SPECIAL SPECIFICATION

8821

Radar Vehicle Sensing Device (RVSD)

1. **Description.** Furnish and install overhead radar vehicle sensing device (RVSD) system as shown in the plans, as detailed in the special specifications and as directed.

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

2. **Materials.** Ensure the RVSD will automatically configure the maximum number of lanes shown on the plans by determining lane boundaries, concrete or metal barriers and detection thresholds. Ensure sensor will automatically configure the number of lanes in the presence of barriers, medians and work zones. Ensure sensor will automatically calibrate vehicle speed, detection levels, and sensitivity. Ensure the RVSD detects vehicle volume, speed and occupancy in all weather conditions without performance degradation. Ensure the RVSD is remote accessible; provides multiple connectivity options for integration into the existing system, and supports the communications protocols identified in Section 2.D “Communication”.

   Provide the RVSD that automatically tunes out stationary objects, such as traffic barriers and retaining walls, prior to completing the configuration. Provide documentation on the auto-configuration and auto-calibration processes.

   Provide an RVSD that does not cause interference or alter the performance of any known equipment.

   Furnish all new equipment and component parts in an operable condition at the time of delivery and installation.

   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 RVSD system.

   Provide all RVSD from the same manufacturer.

   Provide RVSD firmware that is upgradeable by external local or remote download.
A. **Sensor Performance.** Ensure the RVSD provides accurate, real-time volume, average speed and occupancy data. Ensure the RVSD provides user configurable settings for a collection interval from 20 sec. to 15 min. and polling intervals from 20 sec. to 1 hr. Ensure the detections are correctly categorized into a minimum of 3 user definable length-based classifications. Ensure 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 3 hours of local storage for detection interval settings of 20 seconds to 15 minutes in local storage to reduce data loss during communications outages. Ensure the RVSD transfers locally stored data to the Traffic Management Center’s Transportation Sensor System (TSS) when communication is restored.

Transportation Sensor System (TSS) Protocol Document (TSS-Protocol) is available through the “TSS Tools” link on the Department’s website, URL:

http://www.dot.state.tx.us/services/information_systems/engineering_software.htm

Ensure the RVSD operates in side-fire mode. When operating in side-fire mode, a single RVSD must simultaneously detect traffic in the maximum number of lanes as shown on the plans.

Ensure the RVSD maintains accurate performance in all weather conditions, including rain, freezing rain, snow, wind, dust, fog and changes in temperature and light. Ensure RVSD operation continues in rain or snow up to 4 in. per hour, and the device will not experience degraded performance when encased in 1/2 in. of ice.

Ensure volume data is accurate within 5% of actual for any direction of travel in nominal conditions. Ensure individual lane accuracy is within 10% of actual 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 average speed data is accurate within 5 MPH for any direction of traffic for all conditions involving more than 16 vehicles in an averaging interval. Ensure speed accuracy for individual lanes is within 10 MPH of actual for all traffic conditions and similar intervals. Provide true speed detection without the requirement to enter average vehicle lengths for the speed calculation.

Ensure speed data is accurate for individual vehicle measurements. Ensure 50% of all measurements are within one MPH of actual, and 85% is within 5 MPH.
Ensure occupancy data is accurate within 20% of the actual occupancy for any lane when occupancy is less than 30%. For example, if the actual occupancy in a lane is 20%, the measured occupancy must be between 16% and 24%.

Ensure classification data is accurately determined for 90% of detected vehicles.

Provide test data, using methods required in Section 3.F., 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 over entire operational temperature range 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 facility.

C. 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 connectors that provide contacts for all data and power connection.

If communication is conducted over the RS-485 or RS-232 bus, the communication cable must be 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 @ 68°F <= 15 ohms/1000Ft
- Single continuous run with no splices allowed
- Terminated only on the two farthest ends of the cable

D. Communication. Ensure that the RVSD provides communication options that include RS-232, RS-485 or TCP/IP. Provide a RVSD which has the ability to support a variety of baud rates from 9600 to 115200.

Ensure the RVSD provides built in 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.
**Data Packets.** The RVSD must produce data packets containing, as a minimum:

- One or more detection zones
- Collection interval durations
- Sensor ID
- 32-bit time stamps indicating end of collection interval
- Total volume by detection zone
- Average speed in each detection zone during the collection interval. Speed value units must be selectable as either miles per hour or kilometers per hour
- Occupancy in each detection zone during the collection interval, reported in 0.1% increments
- A minimum of 3 vehicle classifications reported as number of vehicles of each classification identified in each detection zone during the collection interval

**E. Operating System 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 must operate on current Department core operating system software. The software must automatically select the correct baud rate and serial communication port from up to 15 serial communication ports. The software must also operate over a TCP/IP connection and support a dial-up modem connection.

When required to interface with Traffic Management Center software, the RVSD system software must meet Transportation Sensor Subsystem Protocol requirements as documented in latest version available on the Department’s website.

The software must give the operator complete control over the configuration process.

The operator must 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 must be able to:

- change the baud rate on the sensor by selecting baud rates from a drop-down list
- add response delays for the communication ports to allow for communication stabilization.
- 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 must be able to upload new firmware into non-volatile memory of the RVSD over any supported communication channel including TCP/IP networks.
F. **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.

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

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

- Functionality testing of all internal subassemblies
- Unit level burn-in testing of 24 hours duration 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 data for each purchased RVSD by serial number.

Externally, the RVSD must be modular in design to facilitate easy replacement in the field. Ensure the total weight of the RVSD does not exceed 5 lbs.

Ensure all external parts are protected against corrosion, fungus growth and moisture deterioration.

H. **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 or 15.249 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 15.245 or 15.249 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 and frequency requirements specified under sections 15.245 and 15.249 of CFR 47 across the operating temperature of the device and over time as the sensor ages.

Provide documentation proving compliance to all FCC specifications.
I. **Support.** Ensure installers and operators of the RVSD are fully trained in the installation, auto-configuration and use of the device.

The manufacturer must train installers and operators to correctly perform the tasks required to ensure accurate RVSD performance. The amount of training necessary for each project will be determined by the manufacturer (not less than 4 hours) and must be included, along with training costs, in the manufacturer’s quote. In addition, provide technical support to provide ongoing operator assistance.

J. **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.

K. **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 double-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.

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

M. **Power Service Protection.** Provide equipment that contains readily accessible, manually re-settable 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.

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

O. **Mechanical Requirements.** Enclose the RVSD in a Lexan polycarbonate, ultraviolet resistant material. The unit must be classified as watertight according to the NEMA 250 Standard.

Provide the RVSD that will withstand a drop of up to 3 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 exposure to ultraviolet rays. Ensure the overall dimensions of the box, including fittings, do not exceed 13 in. x 9 in. x 9 in. Ensure the overall weight of the box, including fittings, does not exceed 15 lbs.

Coat all 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 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 RVSD capable of continuous operation over a temperature range of –35°F to +165°F and a humidity range of 5% to 95% (non-condensing).

3. **Construction.**
   
   A. **General.** Provide equipment designed and constructed 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. **Mounting and Installation.** Install the RVSD according to manufacturer’s recommendations to achieve the specified accuracy and reliability.

   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 stainless steel, or aluminum construction, and supports the load of the RVSD. Incorporate for the mounting assembly a mechanism that can be tilted in both axes, then locked into place, to provide the optimum area of coverage. Ensure the mounting bracket is designed and installed to prevent sensor re-positioning during 80 mph wind conditions.

Proper placement, mounting height and orientation of the RVSD systems must 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 takes 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.

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

D. Mechanical Components. Provide external screws, nuts and locking washers that are stainless steel. 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.


Provide documentation ensuring emissions from the RVSD equipment are not harmful to the public.

Provide additional test reports, for each of the following requirements:

1. NEMA 4X Testing. The RVSD enclosure must 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 must comply with the applicable standards stated in the NEMA TS2-1998 Standard. Provide 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 -49°F for 24 hours
- High temperature storage at +185°F for 24 hours
- Low temp, low DC supply voltage at -30°F and 10.8 VDC
- Low temp, high DC supply voltage at -30°F and 26.5 VDC
- High temp, high DC supply voltage at 165°F and 26.5 VDC
- High temp, low DC supply voltage at 165°F and 10.8 VDC

F. **Testing.** Perform testing in accordance with Article 2, Special Specification, “Testing, Training, Documentation, Final Acceptance, and Warranty.” Test all RVSD to ensure that they comply with all FCC and Department specifications.

Ensure the RVSD meets functional performance requirements of Section 2.A (Sensor Performance) by the following methods:

Verify volume accuracy by performing a manual count on each lane of detection. When compared to the manual counts, the sensor counts must meet performance requirements as stated in Section 2.A.

Verify speed accuracy with laser speed gun provided by TxDOT, radar gun provided by contractor, or by video speed trap using the frame rate as a time reference. Vehicle speeds should be collected and averaged over a minimum of 10 vehicles. When compared to the average speeds collected via laser, the sensor speed data must meet performance requirements as stated in Section 2.A.

G. **Experience Requirements.** The contractor or subcontractor involved in the installation and testing of the RVSD must, as a minimum, meet the following experience requirements:

Two years continuous existence offering services in the installation of RVSD systems.
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 of the business or agency owning the system who can be contacted by the Department regarding the system.

Provide necessary documentation of contractor or subcontractor qualifications pursuant to contract award.

H. 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.


J. 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.” This price is full compensation for furnishing all equipment described under this Item with all cables, connectors, mounting assemblies, interface devices; all documentation and testing; all labor, materials, tools training, warranty, equipment, and incidentals.