video camera sensor may not function as intended. Include a heater, or alternate method, to prevent the formation of ice and condensation in cold weather. Ensure that the heater does not interfere with the operation of the video camera sensor electronics, or cause interference with the thermal video signal. As a minimum, meet the following requirements for each thermal video camera sensor assembly installation:

a. Use a long-life, uncooled Vanadium Oxide (VOx) Microbolometer for the detector sensor, with a spectral range of 7.5 – 13.5 μm.

b. If using analog video, the video standard should be compliant with NTSC Standard and shall have a minimum NTSC array format of 320 x 240, with a 76,800 effective resolution

c. If using digital video, the video standard should be compliant with ATSC Standard H.264

d. For Electromagnetic interference, ensure compliance with FCC Part 15, Subpart B, Class B device requirements.

e. Power: Input voltage shall be 90 – 240 VAC single phase, with standard operating voltage at 110 VAC. Power consumption shall be 1.7 Watts nominal at 110 VAC with a maximum of 18 Watts.

f. The thermal video camera sensor enclosure shall be installed in a light colored enclosure to limit solar heating and prolong equipment life.
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g. Provide a single run of non-spliced outdoor-rated power and coaxial video cabling from the sensor enclosure to the cabinet in accordance with the manufacturer’s recommendations. Interruptions in cable runs shall only be allowable for interfacing necessary surge protection devices. All connectors shall be professionally sealed to manufacturer recommendations.

h. Environmental: -50° C to + 75° C (-58° F to 167° F) operating ambient temperature rated, in 0% - 95% relative humidity, with an IP66 rating.

3. Video Detection System Processor

m. Freeway Cabinet Mounting

The IP addressable, MPEG4 encoded video detection system processor shall be either shelf or rack mountable in a standard 19-inch rack assembly space conforming to Standard CEA-310, 2005, latest version/addendum. If the video processor is shelf mounted, the Contractor shall provide the shelf and the processor unit housing for each processor type. If the video detection system requires a 19" rack with powered backplane, the contractor shall provide the 19" rack and attach all power and communications cables according to manufacturer specifications. The video detection system processor shall be designed for mounting in an enclosed cabinet and/or Hub building without blower fans and mounting without insulation from other electronic devices such as power supplies, communications equipment, etc. The video detection system shall meet NEMA TS-2 temperature requirements.

Power the video detection system processor by 120 VAC, 60 Hz, single phase. If a transformer is required for a 12 or 24 VDC power requirement, the Contractor shall supply the transformer and/or enclosure and size it appropriately for the installation. Size power conductors from the power source for the video detection system processor input so that no more than a 3% voltage drop is experienced (NEC 210-19 a., FPN No. 4). The video detection system processor shall have transient protection that meets the requirements of NEMA TS1-1989 (R1994, R2000, R2005) and NEMA TS2-2003 standards.

• Video Detection System Processor, Type A
  Provide one (1) video inputs on the video detection system processor such that signals from one video camera sensor or other synchronous or non-synchronous video source can be processed in real time. Use BNC connectors on the processor for all video inputs. Use a BNC connector or RCA connector on the front of the video detection system processor for video output.

• Video Detection System Processor, Type B
  Provide at least two (2) video inputs on the video detection system processor such that signals from up to two (2) video camera sensors or other synchronous or non-synchronous video sources can be processed in real time in one cabinet. Use BNC connectors on the back of the video detection system processor for all video inputs. Use a BNC connector on the front or back of the video detection system processor for video output.

• Video Detection System Processor, Type C
  Provide at least four (4) video inputs on the video detection system processor such that signals from up to four (4) video camera sensors or other synchronous or non-synchronous video sources can be processed in real time in one cabinet. Use BNC connectors on the back of the video detection system processor for all video inputs. Use a BNC connector on the front or back of the video detection system processor for video output.

n. Signal or Ramp Meter Cabinet Mounting

Provide an IP addressable processor module, which performs video image processing and MPEG4 encoding, that completely fits within the loop detector slots of the traffic signal or ramp meter controller cabinet input file and that provides a standard relay closure detector input to the controller. Provide from one to four detector outputs through the processor module which communicate through the edge card connector. Use a module that is not wider than two standard input file slots. Include detection indicators on the front panel of the processor module for each channel of detection provided through that module to indicate detector output in real time when the system is operational. Include a BNC connector with gold plated center pin or RCA connector on the front panel for video output to a Monitoring device, and include a RJ-45 Ethernet port connector on the front panel to connect and communicate the Programming Device.
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Provide power to the processor modules through the signal or ramp cabinet detector input file, or the Output Expansion Module.

- **Video Detection System Processor, Type D**
  Provide one (1) video inputs on the video detection system processor such that signals from one video camera sensor or other synchronous or non-synchronous video source can be processed in real time. Use BNC connectors on the processor for all video inputs. Use a BNC connector or RCA connector on the front of the video detection system processor for video output.

- **Video Detection System Processor, Type E**
  Provide at least two (2) video inputs on the video detection system processor such that signals from up to two (2) video camera sensors or other synchronous or non-synchronous video sources can be processed in real time in one cabinet input file. Use BNC connectors on the back of the video detection system processor for all video inputs. Use a BNC connector on the front or back of the video detection system processor for video output.

- **Video Detection System Processor, Type F**
  Provide at least four (4) video inputs on the video detection system processor such that signals from up to four (4) video camera sensors or other synchronous or non-synchronous video sources can be processed in real time in one cabinet input file. Use BNC connectors on the back of the video detection system processor for all video inputs. Use a BNC connector on the front or back of the video detection system processor for video output.

- **Environmental Requirements (All Types)**
  Provide a video detection system processor that operates reliably in a typical roadside traffic cabinet environment. Provide internal cabinet equipment and a video detection system processor that meet the environmental requirements of NEMA TS1-1989 (R1994, R2000, R2005) and NEMA TS2 standards.

  - Operating ambient temperature range: Ensure that temperature limits adhere to NEMA TS2-2003 requirements. Additionally, include a heater to prevent the formation of ice and condensation in cold weather. Do not allow the heater to interfere with the operation of the video camera sensor electronics, or cause interference with the video signal.
  
  - Humidity range: Ensure that humidity limits adhere to NEMA TS2-2003 requirements.

**B. Functional Requirements for Video Detection Systems (all Types)**

This section defines the minimally required functional aspects of the system as well as the required accuracy levels. It also outlines the testing process that will be used to determine whether a proposed video detection system product meets these specifications.

1. Ensure that Video Detection Systems provides vehicle presence, speeds, vehicle counts and roadway occupancies on a lane-by-lane basis. Video detection systems operating in a traffic signal installation shall not be required to provide occupancy or classification data. Verify that the system can, at a minimum, emulate the output of a pair of 6 ft. by 6 ft. in-pavement loops spaced 16 ft. apart. Ensure that the Video Detection Processor is capable of providing a minimum 24 detection zones with one video camera sensor. Verify that the system responds with the accumulated traffic data as collected since the last request.

2. Verify that the detection system is IP-addressable and that all communication addresses are user programmable. Ensure the setup program assigns an IP address to the detection processor. Ensure that configuration to the system are either in serial format using an Electronic Industries Alliance (EIA) standard EIE-232 communication or an Internet Protocol (IP) interface as approved by GDOT’s Information Technology group.

3. Verify that the traffic data collected by the Video Detection System and the system configuration is stored within internal non-volatile memory within the video detection system processor. Perform software updates through an Ethernet, serial, or USB port. Verify that data can be retrieved from the system either locally or via requests from computers at the central Transportation Management Center (TMC) over the communications network.

4. Ensure the video detection system processor front panel includes a visual display of the status of each video input. Indicators shall display, at a minimum, the status of video detection system processor communications, the status of the video detection system processor, the status of communications, and whether or not each video camera sensor is actively detecting. The Video Processor shall allow a remote user with a standard web browser to gain remote access, collect data, control, and configure the VDS.
5. Ensure the Video Detection System includes computer software, which enables the user to program, calibrate, operate and view current status of all system features using a laptop computer, or network-connected workstation at the central TMC. Ensure the system allows the user to view live MPEG4 video from the image sensor with the programmed detectors overlaying the image. Ensure individual vehicle actuations can be viewed while observing the live MPEG4 encoded video.

6. Ensure the Video Detection System configuration data can be uploaded and saved to a laptop or TMC workstation for later re-loading to the video detection processor if necessary.

7. Ensure that the system offers an open Application Programming Interface (API) and software development kit (SDK) for GDOT developers and their consultants to integrate the Video Detection System with Central Software or other third-party software and systems. Furnish needed software licenses for the system.

8. Ensure the system user can use a laptop to reprogram, calibrate, adjust or alter any previously defined detector configurations in the field and also reprogram any detector configurations over the network or from a TMC workstation.

9. Provide software that can communicate concurrently between multiple users and multiple video detection processors on the same network without any interruption or conflict with the normal polling cycle.

C. Additional Functional Requirements for Signal and Ramp Meter Video Detection Systems (Type D, E, F)

1. System Hardware: Provide a detection system that does not require any equipment external to the traffic signal/ramp meter controller cabinet input file (excluding the video camera sensor, video camera sensor power connection, circuit breakers and surge protection for video or data). Mount the processor and expansion modules in the traffic signal/ramp meter controller cabinet input files, using the edge card connector to obtain power and provide contact closure outputs. Rewiring of the backplane or any other cabinet panel for the system is not permitted except for power and grounding for the interface panel, wiring from the video camera sensor to the loop detector panel for the video signal and wiring to obtain power for the video camera sensor.

2. Provide a system capable of providing a minimum of eight detector outputs per video camera sensor. Provide all detector outputs through edge card connectors of the processor module and output expansion module(s). Rewiring external to the edge connectors is not permitted for obtaining a minimum of eight outputs for one video camera sensor.

3. System Software System Processing Software: On the processor module that mounts in the traffic signal/ramp meter controller cabinet input file, include the software that processes the video camera sensor signals and converts the signals into detector outputs. Detect either approaching or receding vehicles in multiple lanes within the field of view (FOV) of each video camera sensor. Provide the capability of detecting vehicles in up to 24 detection zones per video camera sensor with the detection system. Allow the detection zones to be combined to form one output.

4. Detection Compensation: Provide the capability for the processor to compensate for camera movement attributable to temperature effects, wind shifting, pole sway, pole expansion, or vibration.

5. System Configuration Software: On the processor module, include the configuration software to program the detection system, including the detection zones.

6. On a monitoring device, display the detection zones superimposed on the video camera sensor’s images. Provide the capability to create detection zones of varying size and shape to allow best coverage of the viewable roadway lanes and ramps. Provide the capability to save the detection zone format on the processor module card once drawn for a particular video camera sensor image. Provide the following capabilities for the user to view the currently active detector zone format of the MPEG4 encoded processor module via a monitoring device:
   o. Confirmation: When viewing vehicle actuations in real time on the monitoring device, indicate the passage or presence of each vehicle detected by each detection zone by changing the color or intensity of that particular zone.
   p. Detection During Reconfiguration: Provide the capability for the detection system to continue detecting vehicles on all existing zones during reconfiguration, except on the zone that is being reconfigured.
   q. I-VDSn designation: I-VDSn refers to all of the specific VDS components necessary for operation and detection on one approach leg of an intersection. The “n” denotes the approach’s through-movement controller phase in the nomenclature of a typical 8-phase dual-ring intersection operation (e.g., I-VDS2, I-VDS4, I-VDS6, I-VDS8) when four video camera sensors are installed. If more than four video camera
sensors are installed, the “n” denotes the controller phase being detected in the nomenclature of a typical 8-phase dual ring intersection operation. I-VDSn is also used as a prefix to identify the individual VDS components of the “n” approach as follows:

- I-VDSnVCS: the video camera sensor for approach “n”
- I-VDSnCC: the coaxial cable from the video camera to the controller cabinet for approach “n”
- I-VDSnPC: the video camera sensor power cable from the video camera to the controller cabinet for approach “n”
- I-VDSnCSS: the coaxial cable surge suppressor in the controller cabinet for approach “n”
- I-VDSnCJ: the coaxial jumper cable from the coaxial surge suppressor in the controller cabinet to the processor module or detector panel for approach “n”
- I-VDSnPM: the processor module for approach “n”, where a Processor Module, Type A is installed
- I-VDSn/snPM: the processor module for approach “pn” and “sn”, where “pn” is the primary approach and “sn” is the secondary approach, where a Processor Module, Type B is installed.
- Occupancy: individual lane occupancy measured in percent of time

Ramp Meter Controller Cabinet Input File: A Ramp Meter Controller Cabinet Input File is a chassis within a traffic signal cabinet rack that has slots where a detector card provides detector output to the traffic signal controller through its edge card connectors. The backplane connector pin output of the edge connectors conforms to Georgia traffic signal controller cabinet standards for the cabinet type specified in the plans.

I-VDSnnn: I-VDSnnn refers to all of the specific VDS components necessary for operation and detection related to ramp metering installations based on direction, type of detection and lane assignments. The first “n” denotes the approach direction (north, south, east or west) and the second “n” denotes the type of detection, P=Passage Detection Zones, D=Demand Detection Zones, Q=Queuing Detection Zones, ML=Mainline Detection Zones, the third “n” denotes the lane assignment (lane 1=L01, lane 2=L02, lane 3=L03, lane 4=L04), the (e.g., I-VDSnPL01, I-VDSsDL02, I-VDSeQL03, I-VDSwMLAL04). The typical ramp metering layout is shown below:

![Figure 1: Typical Ramp Meter Layout](image)

Lane numbering shall began at the median for mainline travel lanes. Lane numbering for ramp meter lanes shall began with the lane adjacent to the mainline travel lanes.

I-VDS is also used as a prefix to identify the individual I-VDS components used for signal and freeway ramp metering as follows:
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- I-VDSnnnVCS: the video camera sensor for “nnn” direction, type of detection and lane assignment
- I-VDSnnnCC: the coaxial cable from the video camera to the controller cabinet for approach “nnn” direction, type of detection and lane assignment
- I-VDSnnnPC: the video camera sensor power cable from the video camera to the controller cabinet for approach “nnn” direction, type of detection and lane assignment
- I-VDSnnnCSS: the coaxial cable surge suppressor in the controller cabinet for approach “nnn” direction, type of detection and lane assignment
- I-VDSnnnCJ: the coaxial jumper cable from the coaxial surge suppressor in the controller cabinet to the processor module or detector panel for approach “nnn” direction, type of detection and lane assignment
- I-VDSnnnPM: the processor module for approach “nnn” direction, type of detection and lane assignment

D. Accuracy Requirements for Video Detection Systems

Provide a Video Detection System that meets the below minimum accuracy requirements for both daytime and night time conditions:

1. For volume (vehicle counts): 85% (no more than +/- 15% missed actuations).
2. For speed measurement: 85% (no more than +/- 15% error in speed calculation)
3. For occupancy measurement: 85% (no more than +/- 15% missed actuations)
4. For presence detection: 85% (no more than +/- 15% error in missed actuations)

E. Testing

Vendors are required to submit an independent test evaluation report from a third party which verifies the accuracies stated within their specifications.

Develop and submit plans for post-installation testing to the Engineer for consideration and approval. Ensure the plans test all functional requirements outlined in Section 937.2.01, and the accuracy requirements stipulated in Section 937.2.01 D. Provide the Engineer with Application Protocol Interface (API) documentation and Software Development Kit (SDK) for the video detection system, as requested by the Department. GDOT will have 30 days from receipt of the API and SDK to make a determination if it can be integrated. If the device cannot be integrated, the Engineer will give notice that the Contractor must submit a device that can be integrated into the central system software.

1. Post Installation Test Requirements

Utilize the following test procedures after the video detection system has been installed in its entirety as shown on the Plans. Commence no post-installation testing until all video detection systems in the project have been configured and/or calibrated to gather speed, volume, occupancy and/or presence detection, and programmed to communicate on the GDOT network. Including the accuracy testing requirements, at a minimum, provide the following on the test plan to be submitted and approved by the Engineer:

   a. Inspect all vehicle detection system field components to ensure proper installation and cable termination.
   b. Verify that field construction has been completed as specified in the plans.
   c. Inspect the quality and tightness of ground and surge protector connections.
   d. Check power supply voltage and outputs and ensure device connections are as specified in the Plans.
   e. Verify that the installation of cables and connections between all detectors and field cabinets are as specified in the Plans.
   f. Demonstrate that each Video Detection System is fully operational and gathering the required data types at the specified interval. Perform this test from the hub building through which the detection system is connected.
   g. Upon satisfactory completion of step f, GDOT will add the new video detection system(s) into the central system.
937.2.02 Microwave Vehicle Detection System (MVDS)

A. Requirements

1. Microwave Detector Type A

Provide a microwave detection system for ITS installations that meets the following minimum requirements:

   a. Microwave Transmission: The microwave radar detector shall transmit on a frequency band of 24 (twenty-four) GHz or another approved spectral band. It shall comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules or the appropriate Spectrum Management Authority. The Microwave Unit shall not interfere with any known equipment.

   b. Area of Coverage

   The Microwave Unit's field of view shall cover an area defined by an oval shaped beam and its maximum detection range shall be as follows:

   
   | Elevation Beam Width | 50 degrees or more |
   | Azimuth Beam Width   | 12 degrees or less |
   | Range               | up to 250 feet    |

   c. Detection Zones

   The minimum number of detection zones defined shall be no less than ten (10) for side-fired configuration.

   d. Capabilities

   Ensure that Microwave Detection Systems Type A proposed for use provide vehicle presence, classification, speeds, vehicle counts and roadway occupancies on a lane-by-lane basis at a user definable reporting period and can detect a minimum of 10 detection zones where the farthest lane at ideal mounting height can detect at a maximum distance of 250 feet.

   The Microwave Unit shall be a presence detector. It shall be suitable for mounting on roadside poles or on overhead structures at a mounting height determined by the manufacturer, to provide the following:

   • Presence indication of vehicles in its detection zones.
   • Traffic data, periodically accumulated over user defined time intervals in a 10 to 600 sec range, shall be transmitted via serial RS-485 communications lines to a serial port on the terminal server.
   • Traffic data shall be available simultaneously with detection zone contact closures and serial communications. Supply all modules as necessary for simultaneous communications.
   • Vehicle classification by length in a minimum of 3 user defined classes.
   • MVDS shall allow the user to define the contents of transmitted data.
   • Furnish the unit with the required software for data collection, processing, configuration and set-up, and data logging and retrieval. An operator shall be able to use the software to set detector count periods, sensitivities, and other operational features and parameters. The software must be capable of providing both manual and automatic setup and calibration.

   Side-fired configuration data shall include the following in each of up to ten (10) detection zones (lanes):

   • Volume
   • Lane occupancy
   • Average speed

   e. Environmental Conditions and Protection

   Except as stated otherwise herein, the equipment shall meet all its specified requirements during and after subjecting to any combination of the following:

   • Temperature and humidity limits per NEMA TS2-2003 requirements
   • Power surge of ± 1kV (rise time = 1.2 μsec, hold = 50μsec) applied in differential mode to all lines, power and output, as defined by IEC 1000-4-5 and EN 61000-4-5 standards or 300v TS2
• The microwave radar detector shall be resistant to vibration in accordance with IEC 68-2-30 (test Fc), NEMA TS-1 (Section 2.1.12), or approved equivalent
• The microwave detector shall be resistant to shock in accordance with IEC 68-2-27 (test a), NEMA TS-1 (Section 2.1.13), or approved equivalent

f. Mechanical

The microwave radar detector shall be enclosed in a rugged weather proof box and sealed to protect the unit from wind up to 90 mph, dust and airborne particles, and exposure to moisture (NEMA Type 3R or 4x enclosure).

The mounting assembly shall have all coated steel, stainless steel, or aluminum construction, and shall support a load of 20 pounds. The mounting assembly shall incorporate an approved mechanism that can be tilted in both axes and then locked into place, to provide the optimum area of coverage.

g. Electrical

The MVDS unit shall be operable from 12 - 24 VDC. Power supply shall be obtained from the MVDS communications wiring module in the device cabinet. Alternative power sources and adapters shall be submitted and approved by the Engineer.

The MVDS unit shall include Power Management features, allowing remote shutdown or cyclical shutdown of the unit.

h. Cables

Connection between the MVDS and the cabinet equipment shall be provided by a single MVDS unit harness cable that is MS-connector terminated at the MVDS detector and terminated to the MVDS communications wiring module in the equipment cabinets. No splices are permitted in the cable. The cable shall at a minimum provide power and the RS-485 serial data interface to the MVDS unit.

The MS connector pins must be crimped to the cable conductors and assembled and tested by the manufacturer prior to installation and pulling of cable on site. RS-485 signal ground shall be provided by the shield drain wire, an additional conductor, or an additional shielded pair, in accordance with the MVDS unit manufacturer’s recommendations. Twisted pairs shall be identified by separate insulation colors. Communications pairs shall be individually or commonly shielded. Low voltage power conductors shall not be shielded in common with the communications pairs.

i. Electrical Isolation and Surge Protection

All power lines, contact closures and the serial port shall be surge protected within the unit. Contact closures and the serial port shall be isolated. Ensure that the surge protection of all cables and connections meets the minimum requirements of Section 925.2.02 A, part 14, Surge Protection.

j. Data Interface

• Data communications shall be full duplex asynchronous, configurable as:
  • Opto-isolated RS-485 port at rates from 9600 up to 115200 bits per second
  • Separate, local control RS-232 or RS-485 ports
  • Serial data format shall be standard binary NRZ 8 bits data, 1 stop bit, No parity
  • Both point-to-point and multi-dropped configurations shall be supported.

2. Microwave Detector Type B

Provide a microwave detection system for traffic signal installations that meets the following minimum requirements:

a. Microwave Transmission: The microwave radar detector shall transmit on a frequency band of 24 (twenty four) GHz or another approved spectral band. It shall comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules or the appropriate Spectrum Management Authority. The Microwave Unit shall not interfere with any known equipment.

b. Area of Coverage
The Microwave Unit's field of view shall cover an area defined by an oval shaped beam and its maximum detection range shall meet manufacturer’s specification and provide accurate detection to the controller.

c. Detection Zones

The minimum number of detection zones defined shall be no less than eight (8).

d. Capabilities

Ensure that Microwave Detection Systems Type B proposed for use provides vehicle presence on a lane-by-lane basis and can detect a minimum of 8 detection zones where the farthest lane at ideal mounting height can detect at a minimum distance of 100 feet.

The Microwave Unit shall be a presence detector. It shall be suitable for mounting on roadside poles or on overhead structures at a mounting height determined by the manufacturer, to provide the following:

- Presence indication of vehicles in its detection zones.
- Traffic data shall be transmitted to the controller. Supply all modules as necessary for simultaneous communications.
- MVDS shall allow the user to define the contents of transmitted data.
- Furnish the unit with the required software for data collection, processing, configuration and set-up, and data logging and retrieval. An operator shall be able to use the software to set detector count periods, sensitivities, and other operational features and parameters. The software must be capable of providing both manual and automatic setup and calibration.
- Volume
- Travel direction
- Per vehicle speed and direction (in forward looking configuration)

e. Environmental Conditions and Protection

Except as stated otherwise herein, the equipment shall meet all its specified requirements during and after subjecting to any combination of the following:

- Temperature and humidity limits per NEMA TS2-2003 requirements
- Power surge of ± 1kV (rise time = 1.2 μsec, hold = 50μsec) applied in differential mode to all lines, power and output, as defined by IEC 1000-4-5 and EN 61000-4-5 standards or 300v TS2
- The microwave radar detector shall be resistant to vibration in accordance with IEC 68-2-30 (test Fe), NEMA TS-1 (Section 2.1.12), or approved equivalent
- The microwave detector shall be resistant to shock in accordance with IEC 68-2-27 (test a), NEMA TS-1 (Section 2.1.13), or approved equivalent

f. Mechanical

The microwave radar detector shall be enclosed in a rugged weather proof box and sealed to protect the unit from wind up to 90 mph, dust and airborne particles, and exposure to moisture (NEMA Type 3R or 4x enclosure).

The mounting assembly shall have all coated steel, stainless steel, or aluminum construction, and shall support a load of 20 pounds. The mounting assembly shall incorporate an approved mechanism that can be tilted in both axes and then locked into place, to provide the optimum area of coverage.

g. Electrical

The MVDS unit shall be operable from 12 - 24 VDC. Power supply shall be obtained from the MVDS communications wiring module in the device cabinet. Alternative power sources and adapters shall be submitted and approved by the Engineer.

The MVDS unit shall include Power Management features, allowing remote shutdown or cyclical shutdown of the unit.
Section 937—Detection Systems

h. Cables

Connection between the MVDS and the cabinet equipment shall be provided by a single MVDS unit harness cable that is MS-connector terminated at the MVDS detector and terminated to the MVDS communications wiring module in the equipment cabinets. No splices are permitted in the cable. The cable shall at a minimum provide power and the RS-485 serial data interface to the MVDS unit.

The MS connector pins must be crimped to the cable conductors and assembled and tested by the manufacturer prior to installation and pulling of cable on site. RS-485 signal ground shall be provided by the shield drain wire, an additional conductor, or an additional shielded pair, in accordance with the MVDS unit manufacturer’s recommendations. Twisted pairs shall be identified by separate insulation colors. Communications pairs shall be individually or commonly shielded. Low voltage power conductors shall not be shielded in common with the communications pairs.

i. Electrical Isolation and Surge Protection

All power lines, contact closures and the serial port shall be surge protected within the unit. Contact closures and the serial port shall be isolated. Ensure that the surge protection of all cables and connections meets the minimum requirements of Section 925.2.02 A, part 14, Surge Protection.

j. Data Interface

Data communications shall be full duplex asynchronous, configurable as:

- Opto-isolated RS-485 port at rates from 9600 up to 115200 bits per second
- Separate, local control RS-232 OR rs-485 ports
- Serial data format shall be standard binary NRZ 8 bits data, 1 stop bit, No parity
- Both point-to-point and multi-dropped configurations shall be supported.

B. Functional Requirements for Microwave Detection Systems Type A and B

This section defines the minimally required functional aspects of the microwave detection system as well as the required accuracy levels. It also outlines the testing process that will be used to determine whether a proposed microwave detection system product meets these specifications.

1. Verify that the traffic data collected by the Microwave Detection System is stored within internal non-volatile memory. Verify that data can be retrieved from the system either locally or via requests from computers at the central Transportation Management Center (TMC) over the communications network. Verify that the system configuration data and system software is also stored within internal non-volatile memory.

2. Ensure the Microwave Detection System includes computer software for the user to program, calibrate, operate and view current status of all system features using a laptop computer or network-connected workstation at the central TMC. Ensure the system allows the user to view live actuations from the microwave detector with the programmed detectors overlaying a representation of the roadway.

3. Ensure the Microwave Detection System configuration data can be uploaded and saved to a laptop or TMC workstation computer for later re-loading to the video detection processor if necessary. Ensure the system user can use a laptop or TMC workstation to reprogram, calibrate, adjust or alter any previously defined detector configurations. Ensure no periodic adjustments or fine-tuning is required except in the case of physical roadway changes such as lane-shifts, new construction or closures.

4. Ensure that the system offers an open Application Programming Interface (API) and software development kit (SDK) for GDOT developers and their consultants to integrate the Microwave Detection System with GDOT Central Software or other third-party software and systems. Furnish needed software licenses for the system.

C. Accuracy Requirements for Microwave Detection Systems

Provide a Microwave Detection System that meets the below minimum accuracy requirements for all conditions. Accuracy measurements for the testing shall be done with an appropriate sample size of vehicles, over a specific time period. Submit to the Engineer the Test plan for accuracy testing at the location that is site specific to the plans. The test
plan shall take into account the roadway type (freeway, arterial), location (urban, rural), and traffic conditions in order to determine appropriate testing length and sample size. The following conditions shall be met for each sensor installed:

Measurement Accuracy

The following error levels shall be achievable and demonstrated during testing:

<table>
<thead>
<tr>
<th>Parameter (For Type A and B)</th>
<th>Error Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence</td>
<td>±5%</td>
</tr>
<tr>
<td>Time event</td>
<td>10ms</td>
</tr>
<tr>
<td>Input Voltage</td>
<td>±2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter (For Type A)</th>
<th>Error Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>±8%</td>
</tr>
<tr>
<td>Lane Occupancy</td>
<td>±10%</td>
</tr>
<tr>
<td>Average Speed</td>
<td>±10%</td>
</tr>
<tr>
<td>Length Classification limits</td>
<td>±10%</td>
</tr>
</tbody>
</table>

D. Testing

Develop and submit plans for post-installation testing to the Engineer for consideration and approval. Ensure the plans test all functional requirements outlined in Section 937.2.02 B and the accuracy requirements stipulated in Section 937.2.02 C. Provide the Engineer with Application Protocol Interface (API) documentation and Software Development Kit (SDK) for the microwave detection system. GDOT will have 30 days from receipt of the API and SDK to make a determination if it can be integrated. If the device cannot be integrated, the Engineer will give notice that the Contractor must submit a device that can be integrated into the central system software.

1. Post-installation test requirements

Utilize the following test procedures after the microwave detection system has been installed in its entirety as shown on the Plans. Commence no post-installation testing until all microwave detection systems in the project have been configured and/or calibrated to gather speed, volume, classification, and occupancy and programmed to communicate on the GDOT network. Including the accuracy testing requirement, at a minimum, provide the following on the test plan to be submitted and approved by the Engineer.

- h. Inspect all microwave detection system field components to ensure proper installation and cable termination.
- i. Verify that field construction has been completed as specified in the plans.
- j. Inspect the quality and tightness of ground and surge protector connections.
- k. Check power supply voltage and outputs and ensure device connections are as specified in the Plans.
- l. Verify that the installation of cables and connections between all detectors and field cabinets are as specified in the Plans and in accordance with the manufacturers’ recommendations.
- m. Demonstrate that each Microwave Detection System is fully operational and gathering the required data types at the specified interval. Perform this test from the hub building through which the detection system is connected.
- n. Upon satisfactory completion of step f, GDOT will add the new microwave detection system(s) into the central system.

937.2.03 Wireless Magnetometer Vehicle Detector System (WMVD)

This specification sets forth the minimum requirements for a system to detect vehicles on a roadway by using battery-powered magnetometer-type sensors that communicate their detection data by radio to a roadside communications hub before the data is relayed to a freeway cabinet, a local traffic controller cabinet, a central software system, and/or a data
server as required by the application. The application of the WMVDS and equipment specified shall be as shown in the plans. These specifications cover both intersection presence based vehicle detection used for traffic controller input, as well as freeway system or advanced system detection data collection of volume, occupancy and speed.

A. Requirements

The detection system shall provide accurate roadway information as needed to support the traffic management application.

1. The Wireless Battery-Powered Magnetometer Vehicle Detection System shall consist of one or more of the following:
   o. Battery-powered wireless sensors installed in-pavement in each traffic lane w/ reuse enclosure.
   p. Serial Port Protocol (SPP) Digital Radios mounted on the side of the roadway w/ cable and mount.
   q. Wireless battery-powered Repeaters (RPs) mounted on the side of the roadway, serving to extend the radio range of an SPP w/ mount.
   r. Access Point Contact Closure Interface (APCC) cards to provide sensor information processing and support the interface between an SPP and a standard traffic controller using contact closure signals, or mounted in a stand alone cabinet w/ direct IP communications.
   s. Extension (EX) contact closure cards to provide additional detector outputs to a traffic controller
   t. Isolation (ISO) Modules to provide surge protection and isolation, as well as providing signal conditioning to enhance the communication distance from the SPP and the APCC.
   u. Input/Output (I/O) Modules used to provide additional communication options, memory options and a battery backed real time clock.
   v. Software to control and configure the sensors, APCC, SPP’s and RPs.
   w. Communications between a sensor and SPP can be direct, via a single repeater, or via two repeaters operating in tandem. Communications between the sensors and the SPP or RP and between the RP and SPP or another RP shall be via radio.
   x. Detection data shall be capable of being relayed from each AP to a local traffic controller for real-time vehicle detection using contact closure signals. Data shall also be capable of being relayed directly from each AP to a central software system or central server over standard IP (Internet Protocol) networks.
   y. Antenna mounted on the side of the roadway, serving to extend the radio range of the AP.

2. WMVD Sensor Type

   z. All sensor components shall be contained within a single housing.
      • The sensor housing shall conform to NEMA Type 6P and IEC IP68 standards.
      • The sensor components shall be fully encapsulated within the housing to prevent moisture from degrading the components.

   aa. Sensor shall be capable of operation within the temperature and humidity limits set forth in NEMA TS2-2003.

   bb. A sensor shall be battery-powered with a minimum lifetime of seven (7) years when the sensor is configured for and operating under normal traffic conditions.

   cc. Two configurations of sensors shall be available from the manufacturer:
      • Type A: shall provide all sensor functions, including data collection functions
      • Type B: shall support presence detection only
      • The drawings and/or plans shall dictate the sensor type required.

3. Serial Port Protocol (SPP) Device

   dd. An SPP shall support at least 48 sensors with a 0.125 second latency.

ff. All SPP components shall be contained within a single housing.
   • The SPP housing shall conform to NEMA Type 4X and IEC IP67 standards.

gg. The SPP shall communicate to the APCC utilizing a standard CAT5e or higher Ethernet cable.

hh. The SPP shall have a weatherproof Ethernet connector on the bottom.

ii. The Ethernet connector shall be shipped with a cover firmly attached to provide protection from the elements prior to cable connection.
   • The weatherproof connector shall not require any specialized tools for installation.

4. WMVD Repeater (RP)

jj. An RP communicating directly to an AP shall support at least 10 sensors.

kk. An RP communicating to an AP via an intermediate RP (i.e., tandem operation) shall support at least 6 sensors.

ll. An RP shall be battery-powered and battery shall last for a minimum of seven years when operating in normal traffic conditions.

mm. The RP battery shall be field replaceable.


oo. All RP components shall be contained within a single housing.
   • The RP housing shall conform to NEMA Type 4X and IEC IP67 standards.

5. WMVD Access Point Contact Closure (APCC) Card Type

pp. Each APCC card shall be capable of communicating with at least 2 SPP modules.

qq. Optional Extension (EX) cards shall provide additional contact closures in a signal cabinet (user configurable form 1 to 4 outputs each).

rr. The APCC shall provide all the higher level processing and interface functions of the system.

ss. Each APCC card shall provide detector data as contact closure signals to the traffic controller.
   • Type A: An APCC card shall directly plug in to standard 170/2070 input files.
   • Type B: An APCC card shall be supplied within a standard enclosure to supply power for use in freeway applications.

tt. The APCC and EX cards front panel shall be either software or via front panel switches configurable to provide:
   • Presence or pulse mode
   • Delay timing
   • Extension timing


vv. An APCC and EX card shall operate in humidity up to 95% (non-condensing).

6. Isolator module

ww. An Isolator module shall be used between each SPP and APCC to extend communications range and protect the APCC card from transient surges.

xx. The isolator module shall extend the communication range between the APCC and SPP from 33 feet (10 m) to 2000 feet (600 m).

yy. The isolator module shall provide electrical isolation of 1500V.

zz. The isolator module shall provide surge protection of up to 1500V.

aaa. The isolator module shall provide AC power cross protection.
7. Input/Output (I/O) Module Type

An I/O module shall expand the capabilities of an APCC by adding a SD Memory Card Slot and battery backed up real time clock. The module shall be of the following types.

   bbb. Type A: RS232 port for serial communications
   ccc. Type B: Detection data shall be communicated as IP data over GSM-based cellular data services via a GPRS cellular modem.
   ddd. Type C: Detection data shall be communicated as IP data over CDMA-based cellular data services via a 1xRTT cellular modem.
   eee. The I/O module shall be physically mounted to the APCC and shall be the same width. The combined APCC with I/O module shall be the width of a standard 2 slot wide detector amplifier.

8. Antenna

   ggg. Antenna shall operate in an approved frequency band that is compatible with the detection equipment and shall not interfere with any known equipment.
   hhh. Furnish an antenna that will interface with associated detection equipment. Include all necessary cables and connectors per manufacturer’s specification.
   iii. Furnish mounting hardware to secure the antenna to the pole as recommended by the manufacturer of the antenna and as approved by the Engineer.
   jjj. All antenna cable attenuation shall be respective and appropriately sized to the frequency being attenuated at industry standard.

B. Functional Requirements for Wireless Magnetometer Vehicle Detection

1. Sensors

   Each sensor shall detect a vehicle by measuring changes in the earth’s magnetic field near the sensor as caused by a stopped or passing vehicle (i.e., magnetometer-type detection)
   kkk. The sensor shall communicate time-stamped ON and OFF vehicle detection events
   III. Each sensor shall automatically recalibrate in the event of a detector lock
   mmm. Each sensor shall communicate by radio to a nearby SPP, AP, antenna, or RP
   nnn. Each sensor shall automatically re-transmit a detected event if no acknowledgement is received from the AP
   ooo. Each sensor shall respond within 100 seconds when the AP is powered on and transmitting

2. The radio links between each sensor and associated communication link shall conform to the following:

   ppp. The center frequencies, bandwidths, and transmit power levels of the radio links shall allow operation in an unlicensed frequency band
   qqq. Frequency channels shall be employed by the sensors, APs, antenna and RPs to avoid interference with other devices operating in the unlicensed band
   rrr. Frequency channels shall be user-configurable when using 2.4GHz
   sss. At least 16 frequency channels shall be supported

3. If detection data is relayed to a central software system or central server, each installation of the Wireless Battery-Powered Magnetometer Vehicle Detection System shall provide the following measurements, as required by the application:

   ttt. Vehicle volume (count) per lane over a specified time interval
   uuu. Lane occupancy (percent) over a specified time interval
   vvv. Vehicle speed (mph or kph) when more than one sensor is deployed in a lane
www. Per-vehicle speed
xxx. Median speed over a specified time interval
yyy. Mean speed over a specified time interval
zzz. Distribution of speeds over a specified time interval
aaaa. Vehicle classification when more than one sensor is deployed in a lane
bbbb. Per-vehicle length
cccc. Report distribution of vehicle lengths over a specified time interval
dddd. The time interval for measurements shall be selectable from 30 seconds to 24 hours

4. Each sensor in an installation shall be capable of being individually configured with its own sensitivity level.
eeee. A single sensor shall be capable of being configured with a sensitivity level that approximates the detection zone of a standard 6’ x 6’ inductive loop
ffff. Each sensor shall be capable of being configured with relatively higher or lower sensitivity levels as may be required to detect bicycles, motorcycles, or light rail
gggg. An APCC shall support the relay of sensor detection data through several interfaces as required by the application. The APCC shall be capable of simultaneously communicating detection data via the contact closure interface, Ethernet interface, and cellular data modem interface, as applicable.

C. Accuracy Requirements for the Wireless Magnetometer Vehicle Detection System

Provide a WMVD system that meets the below minimum accuracy requirements for all conditions. Accuracy measurements for the testing shall be done with an appropriate sample size of vehicles, over a specific time period. Submit to the Engineer the Test plan for accuracy testing at the location that is site specific to the plans. The test plan shall take into account the roadway type (freeway, arterial), location (urban, rural), and traffic conditions in order to determine appropriate testing length and sample size. The following conditions shall be met for each sensor installed:

D. Measurement Accuracy

The following error levels shall be achievable and demonstrated during testing for the parameters relevant to each installation.

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<tr>
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</tr>
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<tr>
<td>Length Classification limits</td>
<td>±10%</td>
</tr>
</tbody>
</table>

E. Testing

Develop and submit plans for post-installation testing to the Engineer for consideration and approval. Ensure the plans test all functional requirements outlined in Section 937.2.03B and the accuracy requirements stipulated in Section 937.2.03C. Provide the Engineer with Application Protocol Interface (API) documentation and Software Development Kit (SDK) for the WVDS detection system. GDOT will have 30 days from receipt of the API and SDK to make a determination if it can be integrated. If the device cannot be integrated, the Engineer will give notice that the Contractor must submit a device that can be integrated into the central system software. The testing shall prove that all in-pavement sensors are configured and collecting data as required in this specification and as shown on the plans.

1. Post-installation test procedures: Utilize the following test procedures after the WVDS system has been installed in its entirety as shown on the Plans. Commence no post-installation testing until all WVDS systems in the project
have been configured and/or calibrated to gather speed, volume, classification, occupancy, and/or presence and programmed to communicate on the GDOT network as required per installation. Including the accuracy testing requirement, at a minimum, provide the following on the test plan to be submitted and approved by the Engineer:

- hhhh. Inspect all detection system field components to ensure proper installation and cable termination.
- iii. Verify that field construction has been completed as specified in the plans.
- jjjj. Inspect the quality and tightness of cable, ground and surge protector connections.
- kkkk. Check voltage and outputs and ensure device connections are as specified in the Plans and manufacturer recommendations.
- llll. Verify that the installation of cables and connections between all APCC’s and field cabinets are as specified in the Plans.
- mmmm. Demonstrate that each Wireless In-Pavement Vehicle Detection System is fully operational, communicating and gathering the required data types at the specified interval.

### 937.2.04 Short-Range Radio Device Detector System

The Short-Range Radio Device Detection System shall be capable of monitoring and measuring vehicular and pedestrian movement by identifying and comparing unique MAC (Media Access Control) addresses associated with Short-Range Radio enabled electronic devices. The system can be used to collect high quality, high-density travel times by sampling a portion of actual travel activity from the traffic stream of a predetermined route. The MAC address received by a sequence of two or more Short-Range Radio Device receivers shall be matched and used to develop a sample of travel time for that particular segment of the roadway, based on the relative detection times recorded by the adjacent units.

The Short-Range Radio enabled device (sensor) shall be an anonymous Short-Range Radio Device MAC address, which is a hardware identifier for the manufacturer and specific electronic device type. MAC addresses are not associated with any specific user account or any specific vehicle. The MAC address shall not be linked to a specific person through any type of central database, but is assigned by the Short-Range Radio Device electronic chip manufacturer and shall not be tracked through the sales chain. Privacy concerns typically associated with alterative probe systems shall be eliminated.

#### A. Requirements (Type A, Type B, and Type C)

The Short-Range Radio Device Detection System shall be connected to, and work in conjunction with the support data processing system, located in a designated server at the TMC. All The Short-Range Radio Device Detection units shall adhere to the following requirements:

- Short-Range Radio Device: Class 1 Transceiver with 4 dB to 8 dB Omni Directional Antenna
- Environmental: -30°C to +65°C, 5 – 90% humidity
- Connectivity: IP/Ethernet 10/100 Base-T (minimum)
- I/O ports: minimum one (1) RJ45 Ethernet port and one (1) RS-232 Configuration Serial Port

1. **Short-Range Radio Device Detection System, Type A**

   Provide a Short-Range Radio Device Detection System that can be installed in a typical signal or ITS cabinet. The unit shall be enclosed in its own housing and sit on a shelf within the cabinet. Utilize a conduit, as shown on the plans, for routing the antenna cable, and attach the antenna at the location shown on the plans. The power for the Short-Range Radio Device Detection System, Type A unit shall come from typical cabinet power (110 VAC) receptacles or terminal block. Supply all wiring for the Short-Range Radio Device Detection System Type A unit. Should the unit require a POE adapter or transformer to VDC, submit the adapter or transformer to the Department for review. The Contractor shall supply all surge protection devices for the external POE adapter or transformer.

2. **Short-Range Radio Device Detection System, Type B**

   Provide a Short-Range Radio Device Detection System that is self enclosed in a NEMA 4X enclosure that can be mounted to a pole, mast arm or cabinet structure. The voltage input shall be between 6 and 30 VDC, or be able to connect to 110 VAC with appropriate transformers and adapters, as determined by the Department. The Short-Range Radio Device Detection System Type B unit shall be wired to a cabinet or approved communication/power source, as
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shown on the plans. The unit shall not reside within the cabinet. Provide all grounding, wiring, adapters, transformers, and surge protection devices needed to support the Short-Range Radio Device Detection System Type B unit, as installed.

3. Short-Range Radio Device Detection System, Type C

Provide a Short-Range Radio Device Detection System that is self enclosed in a NEMA 4X enclosure that can be mounted to a pole, mast arm or cabinet structure. Provide a Solar Power Array, which includes the solar panel, charging unit and batteries necessary for solar power. The Short-Range Radio Device Detection System Type C unit shall also include a GSM cellular modem with antennas, or approved equivalent. This Short-Range Radio Device Detection System type shall be a completely wireless installation. Provide all grounding, wiring, adapters, transformers, and surge protection devices needed to support the Short-Range Radio Device Detection System Type C unit, as installed.

4. Short-Range Radio Device Detection System Support Data System Software and Database

Provide a Support Data System software package, including all necessary database 3rd party software required in order for the software to run as intended in support and conjunction of the Short-Range Radio Device sensor system. The software shall be installed on a server designated by the Department. It is the Contractor’s responsibility to populate and configure the database for each field Short-Range Radio Device Detection System, and to test the accuracy of the data. The data shall be in an XML format compatible with the Department’s central software. The software shall also display a real time chart or graph showing calculated travel time and speeds of the sampled vehicles and MAC address counts. The Short-Range Radio Device Detection System support software is required for all new Short-Range Radio Device Detection System installations, but shall not be required for additional Short-Range Radio Device Detection System sensor installations on an existing network.

B. Functional Requirements for the Short-Range Radio Device Detection System

The sensor shall be capable of delivering data from both an Ethernet connection and a GSM wireless modem. The Short-Range Radio Device Detection sensor working in conjunction with the network’s support data processing system must deliver real-time speed and travel time information in XML format to the central software system for routes where the sensors are deployed. The system shall be able to add multiple pairs of Short-Range Radio Device Detection sensors to form a network of manageable travel routes. Each route will display the data for the first and last sensor in addition to the travel-time and speed information for that segment. The Short-Range Radio Device Detection sensor shall be able to detect, at a minimum, within a radius of 300 feet when mounted on a pole or mast arm. The data processing shall be able to filter and ‘throw out’ MAC addresses that do not supply accurate information when compared to other device time stamps of the segment between two Short-Range Radio Detection devices. The data shall be smoothed, and be able to process median and mean average speeds. The following data shall be able to be compared and filtered, as needed, to deliver the most accurate information:

1. Pedestrians
2. Oversize Vehicles
3. Mass Transit (i.e. nearby trains or buses)

The Short-Range Radio Device Detection System equipment shall contain advanced features designed to allow the unit to operate efficiently in a remote environment. Diagnostic and configuration information shall be able to be viewed remotely, such that the health and operating status of the sensor is known. The system shall be designed to be able to automatically or remotely “reboot” if a condition is detected that requires such action.

C. Testing

Develop and submit plans for post-installation testing to the Engineer for consideration and approval. Ensure the plans test all functional requirements outlined in Section 937.2.03B. Provide the Engineer with the appropriate XML data interface, as necessary, for testing of the travel time accuracy and integration into the central software.

4. Post-installation test procedures: Utilize the following test procedures after the Short-Range Radio Device Detection System has been installed in its entirety as shown on the Plans. Commence no post-installation testing until all Short-Range Radio Device Detection sensors systems in the project have been configured, calibrated and
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programmed to communicate on the GDOT network to the support data system software. At a minimum, provide the following on the test plan to be submitted and approved by the Engineer:

nnnn. Inspect all Short-Range Radio Device Detection System field components to ensure proper installation and cable termination.

oooo. Verify that field construction has been completed as specified in the plans.

pppp. Inspect the quality and tightness of ground and surge protector connections.

qqqq. Check power supply voltage and outputs and ensure device connections are as specified in the Plans.

rrrr. Verify that the installation of cables and connections between all Short-Range Radio Device units, antennas and field cabinets and/or components are as specified in the Plans.

ssss. Demonstrate that each Short-Range Radio Device unit is fully operational and gathering the required data types at the specified and necessary interval.

937.3 Construction/Installation Requirements

This section shall include typical construction requirements for installing and configuring the vehicle detection systems. This specification only gives general requirements of installations. It is the Contractor’s responsibility to be fully certified and trained in the detection technology application and the required installation of such devices by the manufacturer. All cable connections shall be manufacturer-rated and secured from outside elements. The Contractor shall be experienced and/or certified in proper cable/connector crimping and manufacturer sealing methods so as to ensure a water-tight and corrosion resistant installation. Wrap all other exposed cable connections with self sealing tape for weatherproofing and moisture seal.

Refer to Subsection 107.07 of the Specifications regarding proper conduct of The Work.

937.3.01 Personnel

All personnel shall be fully trained and manufacturer certified in the applicable vehicle detection installation application. When installing into a signal or ramp meter cabinet, the technician shall be minimum International Municipal Signal Association (IMSA) Level II certified.

937.3.02 Equipment

Use machinery such as trucks, derricks, bucket vehicles, saws, trenchers, and other equipment necessary for the work and approved by the Engineer prior to installation operations.

937.3.03 Preparation

Utility Permits

A. Application

Apply for, obtain, and pay for utility services, and pole attachment permits required in the Plans.

B. Maintenance

Maintain these utility services until Final Acceptance of each installation. After Final Acceptance, transfer these services and permits to the Department, local government or jurisdiction responsible for maintenance and operation. Ensure that the transfer does not interrupt service.

C. Utility Location

When installing aerial cable of any type, ensure that overhead clearance and separation requirements conform to local utility company standards, OSHA, the NEC and the NESC. Refer to the Standard Details Drawings for further information on utility clearances.

937.3.04 Fabrication
937.3.05 Construction

A. Video Detection System Installation Requirements

1. General Installation Requirements:
   
   tttt. Install all video camera sensors, video detection system processors, output expansion modules, and associated enclosures and equipment at the locations specified in the Plans and per manufacturer recommendations. For traffic signal/ramp meter controller cabinets (Type D, E, and F processors), mount the processor and output expansion modules within the input files, or at a location as designated by the Engineer. Physical changes to the cabinet input files are not permitted. Make all necessary adjustments and modifications to the detection system prior to obtaining recommendation for system acceptance testing. For freeway applications (Type A, B and C processors), install all rack-mounted equipment with one rack unit space between adjacent equipment in the freeway ITS cabinet.

   uuuu. Installation, surge protection and all cabling shall comply with manufacturer’s recommendation, at a minimum, or as specified in these plans. All equipment, cables, and hardware must be part of an engineered system that is designed by the manufacturer to fully interoperate with all other system components and be fully protected from all surge potential. Connectors installed outside the cabinets and enclosures shall be manufacturer terminated and be corrosion resistant, weather proof, and watertight. Use a UL listed cable that is ozone and UV resistant and weather resistant. Label cables with permanent cable labels at each end.

   vvvv. Wiring and cables must be continuous (without splices) between the VDS camera sensor and processor, except for surge protection connections between sensor and cabinet, so that both the camera and processor are appropriately protected. Coil a minimum of 6 feet of slack in the bottom of the controller or freeway cabinet. Tape ends of unused and spare conductors to prevent accidental contact to other circuits. Label conductors inside the cabinet for the functions depicted in the approved detailed diagrams of the cabinet and VDS documents.

   wwww. Furnish an as-built cabinet wiring diagram, identified by location, for each VDS cabinet. Include all wiring, cabling, connections, and camera mounting height. Place all documentation in a weatherproof holder in the cabinet.

   xxxx. For freeway installations (Type A, B and C processors), install VDS power supply or transformer on a standard DIN rail using standard mounting hardware and power conductors wired to terminal blocks in the cabinet.

2. Camera Sensor Installation (all Types)

   Adjust the video camera sensor lens as recommended by the manufacturer, and as required to minimize vehicle occlusion. For Type A camera sensors, aim the camera so that no part of the horizon is in the video image so as to protect it from the effects of the sun. Mount the camera on the specified pole or structure for that location as shown on the plans.

   Mounting Bracket Assembly: Mount the video camera sensor on a mounting bracket such that its height and position provide a clear view of the approach or lanes. Mount the video camera sensor securely such that it is stable and steady. The mounting bracket assembly includes a video camera sensor mounting bracket, nipple pipe, cable-mount nipple clamp, and all associated hardware and materials. Mount the video camera sensor on a mounting bracket assembly which meets the following requirements unless otherwise specified in the plans:

   yyyyy. Use stainless steel fastening hardware with lock washers on threaded fasteners

   zzzzz. Use a video camera sensor enclosure mounting bracket that is non-rusting and is made from die cast aluminum, extruded aluminum, powder-coated galvanized steel or hot dipped galvanized steel. Provide a mounting bracket that permits vertical and horizontal adjustment of the video camera sensor. Provide a mounting bracket that securely fastens to the video camera sensor enclosure and mounts to the nipple pipe by threading onto the pipe or as a slip-fit, using a set-screw fastener in either above method.

   aaaaaa. Use a 1 ½” (38 mm) aluminum nipple pipe that is threaded on both ends.
bbbbb. Fasten the nipple pipe to the mast arm using a cable mount nipple clamp with minimum 2 5/16” (58 mm) U bolts. Use aircraft grade galvanized steel cables with stainless steel fastening hardware and that make at least two wraps around the mast arm. Do not use banding straps.

Install all VDS equipment into a cabinet type as shown in the plans with the following equipment:

3. Cabinet Equipment (All Types)

ccccc. Wiring, Conductors and Terminal Blocks: Use stranded copper for all conductors, including those in jacketed cables, except for earth ground conductors, which may be solid copper. Neatly arrange all wiring, firmly lace or bundle it, and mechanically secure the wiring without the use of adhesive fasteners. Route and secure all wiring and cabling to avoid sharp edges and to avoid conflicts with other equipment or cabling. Route camera control wiring, and 120 VAC power wiring separately. Terminate all wiring on a terminal block, strip, bussbar, or device clamp or lug; do not splice any wiring. Use a minimum #12 AWG for all conductors of 120 VAC circuits, or as recommended by the manufacturer of the VDS device.

dddddd. Label coaxial cables for VDS cameras. Number all terminal blocks, terminal strips, circuit breakers and bussbar breakers and have each item and each terminal position numbered and named according to function. Labels shall be weather and wear resistant.

eeee. Surge Protection: Protect all copper wiring and cabling entering the cabinet housing by surge protection devices as specified in these specifications and per Section 925.2.02 Section A, part 14. Terminate all wiring between cabinet devices and the transient surge protection devices, except for the video signal coaxial feed, on terminal strips. Use a minimum #16 AWG grounding of each surge protection device, or larger if recommended by the surge protection device manufacturer. Do not “daisy chain” with the grounding wires of other devices including other surge suppressors. Dress and route grounding wires separately from all other cabinet wiring. Install grounding wires with the absolute minimum length possible between the surge protection device and the ground bussbar. Label all surge protection devices with silk-screened lettering on the mounting panel.

ffff. Furnish and install a surge suppressor for each video signal coaxial line. Install a BNC connector, three stage surge protection device for the coax cable that employs gas discharge tubes, series current limiting components, and secondary ‘fine’ protection. The coax surge protection device shall have a surge current rating of 10 kA. For each cabinet housing, include surge protection devices for the VDS camera power lines installed on the terminal bloc.

gggg. All surge protection shall be furnished and installed by the Contractor to protect not only the cabinet processor, but the camera sensor itself from ground rise potential (i.e. surge up to the camera sensor).

hhhh. Documentation: Provide the following documentation in a waterproof documentation pouch in each cabinet:

- One operation manual with programming instructions
- One maintenance manual with schematics
- Three legible wiring prints showing all VDS components, model and serial number and connections with the cabinet

4. Cabinet Equipment (Type A, B, and C)

Component Installation: Fasten all components of the cabinet assembly to be mounted on cabinet side panels with hex-head or Phillips-head machine screws. Install the screws into tapped and threaded holes in the panels. These components include but are not limited to terminal blocks, bussbars, panel and socket mounted surge protection devices, accessory and equipment outlets, and DC power supply chassis. Fasten all other cabinet components with hex-head or Phillips-head machine screws insulated with nuts (with locking washer or insert) or into tapped and threaded holes. All fastener heads and nuts (when used) shall be fully accessible within a complete cabinet assembly, and any component shall be removable without requiring removal of other components, panels, or mounting rails. Do not use self-tapping or self-threading fasteners.

5. Cabinet Equipment (Type D, E, and F)

iiiii. Exercise extreme caution when installing VDS equipment and materials at traffic signal/ramp meter installations. Installation technicians accessing a signal cabinet shall be accompanied by a certified
Section 937—Detection Systems

(minimum) International Municipal Signal Association (IMSA) Level II traffic signal technician. Repair any damage to existing traffic/ramp meter control equipment and materials which occurred during VDS installation to the Engineer’s satisfaction at the Contractor’s sole expense.

jjjjj. In 336S cabinets, locate the VDS power termination panel on the equipment rail in the lower left portion of the rear of the cabinet as shown in the details and plans. Adjust the panel as far toward the cabinet sidewall as possible while still providing access to the circuit breaker. Notify the Engineer immediately if there is any conflict with existing cabinet equipment in this position. Ensure that there is no conflict with door-mounted components when the door is closed.

kkkkk. In 332 and 334 cabinets, locate the VDS coax termination panel in the lower open section of the front of the cabinet equipment rack as shown in the details. Notify the Engineer immediately if there is any conflict with existing cabinet equipment in this position. Ensure that there is no conflict with door-mounted components when the door is closed. Dress, label, and secure all coaxial cabling to and from the coax termination panel such that the panel can be hinged open a minimum of 90 degrees without binding or stressing any coaxial cable.

B. Microwave Detection System Installation Requirements

1. General Installation Requirements

Install all detectors and associated equipment at the locations specified in the Plans. Installation must comply with manufacturer’s recommendation. All detector equipment, cables, and hardware must be part of an engineered system that is designed by the manufacturer to fully interoperate with all other system components for the Microwave Detection System. Surge protection devices must be approved by the manufacturer, and must be of quality or better than manufacturer recommendations.

2. Detector

Furnish and Install the microwave radar detector on poles as shown in the plans using Contractor supplied materials and brackets. Install the microwave radar detector to achieve the field of coverage shown in the Plans. Aiming and alignment shall be per the manufacturer’s recommendations. The Contractor shall verify height requirements based on manufacturer recommendations and shall notify the Engineer should the mounting height vary from the plans. It is the Contractor’s responsibility to make all field adjustments to the locations shown in the Plans, in order to match manufacturer recommendations for operation. All field adjustments shall be approved by the Engineer. The Contractor shall use his laptop to setup the detection zones using detector manufacturer specific software. Use only the latest software that is compatible with the detector, as provided by the manufacturer. Use mounting hardware that meets hardware specifications as described in the Video Detection System Installation Requirements, mounting hardware assembly.

3. Cabinet Equipment

lllll. Wiring, Conductors, and Terminal Blocks: Furnish and Install a manufacturer terminated cable of length necessary for the detector installation. Use only cables provided by the manufacturer of the detection system. The detector end-connector shall be manufacturer assembled and tested prior to installation. It shall be completely watertight and weather resistant. All cabling shall be UV rated for outdoor and underground use. Use only stranded copper for all conductors, including those in jacketed cables, except for earth ground conductors, which may be solid copper. Neatly arrange all wiring, firmly lace or bundle it, and mechanically secure the wiring without the use of adhesive fasteners. Route and secure all wiring and cabling to avoid sharp edges and to avoid conflicts with other equipment or cabling. Route microwave radar detector control wiring and 120VAC power wiring separately so as no transient voltage bleeds over to the detector cable. Terminate all wiring on a terminal block, strip, bussbar, or device clamp or lug; do not splice any wiring from the detector unit to the terminal blocks.

mmmmm. Number and label all terminal blocks, terminal strips, circuit breakers and bussbar breakers and have each item and each terminal position numbered and named according to function. Label terminal blocks, terminal strips, circuit breakers and bussbars with weather and wear resistant labels.

nnnnn. Surge Protection Devices (SPD): Protect all copper wiring and cabling entering the cabinet housing by surge protection devices as specified in this specification and the minimum requirements of Section 925.2.02 Section A, part 14. Terminate all wiring between cabinet devices and the transient surge protection devices and between the microwave radar detection unit and the surge protectors on terminal strips. Use a minimum #16 AWG grounding for each surge protection device, or larger if recommended by
the surge protection device manufacturer. Use insulated green wire and connect the ground wire directly to the ground bussbar. Do not “daisy chain” with the grounding wires of other devices including other surge protection devices. Dress and route grounding wires separately from all other cabinet wiring. Install grounding wires with the absolute minimum length possible between the suppressor and the ground bussbar. Label all surge suppressors with silk-screened lettering on the mounting panel.

ooooo. Furnish and install all necessary transient surge protection devices for the microwave radar detection units such that the detector and cabinet equipment are protected.

ppppp. Component Installation: Fasten all components of the cabinet assembly to be mounted on cabinet side panels with hex-head or Phillips-head machine screws. Install the screws into tapped and threaded holes in the panels. The components include but are not limited to terminal blocks, bussbars, panel and socket mounted surge protectors, terminal servers, Ethernet switches, circuit breakers, and accessory and equipment outlets. Fasten all other cabinet components with hex-head or Phillips-head machine screws installed with nuts (with locking washer or insert) or into tapped and threaded holes. Fasten stud-mounted components to a mounting bracket providing complete access to the studs and mounting nuts. All fastener heads and nuts (when used) shall be fully accessible within a complete cabinet assembly, and any component shall be removable without requiring removal of other components, panels, or mounting rails. Do not use self-tapping or self-threading fasteners.

qqqqq. As-Built Drawings: Furnish an as-built cabinet wiring diagram, identified by location, for each cabinet. Include label names and numbering, surge protection devices (SPD’s), wiring, cabling, and connections. Place all documentation in a weatherproof holder in the cabinet.

4. Cables, Conduit and Power Service

Furnish and install electrical cables used for control, communications signaling and power supply as required by the manufacturer. Do not splice any cable, shield or conductor used for control, communications signaling, or power supply. Identify all conductors of all cables by color and number. Identify the conductor function in as-built documentation included in the cabinet documentation. After termination and dressing the cables in the cabinet, neatly coil and store a minimum of 6 ft of cable slack in the bottom of the cabinet. Cut unused conductors to a length that can reach any appropriate terminal. Bend back unused conductors over their outer jackets and individually tape them.

Install cabling inside new hollow metal or concrete support poles unless otherwise specified. Where devices are installed on existing wood poles, install cabling on the wood poles in rigid metal conduit risers of minimum 2 inch (5.08 cm) diameter. Use weatherheads on all nipple and conduit openings. Neatly install and route cabling to minimize movement in the wind and chafing against the pole, device or bracket. Form a drip loop at the weatherhead and route cabling to minimize water entry into the cable connector. Use a 24” diameter drip loop where cables enter a weatherhead.

5. As-Built Drawings

As-built drawings that include the cabinet wiring diagrams as outlined in 2d above. As-built drawings shall include but not be limited to microwave radar detection locations, microwave radar detection mounting heights, and component lists with brand, model and serial numbers. Place one copy of the as-built drawings in the cabinet documentation pouch and submit another copy to the Engineer.

C. Wireless Magnetometer Vehicle Detection

1. General Installation Requirements

Each installation of the Wireless Battery-Powered Magnetometer Vehicle Detection System shall consist of one or more sensors installed in the center of each traffic lane, avoiding sources of magnetic noise such as underground power cables, overhead high tension power cables, light rail or subway tracks, and power generation stations and sub-stations.

rrrrr. The sensors shall be located as specified by the plans

sssss. For count applications, sensors shall be placed in areas with minimum stop-and-go traffic flow
If vehicle speeds are to be determined by the system, then at least two sensors are required in each lane, separated according to the anticipated average vehicle speed.

- If the anticipated average vehicle speed is less than 25 mph / 40 kph, the spacing between sensors shall be approximately 10 feet / 3 meters (and measured precisely at the time of installation in order to properly configure the system)
- If the anticipated average vehicle speed is greater than 25 mph / 40 kph but less than 45 mph / 75 kph, the spacing between sensors shall be approximately 10 to 12 feet / 3.1 to 3.7 meters (and measured precisely at the time of installation in order to properly configure the system)
- If the anticipated average vehicle speed is greater than 45 mph / 75 kph, the spacing between sensors shall be approximately 20 to 24 feet / 6.1 to 7.3 meters (and measured precisely at the time of installation in order to properly configure the system)

Prior to installation, the contractor shall provide personnel that have been certified by the manufacturer to test and pre-configure the components, including assigning channels and sensors to SPP, RP’s, etc. The Contractor shall record all detection component ID numbers on a project plans drawing or intersection detail prior to installation, and supply all drawings showing the recordings as part of the as-builts at the end of the project. The Contractor shall install each sensor in the roadway per Manufacturer’s recommendations. The contractor will install Type B sensors for stop bar detection only, where presence is only required, and Type A sensors will be deployed for all other detection applications.

2. Sensor Installation:
   For a sensor installed just below the roadway surface:
   - The roadway shall be core drilled to provide a 4” diameter hole, a minimum 2.25” / 5.7 cm deep
   - The sensor shall be placed inside a small, clear plastic shell formed to provide a tight fit around the sensor.
   - A small layer of epoxy approximately 1.25” / 3.2 cm shall be applied to the bottom of the cored hole.
   - The epoxy must adhere to the following requirements:
     - The epoxy shall be a two part poly-urea based joint sealant.
     - It shall have self leveling characteristics.
     - The surface the epoxy will be bonding to shall be free of debris, moisture and anything else which might interfere with the bonding process.
     - The epoxy shall be approved by the manufacturer of the detection system
   - The sensor shall then be placed on top of this layer of epoxy in the correct orientation as clearly marked on the sensor
   - The sensor shall be fully encapsulated with the epoxy to the lip of the cored hole

3. Sensor to Repeater, or Sensor to SPP Installation:
   The maximum distance between a sensor installed in the roadway and an SPP or an RP with a clear line-of-sight between devices shall be:
   - At least 175 feet / 53 meters for an SPP or RP installed 30 feet / 9 meters above the roadway
   - At least 150 feet / 46 meters for an SPP or RP installed 20 feet / 6 meters above the roadway
   - At least 125 feet / 38 meters for an SPP or RP installed 16 feet / 5 meters above the roadway
   - The maximum distance between an SPP and an RP or between an RP and another RP shall be at least 750 feet / 228.6 meters when both units are installed 18 feet / 5.5 meters above the roadway and with a clear line-of-sight between devices

4. Repeater to SPP Installation:
   Maximum wireless distances shall be based on the following:
SPP or Repeater front of the housing shall be aimed directly at the device (SPP, RP or Sensor) it is communicating with.

Deviations from the centerline of the front of the SPP or RP shall reduce the effective distance of communication.
D. Short-Range Radio Device Detection System Installation Requirements

1. General Installation Requirements

   hhhhhh. Install the Short-Range Radio Device Detection antenna and/or NEMA 4X enclosure on poles as shown in the plans using Contractor supplied materials and brackets. Install the Short-Range Radio Device Detector to achieve the field of coverage shown in the Plans. Make field adjustments to the locations shown in the Plans only with the Engineer’s approval.

   iiiii. The minimum recommended mounting height for the Short-Range Radio Device sensor antenna shall be 10 feet above grade, unless otherwise approved by the Engineer. When using a solar power supply the panel shall be mounted in accordance with environmental and location geographic conditions, and as shown and noted in the plans. It shall be the Contractor’s responsibility to tune the sensor for best coverage of the roadway vehicles being detected.

   jjjjjj. All mounting hardware shall be stainless steel or aluminum, and shall not be susceptible to weather and rusting. Use mounting hardware specifications as outlined in the Video Detection System Installation Requirements. Route all cabling within new conduit, unless otherwise approved by the Engineer. Protect the Short-Range Radio Device processor from the antenna with a surge protection device of specification recommended by the manufacturer.

   kkkkkk. It is the Contractor’s responsibility to populate and configure the database and support data system software package and to test the accuracy of the data. Each Short-Range Radio Device Detector shall be configured in the software and show that it is taking a representative sample of vehicles from the traffic stream.

937.3.06 Quality Acceptance/Testing

The acceptance testing of the vehicle detection systems shall consist of two phases: 1) post installation detection system site testing, as outlined in the specific detection technology sections; and 2) burn-in period. Perform acceptance testing for all equipment, hardware and work as provided under this Contract. Perform all testing in the presence of the Engineer. Submit all testing plans and documents to the Engineer during the submittal phase of the vehicle detection equipment.

A. Burn-in Period

1. General Requirements

   llllll. Provide a 30-day burn-in period for all work and equipment included in the Contract and associated with the vehicle detection equipment. The burn-in period shall consist of the field operation of the specific vehicle detection system in a manner that is in full accordance with the requirements of the Plans and Specifications.

   mmmmmmm. Conduct only one (1) burn-in period on the entire Contract for all vehicle detection devices. Commence with the burn-in period only after meeting all of the following requirements:

   - All work required in all Contract documents for the vehicle detection system project-wide has been completed and inspected by the Engineer.
   - Successfully complete the Post-Installation Vehicle Detection System Site Testing.

   nnnnnn. Commence with the burn-in period upon written authorization by the Department to commence. Terminate the burn-in period 30 consecutive days thereafter unless an equipment malfunction occurs. Stop the burn-in period for the length of time any equipment is defective. After repairing the equipment so that it functions properly, resume the burn-in period at the point it was stopped.

   ooooooo. Successful completion and acceptance of the burn-in period will be granted on the 31st day unless any equipment has malfunctioned. If any equipment has failed during the burn-in period, final acceptance will be withheld until all the equipment is functioning properly.

   ppppppp. When one specific piece of equipment has malfunctioned more than three times during the 30 day burn-in period, replace that unit with a new unit at no cost to the Department. Multiple failures of detection devices in different locations shall be determined as a failure of the 30 day burn-in period. The Contractor shall investigate the detection system failure and shall give a full report to the Engineer. The Contractor shall replace the failed devices and shall restart the burn-in period at Day 1, once those devices have been replaced and retested.
2. Contractor Responsibilities

During the burn-in period, maintain all work under this Contract in accordance with the Specifications. Restore any work or equipment to proper operating condition within 12 hours after notification.

3. Department Responsibilities

Department responsibilities during the burn-in period will be as follows:

- Expeditious notification of Contractor upon failure or malfunction of equipment
- In the event that the Contractor does not provide the services enumerated above under his Contract responsibilities, the Department or its authorized agents may in the interest of public safety take emergency action to provide for adequate traffic control. Pay any costs incurred as a result of these emergency actions. Such action by the Department will not void any guaranties or warranties or other obligations set forth in the Contract.

4. Burn-In Period Acceptance

The Department will make burn-in period acceptance after satisfactory completion of the required burn-in period and on the basis of a comprehensive field inspection of the complete vehicle detection system in accordance with the Specifications. Upon burn-in period acceptance but prior to Final Acceptance of the entire Contract, maintain the complete vehicle detection system in accordance with the specifications.

937.3.07 Contractor Warranty and Maintenance

Equipment provided under this specification shall be warranted by the manufacturer to be free from defects in materials and workmanship for a minimum of three (3) years from Maintenance Acceptance.

The manufacturer’s and supplier’s warranties shall be transferable to the agency or user that is responsible for maintenance and shall be continuous throughout their duration.

During the warranty period, the manufacturer shall repair or replace any faulty equipment without cost to the purchaser, State of Georgia, or maintaining agency for all incidentals to the repair or replacement, including but not limited to parts, labor, or shipping.

The manufacturer shall be responsible for providing firmware or software updates associated with the CCTV system at no cost to the State of Georgia or maintaining agency during the warranty period. Further, the manufacturer is also responsible for ensuring that any updates will not degrade the original functionality of the product warranted.

The manufacturer and/or supplier shall provide consultation to the Department or user that is responsible for maintenance as needed at no cost during the warranty period for operating questions or problems that arise.

937.3.08 Training

Provide a minimum of at least eight (8) hours of configuration and maintenance training. The persons to be trained will be determined by the Engineer. Configuration training should last a minimum of three (3) hours and must include instructions for programming, hands on training in programming detection zones, adjusting, and calibrating the detection system. One hands on unit shall be provided per attendee during training. Operation and Maintenance training should last a minimum of five (5) hours and must include instructions on troubleshooting, maintenance, and operation for all detection system components. Each class will have a maximum of eight (8) people. The contractor must provide a training notebook to each trainee and an electronic copy of the training notebook to the Engineer.

The contractor must provide a location for holding the courses and pay all costs associated with travel and accommodation of the trainees if training is conducted away from the project area.

Notify the Engineer 20 days before training and agree on a time and place to conduct the training. If agreement cannot be reached, the Engineer will determine the time.
937.4 Measurement

937.4.01 Video Detection System

A. Video Camera Sensor Assembly (All Types)

Video camera sensor assemblies are measured for payment per each actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install the following minimum items for a video camera sensor assembly.

1. Camera, environmental enclosure, and mounting assembly with all associated hardware.
2. Cabinet equipment, including but not limited to wiring, conductors, terminal blocks, surge protection devices, and mounting panels
3. All weather heads, vertical conduit risers, and conduit hardware on the VDS support pole for power service, grounding, communications, and control. If VDS and CCTV are mounted on the same pole, install common weather heads, conduit risers, and conduit hardware under Section 936 of the Specifications.
4. All hardware and materials necessary to provide electrical power service to the VDS field location as shown in the Plans, including but not limited to vertical sections of conduit, conduit hardware, wire, circuit breakers, disconnect closures, and grounding. The Department will pay for horizontal sections of conduit separately.
5. All cables, connectors, hardware, interfaces, supplies, and any other items necessary for the proper operation and function of any VDS system component to carry video signals to the video detection system processor. All cables shall have manufacturer installed and tested connector ends at the detection side of the cable.

B. Video Detection System Processor (All Types)

Video detection system processors are measured for payment per each actually installed, configured, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install a video detection system processor to include, at a minimum, the following:

1. Video detection system processor module
2. Appropriate power supplies, power and communication wiring.
3. Necessary housing and rack assemblies for processors that do not plug directly into signal cabinet input files
4. System software provided within the video detection system processor and configuration software

C. Output Expansion Module

Output expansion modules are measured for payment per each actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install an Output Expansion Module to include, at a minimum, the following:

1. Output expansion module
2. Any cabling and hardware required to connect to the processor module or additional expansion modules to the cabinet and controller input pins

D. Testing

Testing is measured as a lump sum for full delivery of testing and acceptance requirements.

E. Training

Training is measured as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training.

937.4.02 Microwave Radar Detection

A. Microwave Radar Detector Assembly
Microwave radar detection assemblies are measured for payment per each actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install the following minimum items for a microwave detection assembly:

1. Microwave radar detector (including housing)
2. Field cabling surge protection devices, and cabinet equipment. Field cable shall have manufacturer installed end connector at the detection end
3. Power supply modules
4. Serial communication modules
5. Local communication modules
6. Mounting bracket(s)
7. All weatherheads, vertical conduit risers, and conduit hardware on the support pole for power and detector signal as shown in the plans
8. Configuration and Software

B. Testing

Testing is measured as a lump sum for full delivery of testing and acceptance requirements.

C. Training

Training is measured as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training.

937.4.03 Wireless In-Pavement Vehicle Detection

A. Sensor (All Types)

Sensors are measured for payment per each actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install the following minimum items for a sensor detection assembly:

1. Sensor
2. Epoxy
3. Core Drilling and Placement
4. Sensor plastic enclosure
5. Configuration and Software

B. Access Point Contact Closure (All Types)

Access Point Contact Closure assemblies are measured for payment per each actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, the APCC shall include all configuration, software, enclosures, surge protection devices and power supplies, as necessary for a full installation. Provide all modules and cabling with the APCC for connection directly into an Ethernet switch.

C. Wireless Repeater

Repeaters are measured for payment per each actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install the following minimum items for a wireless repeater assembly:

1. Repeater including housing
2. 7-year battery
3. Mounting hardware
4. Configuration and Software
D. Serial Port Protocol Unit (SPP)

SPP’s are measured for payment per each actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install the following minimum items for a SPP assembly:

1. Radio unit including housing
2. Cabling, surge protection devices and connectors from unit to cabinet
3. Mounting hardware
4. Configuration and Software

E. Expansion Contact Closure Card

Expansion Contact Closure Cards (EX) are measured for payment per each actually installed, complete, functional, and accepted. The EX card shall include all configuration to provide a full contact closure detection system.

F. Isolator Module

Isolator Modules are measured for payment per each actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install the isolation module at all locations the Wireless In-Pavement Detection System is called out in the plans. Ensure that the isolation module is installed per the manufacturer recommendation and is providing protection and amplification of the signal. This shall include all configuration of the unit.

G. Input/Output Module

Input/Output Modules are measured for payment per each actually installed, complete, functional, and accepted. Ensure that the Input/Output module is installed per the manufacturer recommendation and is providing the correct communications options necessary for the installation. This shall include all configuration of the unit.

H. Testing

Testing is measured as a lump sum for full delivery of testing and acceptance requirements.

I. Training

Training is measured as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training.

937.4.04 Short-Range Radio Device Detection System (All Types)

A. Short-Range Radio Device Detection System (All Types)

Short-Range Radio Device Detectors are measured for payment per each actually installed, complete, functional, and accepted. Each type of system shall be complete, installed and in place and include all units necessary for full operation, as determined by Type. Unless otherwise specified in the Plans, furnish and install the following minimum items for a Short-Range Radio Device Detection assembly:

1. Short-Range Radio Device Detection assembly, including housing and necessary power supplies
2. Power and communications cabling
3. Antenna and mounting hardware
4. Surge Protection Devices
5. Cellular Modem (if applicable)
6. Solar Panel Array (if applicable)
7. Solar Battery charger (if applicable)
8. Batteries (if applicable)
9. NEMA 4X Enclosure (if applicable)

10. Configuration

B. Short-Range Radio Device Detection System Support Data System Software and Database Package

Short-Range Radio Device Detection System software and database packages are measured for payment per each package actually installed, complete, functional, and accepted. Each type of system shall be complete, installed and in place. Unless otherwise specified in the Plans, furnish and install the following minimum items for Short-Range Radio Device Detection System software:

1. Installation of the Software on a Department determined server
2. Installation of the Database software on a Department determined server
3. Configuration of the Short-Range Radio Device Detection System units and initial testing on the software
4. Testing of the XML data and interface to the central system

937.5 Payment

A. General

All Vehicle Detection assemblies, complete in place and accepted by the Department after a successful 30 day burn-in period, are paid for at the Contract Unit Price. Payment is full compensation for furnishing and installing the vehicle detection technology as shown on the plans.

B. Testing

The Department will pay for testing performed as prescribed by this Item, measured as provided under Measurement at the Lump Sum Contract bid price.

C. Training

Training is paid for as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training, measured as provided under Measurement at the Lump Sum Contract bid price.

Payment is full compensation for furnishing and installing the items complete in plans according to this Specification.

Payment will be made under:

<table>
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<tr>
<th>Item No.</th>
<th>Description</th>
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