SPECIAL SPECIFICATION

6314

Radar Vehicle Sensing Device (RVSD)

1. **Description.** Furnish and install overhead/side-fired microwave vehicle true presence detection system as shown in the plans, as detailed in the special specifications and as directed by the Engineer. Provide all equipment required to interface with an existing/proposed infrastructure as subsidiary.

   Ensure after the setup, there is no external tuning controls of any kind, which will require an operator.

   Furnish all new equipment and component parts of the latest proven design and manufacture, and in an operable condition at the time of delivery and installation. Provide all parts that are of high quality workmanship.

   Provide design to prevent reversed assembly or improper installation of connectors, fasteners, etc. Design each item of equipment to protect personnel from exposure to high voltage during equipment operation, adjustments, and maintenance.

   Include licenses for all equipment, where required, for any software or hardware in the system.

   Provide all RVSD from the same manufacturer.

   Provide flash upgradeable RVSD firmware.

2. **Functional Requirements.** Ensure the RVSD is easy to install and shall automatically configure up to 8 lanes of traffic by automatically determining lane boundaries, and detection thresholds. Ensure the RVSD utilizes ranging radar that incorporates Frequency Modulated Continuous Wave (FMCW) to accurately detect vehicle volume, speed and occupancy in all weather conditions without performance degradation, and the device operates accurately in both side-fire and forward-fire installations. Ensure the RVSD is remote accessible; provide multiple connectivity options for easy integration into legacy systems, and support the communications protocols identified in Section 2.F “Communication”. Ensure the RVSD is manufactured to the strictest industry standards to ensure product quality and minimize the risk of failure due to error. The manufacturer shall thoroughly train installers and operators to ensure accurate RVSD performance.

   Provide the RVSD that requires less than 10 of the largest vehicles expected on the roadway shall be allowed to pass the RVSD and tunes out stationary detections, such as traffic barriers and retaining walls, prior to completing the configuration.
Provide documentation that demonstrates the auto-configuration process.

Provide the RVSD that does not interfere with any known equipment.

Ensure no component be of such design, fabrication, nomenclature, or other identification as to preclude the purchase of said component from any wholesale electronic distributor.

A. **Sensor Performance.** Ensure the RVSD provides accurate, real-time volume, average speed and occupancy data. Ensure the detections are correctly categorized into 3 user definable length-based classifications. Ensure true vehicle detections occur at a range of 9 ft. to 200 ft. from the RVSD. Ensure the RVSD unit or accompanying field equipment provides a minimum of 650 detection records with a user configurable detection interval ranging from 20 second to 15 minutes in local storage to reduce data loss during communications outages. Ensure the RVSD transfers locally stored data to the Traffic Data Collection Subsystem (TDCS) when communication is restored.

Ensure the RVSD provides 2 modes of operation: side-fire and forward fire. When operating in side-fire mode, a single RVSD shall detect traffic in up to 8 lanes of traffic simultaneously; in forward-fire mode, the RVSD shall provide data for a single lane.

Ensure the RVSD maintains accurate performance in all weather conditions, including rain, freezing rain, snow, wind, dust, fog and changes in temperature and light. Provide the device that is capable of continuous operation over an ambient temperature range from -37°C to 74°C, and a relative humidity range from 5% to 95% (non-condensing). Ensure RVSD operation continues in rain or snow up to 10 cm per hour, and the device shall not experience degraded performance when encased in 1/2 in. of ice up to a range of 200 ft.

Ensure Side-fire Volume data is accurate within 5% of truth for any direction of travel in nominal conditions. Individual lane accuracy is within 10% of truth during nominal conditions. Nominal conditions exist when traffic is flowing at speeds greater than 10 miles per hour, with less than 10% truck traffic per lane and at least 30% of each vehicle visible above roadway barriers for true sensor detection.

Ensure forward-fire Volume data is accurate within 5% of truth.

Verify volume accuracy by comparing recorded video to the RVSD detections. Record the number of missed vehicles and false detections. Calculate errors by dividing the difference between missed and false detections by the total number of vehicles. To ensure low variability in performance, missed and false detections shall not exceed 15%. Provide such performance analysis for the following environments:

- Free flowing traffic (speeds greater than 45 mph)
- Congested traffic (speeds from 15 to 40 mph)
- Traffic in a lane roughly 10 ft. beyond a concrete barrier
- 20 ft. and 200 ft. lateral offset- simultaneous performance
Ensure side-fire Average Speed data is accurate within 5 mph for any direction of traffic for all conditions involving more than 16 cars in an interval. Ensure speed accuracy for individual lanes is within 10 mph of truth for all traffic conditions and similar intervals.

Ensure forward-fire Speed data is accurate for individual vehicle measurements. Ensure 50% of all measurements are within one mph of truth, and 85% is within 5 mph.

Verify speed accuracy with radar gun, or by video speed trap using the frame rate as a time reference.

Ensure occupancy data is accurate within 10% of truth for any direction of travel when occupancy is less than 30%. For example, if the true occupancy in a lane is 20%, the measured occupancy shall be between 14 and 26%. Ensure lane occupancy is accurate within 20% in similar conditions. Provide test data verifying this performance.

Ensure classification data is accurately determined for 90% of detected vehicles. Separate vehicles into three user-definable classifications. Provide test data verifying this performance.

Provide test data demonstrating or proving performance.

**B. Performance Maintenance.** Provide RVSD that does not require cleaning or adjustment to maintain performance. Ensure it does not rely on battery backup to store configuration information. Ensure the RVSD, once calibrated, does not need recalibration to maintain performance unless the roadway configuration changes. Provide remote connectivity to the RVSD to allow operators to change the unit’s configuration, update the unit’s firmware programming and recalibrate the unit automatically from a centralized maintenance facility.

**C. Mounting and Installation.** Install the RVSD according to the following conditions to achieve the specified accuracy and reliability:

Ensure that RVSD units installed do not interfere with or alter the performance of other RVSD units installed. Document the method used to avoid such interference and provide test data to verify proper operation.

Mount the RVSD with its cable connector pointing towards the ground and tilted so that the RVSD is aimed at the center of the lanes to be monitored. Typically, tilt off the RVSD of vertical by 10 to 20 degrees. Align the RVSD so that the side-to-side angle is within approximately ±2° of perpendicular to the flow of traffic.

Verify, with manufacturer assistance, the final RVSD placement if the RVSD is to be mounted near large planar surfaces (sound barrier, building, parked vehicles, etc.) that run parallel to the monitored roadway.
Include, at a minimum, radar detector unit, enclosures, connectors, cables, junction box, mounting equipment and hardware, controller interface boards and assemblies, local and remote software, firmware, power supply units and all other support, calibration, and test equipment for the RVSD system.

Furnish the RVSD with bracket or band designed to mount directly to a pole or overhead mast-arm or other structure. Ensure the mounting assembly has all painted steel, stainless steel, or aluminum construction, and supports a load of 20 lb. Incorporate for the mounting assembly a ball-joint, or other approved mechanism that can be tilted in both axis, then locked into place, to provide the optimum area of coverage.

Proper placement, mounting height and orientation of the RVSD systems are critical to the overall performance and accuracy of the systems and shall conform to the manufacturer's published requirements for the system provided. Install the RVSD units as shown on the plans. Analyze each proposed pole location to assure that the RVSD installation will comply with the manufacturer’s published installation instructions. Advise the Engineer, before any trenching or pole installation has taken place, of any need to move the pole from the location indicated in the plans in order to achieve the specified detector performance. Confirm equipment placement with the manufacturer before installing any equipment.

Ensure alignment, configuration and any calibration of the RVSD take less than 15 minutes per lane once mounting hardware and other installation hardware are in place. Install RVSD units such that each unit operates independently and that detectors do not interfere with other RVSD units or other equipment in the vicinity.

D. **Forward-fire Mounting.** Mount the RVSD between 15 and 30 ft. above the road surface of the detection lane. If mounted directly over a lane, adjust the RVSD so that the connector is pointing towards the road surface and the RVSD is tilted at an angle off of vertical between 25° and 45°. Aim the RVSD parallel to the roadway to within ±2°.

For a forward-fire installation mounted to the side of the detection zone, consult the manufacturer for proper installation guidelines.

Ensure that RVSD units installed do not interfere with or alter the performance of other RVSD units installed. Document the method used to avoid such interference and provide test data to verify proper operation.

E. **Cabling.** Supply the RVSD with a connector cable of the appropriate length for each installation site.

Ensure the connector meets the MIL-C-26482 specification. Provide an environmentally sealed shell backshell that offers excellent immersion capability, and is designed to interface with the appropriate MIL-C-26482 connector. Encase all conductors that interface with the connector in a single jacket and ensure the outer diameter of this jacket is within the backshell’s cable O.D. range to ensure proper
sealing. Ensure the backshell has a clampbar style strain relief with enough strength to support the cable slack under extreme weather conditions. Provide the MIL-C-26482 connector that provide contacts for all data and power connection.

If communication is conducted over the RS-485 bus, the communication cable is Belden 9331 or an equivalent cable with the following specifications:

- Shielded, twisted pairs with a drain wire
- Nominal Capacitance Conductor to Conductor @ 1Khz <= 26pF/Ft
- Nominal Conductor DC Resistance @ 20°C <= 15 ohms/1000Ft
- Single continuous run with no splices allowed
- Terminated only on the two farthest ends of the cable.

If communication is conducted over the RS-232 bus, the communication cable is Belden 9331 or an equivalent cable with the following specifications:

- Shielded, twisted pairs with a drain wire
- Nominal Capacitance Conductor to Conductor @ 1Khz <= 26pF/Ft
- Nominal Conductor DC Resistance @ 20°C <= 15 ohms/1000Ft
- Single continuous run with no splices allowed
- The RS-232 Driver must be able to source and sink ±7mA or more

F. Communication. Ensure the RVSD shall provide communication options that include RS-232, RS-485 or TCP/IP. Ensure the RVSD must also have the ability to support a variety of baud rates from 9600 to 115200.

Ensure the RVSD provides RS-232, RS-485 and an internal serial communication port. Each communication port must support all of the following baud rates: 9600, 19200, 38400, 57600 and 115200. Additionally, the RS-232 port must be full-duplex and must support true RTS/CTS hardware handshaking for interfacing to various communication devices.

1. Data Packets. The RVSD shall produce data packets containing, as a minimum,
G. **Windows®-based Software.** Provide the RVSD to also include graphical user interface software that displays all configured lanes and provides visual representation of all detected vehicles. The graphical interface shall operate on Windows 98, Windows 2000, Windows NT 4.0 and Windows XP Pro. The software shall automatically select the correct baud rate and serial communication port from up to 15 serial communication ports. The software shall also operate over a TCP/IP connection and support a dial-up modem connection.

The software shall also give the operator complete control over the configuration process.

The operator shall have the ability to save the configuration information to a file or reload the RVSD configuration from a file using the graphical user interface software.

Using the installation software the operator shall be able to easily change the baud rate on the sensor by selecting baud rates from a drop-down list, as well as add response delays for the communication ports. Additionally, the operator shall have the ability to switch between data pushing and data polling, and change the RVSD’s settings for Flow Control from none to RTS/CTS and vice versa.

The operator shall be able to upload new firmware into non-volatile memory of the RVSD over any supported communication channel including TCP/IP networks.

H. **Software.** Provide any and all programming and software required to support the RVSD system. Install the programming and software in the appropriate equipment at the time of acceptance testing. Complete and pass acceptance testing using a stable release of the programming and software provided.

Provide software update(s) free of charge during the warranty period.

I. **Manufacturing Requirements.** Ensure the assembly of the units adheres to industrial electronic assembly practices for handling and placement of components.

The RVSD shall undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Include the following testings:

- Functionality testing of all internal subassemblies
- Unit level burn-in testing of duration 24 hours or greater
- Final unit functionality testing prior to shipment

Provide test results and all associated data for the above testing, for each purchased RVSD by serial number. Additionally, maintain and make available manufacturing quality data for each purchased RVSD by serial number.

Externally, the RVSD shall be modular in design to facilitate easy replacement in the field. Ensure the total weight of the RVSD does not exceed 5 lbs.
Provide all external parts made of corrosion resistant material, and protect all materials from fungus growth and moisture deterioration.

J. **FCC.** Ensure the RVSD has Federal Communications Commission (FCC) certification. Display the FCC-ID number on an external label. Ensure each RVSD is Federal Communications Commission (FCC) certified under CFR 47, Part 15, section 15.245 as a field disturbance sensor. Display this certification on an external label on each device according to the rules set out by the FCC.

Provide the RVSD system that is FCC certified under Part 15, Subpart C, Section 15.250 for low-power, unlicensed, continuous radio transmitter operation. Assure that the RVSD system will not cause harmful interference to radio communication in the area of installation. If the operation of the RVSD system causes harmful interference, correct the interference at the Contractor’s expense.

Provide the RVSD that transmits in the 10.50 – 10.55 GHz or 24.00 – 24.25 GHZ frequency band and meets the power transmission requirements specified under sections 15.245 and 15.249 of CFR 47.

Provide documentation proving compliance to all FCC specifications.

K. **Support.** Ensure installers and operators of the RVSD are fully trained in the installation, auto-configuration and use of the device.

The manufacturer shall thoroughly train installers and operators to correctly perform the tasks required to ensure accurate RVSD performance. The amount of training necessary for each project shall be determined by the manufacturer and shall be included, along with training costs, in the manufacturer’s quote. In addition, provide technical support to provide ongoing operator assistance.

L. **Power Requirements.** Provide the RVSD that operates either at 12 VDC to 28 VDC or at 12 VAC to 24 VAC from a separate power supply to be provided as part of the bid item and ensure it does not draw more than 10 watts of power each.

Provide the separate power supply or transformer that operates from 115 VAC ±10%, 60 Hz ±3 Hz.

Provide equipment operations that are not affected by the transient voltages, surges and sags normally experienced on commercial power lines. Check the local power service to determine if any special design is needed for the equipment. The extra cost, if required, must be included in the bid of this item.

Provide equipment that is designed such that the failures of the equipment must not cause the failure of any other unit of equipment. Ensure automatic recovery from power failure shall be within 15 seconds after resumption of power.

M. **Wiring.** Provide wiring that meets the requirements of the National Electric Code.

Provide wires that are cut to proper length before assembly. Provide cable slacks to facilitate removal and replacement of assemblies, panels, and modules. Do not
doubled-back wire to take up slack. Lace wires neatly into cable with nylon lacing or plastic straps. Secure cables with clamps. Provide service loops at connections.

N. **Transient Suppression.** Provide DC relays, solenoids and holding coils that have diodes or other protective devices across the coils for transient suppression.

O. **Power Service Protection.** Provide equipment that contains readily accessible, manually resettable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection.

Provide and size circuit breakers or fuses such that no wire, component, connector, PC board or assembly must be subjected to sustained current in excess of their respective design limits upon the failure of any single circuit element or wiring.

P. **Fail Safe Provision.** Provide equipment that is designed such that the failures of the equipment must not cause the failure of any other unit of equipment. Ensure automatic recovery from power failure shall be within 15 sec. after resumption of power.

Q. **Mechanical Requirements.** Enclose the RVSD in a Lexan polycarbonate, ultraviolet resistant material and the unit is classified as watertight according to the NEMA 250 Standard.

Ensure the enclosure is classified "f1" outdoor weatherability in accordance with UL 746C.

Provide the RVSD that will withstand a drop of up to 5 ft. without compromising its functional and structural integrity.

Do not use silicone gels or any other material, for enclosure sealing, that will deteriorate under prolonged exposed to ultraviolet rays. Ensure the overall dimensions of the box, including fittings, do not exceed 13 in. x 9 in. x 6 in. Ensure the total weight of the RSVD assembly does not exceed 5 lb.

Coat printed circuit boards with a clear-coat moisture and fungus resistant material (conformal coating).

Ensure external connection for telecommunications and power be made by means of a single military style multi-pin connector, keyed to preclude improper connection.

1. **Modular Design.** Provide equipment that is modular in design to allow major portions to be readily replaced in the field. Ensure modules of unlike functions are mechanically keyed to prevent insertion into the wrong socket or connector.

   Identify modules and assemblies clearly with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

2. **Connectors and Harnesses.** Provide external connections made by means of connectors. Provide connectors that are keyed to preclude improper hookups. Color code and/or appropriately mark wires to and from the connectors.
Provide connecting harnesses of appropriate length and terminated with matching connectors for interconnection with the communications system equipment.

Provide pins and mating connectors that are plated to improve conductivity and resist corrosion. Cover connectors utilizing solder type connections by a piece of heat shrink tubing securely shrunk to insure that it protects the connection.

3. **Environmental Requirements.** Provide detector capable of continuous operation over a temperature range of –34.6°F (-37°C) to +165.2°F (+74°C) and a humidity range of 5% to 95% (non-condensing).

3. **Construction.**

   A. **General.** Provide equipment that utilizes the latest available techniques for design and construction with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

   Design the equipment for ease of maintenance. Provide component parts that are readily accessible for inspection and maintenance. Provide test points that are for checking essential voltages and waveforms.

   B. **Electronic Components.** Provide electronic components in accordance with Special Specification, "Electronic Components".

   C. **Mechanical Components.** Provide external screws, nuts and locking washers that are stainless steel; no self-tapping screws will be used. Provide parts made of corrosion resistant material, such as plastic, stainless steel, anodized aluminum or brass. Protect materials from fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.

   D. **Documentation Requirements.** Provide documentation in accordance with Article 4, Special Specification, “Testing, Training, Documentation, Final Acceptance, and Warranty”.

   E. **Testing.** Perform testing in accordance with Article 2, Special Specification, “Testing, Training, Documentation, Final Acceptance, and Warranty.” Test all RSVD to ensure compliance to all FCC and Department specifications.

   Supply a medical statement as to the safety of the unit to the general public (example: Pacemakers, etc.).

   Additional testing requirement is as follows:

1. **NEMA 4X Testing.** The RVSD enclosure shall conform to test criteria set forth in the NEMA 250 Standard for Type 4X enclosures. Provide third party enclosure test results for each of the following specific Type 4X criteria:

   - External Icing (NEMA 250 Clause 5.6)
   - Hose-down (NEMA 250 Clause 5.7)
   - 4X Corrosion Protection (NEMA 250 Clause 5.10)
• Gasket (NEMA 250 Clause 5.14)

2. **NEMA TS2-1998 Testing.** The RVSD shall comply with the applicable standards stated in the NEMA TS2-1998 Standard. Make available third party test results for each of the following specific tests:

   • Shock pulses of 10g, 11 ms half sine wave
   • Vibration of .5 Grms up to 30 Hz
   • 300 V positive/negative pulses applied at 1 pulse per second at minimum and maximum DC supply voltage
   • Cold temperature storage at -45°C for 24 hours
   • High temperature storage at +85°C for 24 hours
   • Low temp, low DC supply voltage at -34°C and 10.8 VDC
   • Low temp, high DC supply voltage at -34°C and 26.5 VDC
   • High temp, high DC supply voltage at 74°C and 26.5 VDC
   • High temp, low DC supply voltage at 74°C and 10.8 VDC

F. **Experience Requirements.** The Contractor or designated subcontractors involved in the installation and testing of the RVSD shall, as a minimum, meet the following requirements:

   Three years experience in the installation of RVSD system.

   Two installed RVSDs where systems have been in continuously satisfactory operation for at least 1 year. Submit as proof, photographs or other supporting documents, and the names, addresses and telephone numbers of the operating personnel who can be contacted regarding the system.

   Provide necessary documentation of subcontractor qualifications pursuant to contract award.

G. **Technical Assistance.** Ensure that a manufacturer's technical representative is available on site to assist the Contractor's technical personnel at each installation site and with RVSD equipment installation and communication system configuration.

   Do not execute the initial powering up of the RVSD without the permission of the manufacturer's representative.

H. **Training.** Provide training in accordance with Article 3, Special Specification, “Testing, Training, Documentation, Final Acceptance and Warranty.”

I. **Warranty.** Provide a warranty in accordance with Article 6, Special Specification, “Testing, Training, Documentation, Final Acceptance and Warranty.”

4. **Measurement.** This Item will be measured as each unit complete in place.

5. **Payment.** The work performed and material furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Radar Vehicle Sensing Device”. These prices shall include all equipment described under this
Item with all cables and connectors, mounting assemblies, all documentation and testing; and shall include the cost of furnishing all labor, materials, training, warranty, equipment, and incidentals.