Special Specification 6114
Wireless Magnetometer Vehicle Detection System

1. DESCRIPTION

Install a Wireless Magnetometer Vehicle Detection System (WMVDS) as detailed in the plans that detects vehicles on a roadway by measuring changes in the earth's magnetic field and provides detector outputs to a traffic controller and other devices. This Item defines the requirements for a system that detects vehicles on a roadway using one or more battery powered wireless magnetometer vehicle detectors and system components to transmit detection information to the controller cabinet interface modules compatible with NEMA TS-2 V2.06b cabinet detector rack.

The system maybe composed of these principal items: One or more of the following items: installation of in-pavement sensors for each lane, materials to mount the detectors in the pavement, all mounting equipment for a complete system, all wireless communication links to the controller cabinet, method to interface with NEMA V2.06b controller or cabinet detector, surge protection for the WMVDS, and the system software for set-up and monitoring of the WMVDS system.

All equipment must be on TxDOT's Qualified Products List (QPL).

1.1. **Definitions.**

1.1.1. **3-Axis Magnetometer.** Instrument used for measuring the magnitude and direction of the earth's magnetic field. Device used to detect changes in the earth's magnetic field within the vicinity of the instrument. The 3-axis magnetometer measures the height, width and length of the magnetic field around the instrument referenced as the X, Y, and Z axis.

1.1.2. **Interface Module.** Modules used to plug into the detector rack of a NEMA TS-2 or traffic controller cabinet or input file 170 or 2070 traffic controller cabinet. Provides contact closure to the assigned detector channel when vehicle detection is achieved by the in-pavement sensor.

1.1.3. **Base Module.** Shelf mounted processor to communicate with Access Points wired or wirelessly and output detector calls to traffic signal controller or detection rack.

1.1.4. **Wireless Communications Link.** Data communications channel connecting to nodes of a communications link using a radio frequency (RF) to connect the nodes. Wireless links to connect nodes such as: access point to the sensor, and/or access point to repeater.

1.1.5. **Access Point.** Wireless communications device used as the connecting node to establish a data communications link from the sensor to the interface module.

1.1.6. **Repeater.** Optional wireless node device used to receive/ transmit data with the access point. Repeater is typically located near the sensor and may be used in tandem with another repeater for longer distances or to communicate around obstructions.

1.1.7. **In-pavement Sensor.** Device placed in the roadway and used to detect a change in the earth's magnetic field when a vehicle passes over its measured area of influence. In-pavement sensor houses the 3-axis magnetometer used to sense the change in the earth's magnetic field. Sensor acts as a data communications device to an access point to transmit contact closure when detection is achieved by the 3-axis magnetometer.

1.1.8. **System software.** Computer software used for set-up and monitoring of the WVMDS. Software allows the user to assign sensors to detector channels and to select sensitivity levels needed for the application. Software may be a Windows based application or else reside in the WMVDS system and provide access by means of a standard web-browser.

1.1.9. **Detection zone.** Area of measured magnetic lines of flux by the in-pavement sensor.

1.1.10. **Presence Detection.** The ability of a vehicle detector to sense that a vehicle, whether moving or stopped, has appeared in its zone of detection.

1.1.11. **Passage Detection.** The ability of a vehicle detector to detect the passage of a vehicle moving through its zone of detection and to ignore the presence of a vehicle stopped within its zone of detection.

1.1.12. **Detection Accuracy.** The measure of the basic operation of a detection system (shows detection when a vehicle is in the detection zone and shows no detection when there is not a vehicle in the detection zone).

1.1.13. **Delay Timing.** When selected, applies delayed contact closure to the associated detector channel input. When a vehicle is detected by the WMVDS, the delay timing must time out before contact closure can occur to the detector channel.

1.1.14. **Extension Timing.** Then selected, applies additional contact closure to the associated detector channel input. When a vehicle is no longer detected within a detection zone, extension timing must time out before contact closure is removed from the associated detector channel.

1.2. **Functional Capabilities.**

The WMVDS must be capable of detecting a variety of vehicle types including bicycles, motorcycles, automobiles, large trucks and light rail trains. The system must allow the user to select sensitivity levels needed to achieve contact closure to the assigned detector channel. Magnetometer sensitivity level adjustments must allow for different levels of vehicle detection. Sensitivity level settings to the magnetometer must be accomplished using WMVDS software via wireless communication.

The WMVDS must be able to perform presence or passage detection as described in this specification.

The WMVDS must be able to perform delay and extension timing as described in this specification.

Equipment failure such as: the sensor, communications link, access point radio, repeater radio (if used) or interface module, must result in constant vehicle call “fault state” on the affected detector channel to the traffic controller.

Detection accuracy must be comparable to properly operating inductive loops. Detection accuracy must include the WMVDS ability to detect the presence of any vehicle within the sensors magnetic field and to communicate contact closure to the appropriate detector channel. If the WMVDS “false detects,” (system applies contact closure when a vehicle is not present in the sensors magnetic field), this will count against the accuracy measured during performance testing. A minimum of 95% detection accuracy must be achieved by the WMVDS when measured in a 24 hr. period.

The WMVDS must provide real time vehicle detection (within 150 milliseconds (ms) of vehicle arrival). Once detection is achieved by the sensor, the traffic controller must receive contact closure to the assigned detector channel within the 150 ms time frame.

2. EQUIPMENT

2.1. **In-Pavement Sensors Hardware.** All materials must be able to operate at temperatures from -40°F to +176°F. In-pavement sensors and epoxy are included. In-pavement sensors must consist of a 3-axis

magnetometer, a microprocessor, a wireless transmitter, and a battery. In-pavement sensor components must be contained within a single housing.

In-pavement sensors must be installed per manufacturer recommended instructions.

In-pavement sensors must be capable of presence detection as defined in this specification. The in-pavement sensors as a minimum must create a 6 ft. length x 6 ft. width accurate area of detection when used for presence detection at an intersection.

In-pavement sensors must be capable of passage detection as defined in this specification. The in-pavement sensors as a minimum must create a 6 ft. length x 4 ft. width accurate area of detection when the sensors are set back from the intersection for passage detection on an arterial.

In-pavement sensors as a minimum must use a 3-axis magnetometer in the design and operation of the unit.

The sensor must monitor the earth's magnetic field throughout the course of the day and establish a baseline reference value for the X, Y, and Z axis. As a minimum the refresh rate on the magnetometer's processor will be 128 HZ, providing a sampling rate of 8ms to the earth's magnetic field. The sensor must be able to detect a change in the magnetic field as referenced to the sensitivity setting selected by the user.

The in-pavement sensor must operate on batteries without the need for underground power or communication cable connections to the unit.

The average operating life span of the sensor under battery power must be a minimum of 10 yr.

2.2. **Interface Module.**

The operating temperature range of the interface module, as a minimum must be -30°F to +165°F.

The interface module must be designed to operate in a NEMA TS-2 detector rack or 170/2070 cabinet input file. The interface module must be capable of operating on 12V or 24V DC (detector racks may be wired for 12V or 24V DC).

The interface module as a minimum must make available two channels on the module. Sensors must be assignable, via the WMVDS software, to the available detector channels on the module.

The front face of the rack mounted module must identify detector channel 1 and detector channel 2. Each must use an LED to indicate contact closure on the channel. When vehicle detection is achieved, the LED will be on and contact closure applied to the detector channel. During periods of no vehicle detection the LEDs will be in an off state and no contact closure will be applied to the detector channel.

Whenever the fault state is active, contact closure will be applied to the appropriate detector channel.

2.3. **Communication Requirements.**

Access points and repeaters must be rated for outdoor use and housed in an appropriate NEMA enclosure. The operating temperature range of these devices, as a minimum, must be from -30°F to +140°F.

As a minimum, access points must be capable of handling data communications for up to 75 sensors. The access points must be able to communicate to sensors from a distance of 700 ft.

All communications equipment will operate in an unlicensed frequency range permitted by the FCC.

The communications system must accommodate other wireless equipment sharing the frequency band and have a means to avoid interference. Acceptable means will include spread spectrum, frequency hopping, user-selectable frequency channels, and other substantial means.

All communications equipment must meet all applicable FCC standards as required for the frequency range used by the WMVDS.

Surge protection meeting GR 1089 standards must be used for devices receiving power over ethernet.

Access points must be able to operate from 120 VAC line power or power over Ethernet (48V DC) or under battery power. When operating from battery power, the use of a solar array to trickle charge batteries is optional.

Access point home run cable of up to 1000 ft. long must be supported. It must have tough UV-resistant, waterproof polyethylene jacket, a gel-filled core, insulated conductors, and meet TIA/EIA-A CAT5e requirements.

2.4. **Software.**

Provide GUI software that will allow the monitoring, setup, and programming of all detector unit functions features, and timing entries.

Firmware for In-pavement sensors and access points must be upgradable via a wireless connection to the device.

The software must allow for sensitivity adjustments to the sensor detection algorithms used by the WMVDS. As a minimum the system will use 12 different sensitivity levels to adjust for site conditions and class of vehicle. The sensitivity adjustments must be selectable by the user. When a change to the magnetic field is equal to or greater than the selected sensitivity setting, a detect signal will be transmitted to the controller by a contact closure or other standard interface method.

The software must allow the user to program delay time as defined in this specification. As a minimum, the software must allow for a range 0 to 25 seconds of delay time.

The software must allow the user to program extension time as defined in this specification. As a minimum, software must allow for a range 0 to 5 seconds of extension time.

The software will allow the user to assign selected sensors to specific radios or detector channels. In-pavement sensors must be assignable to radios or detector channels via system software.

2.5. **Installation and Training.**

When required by plans or purchasing agency, the supplier or manufacturer of the WMVDS will supervise and assist in the installation and set-up of the equipment. A factory certified representative from the manufacturer will be on-site during installation of the WMVDS.

Instruction personnel are required to be certified by the equipment manufacturer. The User's Guide is not an adequate substitute for practical, classroom training and formal certification by an approved agency.

Formal levels of factory authorized training are required for installers, contractors and system operators. All training must be certified by the manufacturer.

2.6. **Warranty, Maintenance and Support.**

The WMVDS must be warranted to be free of defects in material and workmanship for a period of 5 yr. from date of shipment from the supplier’s facility. During the warranty period, the supplier will repair with new or

refurbished materials, or replace at no charge, any product containing a warranty defect provided the product is returned FOB to the supplier's factory or authorized repair site.

This warranty does not apply to products damaged by accident, improper operation, improper installation, abused, serviced by unauthorized personnel or unauthorized modification. During the warranty period, technical support must be available from the supplier via telephone within 8 hr. of the time a call is made by a user, and this support must be available from factory certified personnel or factory certified installers.

Ongoing software support by the supplier must include updates of the WMVDS processor unit and software. These updates must be provided free of charge during the warranty period. The update of the WMVDS software must be tested and approved by TxDOT before installation.

The supplier must maintain a program for technical support and software updates following expiration of the warranty period. This program must be made available to TxDOT or agency responsible for maintenance in the form of a separate agreement for continuing support.

The supplier must maintain an adequate inventory of parts to support maintenance and repair of the WMVDS.

3. WORK METHODS

Install the in-pavement sensors in concrete or asphalt pavement as shown on the plans. No in-pavement sensors will be installed before or during road paving.

Install the in-pavement sensors per manufacturer instructions. Place core to avoid 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.

Correctly orientate in-pavement sensors as clearly marked on the sensor.

Mount hardware with provided hardware as shown on the plans. Orient equipment with manufacture recommended line of sight distances between components to maintain proper communications.

4. MEASUREMENT

The WMVDS will be measured as each for all equipment installed, made fully operational, and tested per intersection in accordance with this special specification or as directed.

This is a plans quantity measurement Item. The quantity to be paid is the quantity shown in the proposal unless modified by Article 9.2, "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for a "WMVDS System" with the equipment as specified on the plans and quantities per intersection.

These prices are full compensation for all materials and furnishing all labor, tools, cabling, connectors, equipment and incidentals necessary to complete the work. These prices include all associated mounting hardware and associated field equipment required for a complete and fully functional wireless battery powered magnetometer detection system.