

**BID FORM**

MISSOURI DEPARTMENT OF TRANSPORTATION

GENERAL SERVICES

830 MoDOT DRIVE – P.O. BOX 270

JEFFERSON CITY, MO 65102

REQUEST NO.	1-071003
DATE	September 20, 2007
PAGE NO.	1 NO. OF PAGES 17

SEALED BIDS, SUBJECT TO THE ATTACHED CONDITIONS WILL BE RECEIVED AT THIS OFFICE UNTIL

**2:00 PM, LOCAL TIME, OCTOBER 03, 2007**

AND THEN PUBLICLY OPENED AND READ FOR FURNISHING THE FOLLOWING SUPPLIES OR SERVICES.

**QUOTATIONS TO BE BASED F.O.B. MISSOURI DEPARTMENT OF TRANSPORTATION**  
Submit net bid as cash discount stipulations will not be considered

Jefferson City, MO

DEFINITE DELIVERY DATE MUST BE SHOWN. SIGN AND RETURN BEFORE TIME SET FOR OPENING. **ALL BIDS SHOULD BE EXTENDED AND TOTALED.**

**BUYER:** Amy Bailey

**BUYER TELEPHONE:** 573-522-6188

ITEM NO.	SUPPLIES OR SERVICES	MFG. NO. OR BRAND	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	<p><b>CONTRACT FOR FURNISHING “RADAR VEHICLE SENSING DEVICES” FROM DATE OF AWARD THROUGH MARCH 31, 2008, WITH AN OPTION OF ONE (1) SIX (6) MONTH RENEWAL</b></p> <p>Please see attached specifications, pricing pages and delivery requirements.</p> <p><b>Note to Respondent:</b> A vendor must be in compliance with the laws regarding conducting business in the State of Missouri. The compliance to conduct business in the state shall include but may not be limited to: Registration of business name, vendors MUST submit a bid/proposal that correctly and accurately identifies the company name that is registered to do business in the State of Missouri. All vendors who are required to execute a contractual agreement MUST submit a copy of their certificate with the signed copy of the contract agreement before the purchasing department can proceed with MoDOT legal contract approval.</p>					

(SEE ATTACHED FOR CONDITIONS AND INSTRUCTIONS)

*In compliance with the above invitation for bids, and subject to all conditions thereof, the undersigned bidder agrees to furnish and deliver any or all the items on which prices were quoted within (SEE PRICING PAGES) days after receipt of formal purchase order.*

**Date:** \_\_\_\_\_

**Telephone No.:** \_\_\_\_\_

**Fax No.:** \_\_\_\_\_

**Federal I.D. No.** \_\_\_\_\_

**Firm Name:** \_\_\_\_\_

**Address:** \_\_\_\_\_

**By (Signature):** \_\_\_\_\_

**Type/Print Name** \_\_\_\_\_

**Title:** \_\_\_\_\_

Is your firm MBE certified?  Yes  No

Is your firm WBE certified?  Yes  No

List all agencies your firm is currently certified with. \_\_\_\_\_

**PRICING PAGES**  
Pricing Pages – 1 page with a total of 1 item

<b>CATEGORY 1 – RADAR VEHICLE SENSING DEVICES</b>					
<b>Item #:</b>	<b>Description:</b>	<b>Mfg. No. or Brand</b>	<b>Qty:</b>	<b>Unit Price:</b>	<b>Extended Total:</b>
#1	RADAR VEHICLE SENSING DEVICES		10		
<b>TOTAL:</b>					<b>\$</b>

**THE QUANTITIES SHOWN ARE ESTIMATED REQUIREMENTS FOR THE PERIOD SPECIFIED  
NO QUANTITIES WILL BE GUARANTEED**

**ALL ORDERS WILL BE PLACED ON AN “AS NEEDED” BASIS**

**NOTE:** **Renewal Periods - If the option for renewal is exercised by the Missouri Department of Transportation, the contractor shall agree that the prices for the renewal period shall not exceed the maximum price for the applicable renewal period stated herein.**

- a. If renewal prices are not provided, the prices during renewal periods shall be the same as during the original contract period.**
- b. Missouri Department of Transportation does not automatically exercise its option for renewal based upon the maximum price and reserves the right to offer or to request renewal of the contract at a price less than the maximum price stated.**
- c. In the event the Missouri Department of Transportation exercises its option(s) to renew the contract, the requirements for future years shall be basically similar.**
- d. Bidders must provide a maximum percentage cost increase for the specified period.**

1<sup>st</sup> Renewal Period  
Maximum Percentage  
(April 1, 2008 – September 30, 2008)

\$ \_\_\_\_\_  
**Maximum percentage per unit**

## 1.0 General

This item shall govern the purchase and installation of aboveground Radar Vehicle Sensing Devices (RVSD). Test results and other documentation demonstrating RVSD performance and capabilities shall be provided.

The RVSD shall:

<b>Requirement</b>	<b>Section</b>
Auto-configure and auto-calibrate up to ten lanes of traffic	<b>3.0</b>
Provide volume ( $\pm 5\%$ ), individual vehicle speed ( $\pm 4$ mph), eighty-fifth percentile speed ( $\pm 3$ mph), occupancy ( $\pm 10\%$ ), and classification data under nominal traffic conditions and in all weather conditions over a range of 9 ft. to 250 ft. from the RVSD; and perform accurately without requiring cleaning or maintenance	<b>4.0</b>
Have a range resolution of four ft. or less and therefore use a bandwidth of 240 MHz or more	<b>5.0</b>
Be mountable in a side-fire position with an offset of nine ft. or more	<b>6.0</b>
Communicate over RS-232 and RS-485 at user-selectable baud rates, and support several data protocols	<b>7.0</b>
Consume less than 9 Watts with a DC input between 12 VDC and 28 VDC	<b>8.0</b>
Provide easy-to-use, Windows CE based installation software that communicates over serial and TCP/IP connections	<b>9.0</b>
Use the latest in modern integrated PCB antenna and RF circuit design techniques	<b>10.0</b>
Be enclosed in a water-resistant, UV-protected enclosure	<b>11.0</b>
Provide an optional input file card compatible with 170, 2070, NEMA TS1 and NEMA TS2 input file racks	<b>12.0</b>
Adhere to strict manufacturing standards	<b>13.0</b>
Be FCC certified	<b>14.0</b>
Have an enclosure that passes third party NEMA 4X environmental testing	<b>15.0</b>
Have passed third party testing for the NEMA TS2 –1998 Environmental specification	<b>16.0</b>
Be supported with necessary training and customer support	<b>17.0</b>
Be supported by the appropriate test results and documentation provided by the manufacturer at the time of the bid submittal	<b>18.0</b>
Be warranted for a period of two (2) years from date of shipment	<b>19.0</b>

## 2.0 Product Description

The Radar Vehicle Sensing Device shall be a non-intrusive device. The RVSD shall also:

- Be easy to install
- Automatically configure up to ten lanes of traffic by determining lane boundaries and detection thresholds
- Utilize a digitally-generated, modulated signal to accurately detect vehicle volume, speed, and occupancy in all weather conditions without performance degradation

- Operate accurately in side-fire installations
- Be remote accessible
- Provide multiple connectivity options for easy integration into legacy systems
- Support a variety of data protocols
- Be manufactured to the strictest industry standards
- Utilize automated assembly processes 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.

### **3.0 Auto-Configuration**

The RVSD shall have a method for automatically configuring the detection device. This auto-configuration method shall execute on a processor internal to the RVSD and shall not require an external PC or other processor. This auto-configuration method shall automatically define traffic lanes or detection zones by detecting the relative position of vehicles within the RVSD's field of view.

The RVSD shall include a transceiver capable of detecting multiple vehicles present within its field of view. The RVSD shall also include a processor or computer with executable instructions that estimates the position of each of the vehicles, records the position of the vehicles, generates a probability density function estimation from each position of the vehicles, and defines traffic lanes from that probability density function estimation. The vehicle probability density function represents the probability that a vehicle will be located at any range.

The auto-configuration method shall automatically, with no user intervention, assign lane or zone boundaries and detection thresholds using the statistical representation of the relative vehicle positions. The auto-configuration method shall not prohibit the ability of the user to manually adjust the RVSD configuration. Documentation demonstrating the auto-configuration process shall be provided.

### **4.0 Sensor Performance**

The RVSD shall provide accurate, real-time volume, average speed and occupancy data. A single RVSD shall detect up to ten lanes of traffic simultaneously. Detections shall be correctly categorized into four length-based classifications. True vehicle detections shall occur within a range of 9 ft. to 250 ft. from the RVSD.

The RVSD shall maintain accurate performance in all weather conditions, including: rain, freezing rain, snow, wind, dust, fog and changes in temperature and light. The device shall not rely on temperature compensation circuitry and shall be capable of continuous operation over an ambient temperature range of -40° C to 75° C, and a relative humidity range of 5 percent to 95 percent (non-condensing). RVSD operation shall continue in rain or snow up to ten centimeters per hour.

Test data demonstrating or proving performance shall be provided.

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

The number of missed vehicles and false detections shall be recorded. Errors shall be calculated 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 percent. Such performance analysis shall be provided for the following environments:

- Free flowing traffic (speeds greater than 45 mph)
- Congested traffic (speeds from 15 to 40 mph)
- Traffic with a lane roughly five ft. beyond a concrete barrier
- 20 foot and 240 foot lateral offset (simultaneous performance)

**Speed** shall be a measured quantity using a dual antenna radar speed trap; and shall not be derived from a presence measurement as this has been shown to produce biases during congestion. Average speed data shall be accurate within three mph for each lane, and 90 percent of individual vehicle speed estimates shall be within four miles per hour for any direction of traffic and for all conditions.

**Occupancy data** shall be accurate within 10 percent of truth for any direction of travel on a roadway. For example, if the true occupancy in a lane is 20 percent, then the measured occupancy shall be between 18 and 22 percent. Lane occupancy shall be accurate within 20 percent in similar conditions. Test data verifying this performance shall be provided.

**Classification data** shall be accurately determined for 80 percent of detected vehicles. Vehicles shall be separated into four user-definable classifications. Test data verifying this performance shall be provided.

#### **4.1 Performance Maintenance**

The RVSD shall not require cleaning or adjustment to maintain performance. It also shall not rely on battery backup to store configuration information.

Once the sensor is calibrated, it shall not need recalibration to maintain performance unless the roadway configuration changes. In that case, the RVSD's remote connectivity shall allow operators to reconfigure and recalibrate the sensor automatically.

#### **5.0 Range Resolution**

To achieve the specified accuracy in a variety of conditions, the resolution shall not be larger than ten ft. null to null and four ft. at the half-power level. This requires a functional bandwidth of 240 MHz. This reduces the problem of vehicle responses getting drowned out by brighter vehicles in adjacent lanes and improves performance for moving and stopped vehicles near barriers. This resolution allows event based detection as opposed to zone based detection. Event based detection will correctly detect lane changing vehicles.

#### **6.0 Mounting and Installation**

To achieve the specified accuracy and reliability, the RVSD shall be installed according to the following conditions:

- Two RVSD units shall not be mounted so that they are pointed directly at each other.
- An RVSD shall not be placed within 20 ft. of another RVSD unless each device is configured to operate on a different RF channel using the installation software.

#### **6.1 Mounting Assembly**

The RVSD shall be mounted directly onto a mounting assembly fastened to a pole, overhead mast-arm, or other solid structure. The mounting assembly shall provide the necessary degrees of rotation to ensure

proper installation. It shall be constructed of weather resistant materials and shall be able to support a 20-pound load.

## 6.2 Side-Fire Mounting

The RVSD shall be mounted according the following table, based on a recommended offset of 20 ft. or more from the first detection zone:

**Mounting Height Guidelines**

Offset from first detection lane (feet)	Recommended Mounting Height (feet)	Minimum Mounting Height (feet)	Maximum Mounting Height (feet)	
10	12	9	15	
11	12	9	16	
12	13	10	16	
13	13	11	17	
14	14	11	17	
15	15	12	18	
16	15	12	18	
17	16	13	18	
18	17	14	19	
19	17	14	19	
20	18	15	20	
21	18	15	21	
22	18	16	22	
23	19	16	23	
24	19	16	24	
Recommended Offset	25	20	17	25
	26	20	17	26
	27	21	18	27
	28	21	18	28
	29	21	18	29
	30	22	19	30
	31	22	19	31
	32	22	19	32
	33	23	19	33
	34	23	19	34
	35	23	20	35
	36	23	20	36
37	23	20	37	
38	24	21	38	
39	24	21	39	
40	25	22	40	
41	25	22	41	
42	26	22	42	
43	26	22	43	
44	27	23	44	
45	27	23	45	
46	28	23	46	
47	28	24	47	
48	29	24	48	
49	29	24	49	
50 ft. to 180 ft.	30	25	Height must be less than the offset (i.e. if offset = 80 ft., the maximum height is also 80 ft.)	

**NOTE: Depending on the site and type of traffic, the sensor may tend to over count or under count. If the sensor is over counting, reduce the height of the sensor by 3 ft and reconfigure the sensor. If the sensor is under counting, increase the height of the sensor by 3 ft. Reducing the height of the sensor normally improves performance.**

The RVSD shall be mounted 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, the RVSD is tilted off of vertical by 10-20 degrees. The RVSD shall be aligned so that the side-to-side (azimuth) angle is within approximately  $\pm 2$  degrees of perpendicular to the flow of traffic. Software shall be available to verify the accuracy of the azimuth pointing angle.

If multiple RVSD units are pointed in the same direction, each shall be configured to operate on a different RF channel.

A distance of 40 ft. (or more), along the direction of the roadway, shall separate the RVSD's if they are located on opposing sides of a roadway.

When possible, the RVSD pole placement shall be selected where there is no guardrail or other type of barrier between the pole and the first lane of traffic.

When possible, the RVSD pole placement shall be selected where there are no large planar surfaces (sound barrier, building, parked vehicles, etc.) that run parallel to the monitored roadway within 70 ft. of the pole location.

It is recommended that the manufacturer be consulted to verify 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.

### **6.3 Cabling**

The RVSD shall be supplied with a connector cable of the appropriate length for each installation site.

The connector shall meet the MIL-C-26482 specification. The backshell shall be an environmentally sealed shell that offers excellent immersion capability, and is designed to interface with the appropriate MIL-C-26482 connector. All conductors that interface with the connector shall be encased in a single jacket; and the outer diameter of this jacket shall be within the backshell's cable O.D. range to ensure proper sealing. The backshell shall have a clamp bar-style strain relief with enough strength to support the cable slack under extreme weather conditions. Recommended connectors are Cannon's KPT series; and recommended backshells are Glenair Series 37 cable sealing backshells. The MIL-C-26482 connector shall provide contacts for all data and power connections.

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

- Shielded, twisted pairs with a drain wire
- Nominal Capacitance Conductor to Conductor @ 1Khz  $\leq 26$ pF/Ft
- Nominal Conductor DC Resistance @ 20 Deg C  $\leq 15$  ohms/1000Ft
- Single continuous run with no splices allowed
- Terminated only on the two farthest ends of the cable.
- The operational baud rate and cable length shall not exceed the following limits:

Baud Rate	*Cable Length
115.2Kbps	300Feet
57.6Kbps	600Feet
38.4Kbps	800Feet
19.2Kbps	1000Feet
9.6Kbps	2000Feet

**NOTE: These represent maximum data rates. The data rate used should be the minimum data rate required for operation.**

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

- Shielded, twisted pairs with a drain wire
- Nominal Capacitance Conductor to Conductor @ 1Khz  $\leq$  26pF/Ft
- Nominal Conductor DC Resistance @ 20 Deg C  $\leq$  15 ohms/1000Ft
- Single continuous run with no splices allowed
- The RS-232 Driver must be able to source and sink +/- 7mA or more
- The operational baud rate and cable length shall not exceed the following limits:

Baud Rate	*Cable Length
115.2Kbps	40Feet
57.6Kbps	60Feet
38.4Kbps	100Feet
19.2Kbps	140Feet
9.6Kbps	200Feet

*NOTE: These represent maximum data rates. The data rate used should be the minimum data rate required for operation.*

If 12 VDC is being supplied for the RVSD, the power cable shall be Belden 9331 or an equivalent cable with the following specifications:

- Two shielded, twisted pairs with two drain wires connected in parallel
- Nominal Capacitance Conductor to Conductor @ 1Khz  $\leq$  26pF/Ft
- Nominal Conductor DC Resistance @ 20 Deg C  $\leq$  15 ohms/1000Ft
- The cable length shall not exceed 100 ft.

If 24 VDC is being supplied for the RVSD, the power cable shall be Belden 9331 or an equivalent cable with the following specifications:

- Two shielded, twisted pairs with two drain wires connected in parallel
- Nominal Capacitance Conductor to Conductor @ 1Khz  $\leq$  26pF/Ft
- Nominal Conductor DC Resistance @ 20 Deg C  $\leq$  15 ohms/1000Ft
- The cable length shall not exceed 600 ft.

If a cable length of 600 ft. to 2000 ft. is required, the power cable shall be an ANIXTER 2A-1002 or equivalent cable that meets the following requirements:

- 10 AWG Conductor Size/Gauge
- Two Conductor count

- Stranded Cable Type
- Bare Copper material
- 600 Volt range
- 90° Centigrade Temperature rating
- PVC/Nylon Insulation material
- PVC – Polyvinyl chloride jacketing material
- 40 Amps per conductor

Both communication and power conductors can be bundled together in the same cable as long as the above-mentioned conditions are met.

## 6.4 Lightning Surge Protection

Lightning surge protection that meets or exceeds the EN 61000-4-5 Class 4 specifications shall be installed no farther than 40 ft. along the RVSD cable from the RVSD unit. To ensure the continued operation of the RVSD in the presence of electrical surges, all connections to the RVSD shall be protected including power, RS-232 communication lines, RS-485 communication lines, and ground.

## 6.5 Power Supply

The AC-to-DC power converter, supplying the DC voltage for the RVSD, shall provide the following:

Power Rated	>15 W @25°C / 10> W@74°C minimum per RVSD unit
Operating Temperature Range	From –34°C to +74°C
Operating Humidity Range	From 5% to 95% @25°C non-condensing
Input Voltage	From 85 V (AC) to 264 V (AC) or 120 V (DC) to 370 V (DC)
Input Frequency	From 47 Hz to 63 Hz
Output Voltage	24 VDC ±4%
Hold Up Time	>20 ms at 120 V (AC)
Withstand Voltage	Input to Output: 2 kV, Input to Ground: 1.5 kV
Safety Standards	UL 60950, EN60950
EMC Standards	EN55022 Class B and EN61000-3-2, 3
Brown-Out Protection	In brown-out conditions (i.e. <85VAC input) the output voltage shall be less than 1 VDC

## 7.0 Communication

The RVSD shall provide two or more communication ports that can be accessed simultaneously using any RVSD-supported protocol. This will enable multiple operators to collect data from the RVSD at the same time without interrupting or interfering with each other.

The RVSD shall provide both RS-232 and RS-485 communication. Both communication ports shall support all of the following baud rates: 9600, 19200, 38400, 57600 and 115200. Additionally, the RS-232 port shall be full-duplex and shall support true RTS/CTS hardware handshaking for interfacing with various communication devices.

### 7.1 Data Protocols

The RVSD shall support three different data protocols for all lanes being monitored: Interval (bin) data, Event (per vehicle) data, and Real-time True Presence data. The data protocol document shall be provided free of charge.

The Interval (bin) data packet protocol shall support:

- One or more detection zones of data per packet
- Sensor ID

- 32-bit or larger time stamps in one second or smaller increments that indicate the end of time interval
- Total volumes of more than 65536 (necessary for time intervals greater than 10 minutes)
- Speed values in either “Miles Per Hour” or “Kilometers Per Hour”
- Occupancy in 0.1 percent increments
- Four types (or more) of vehicle classifications with volumes per class

The Event (per vehicle) data packet protocol shall support:

- Sensor ID
- 32-bit time stamps in 2.5 millisecond increments or less that indicate the time the vehicle left the detection zone
- Speed values in either “Miles Per Hour” or “Kilometers Per Hour”
- Resolution of vehicle duration in the detection zone in 2.5 ms increments or less
- Four types (or more) of vehicle classification

The Real-time True Presence data packet protocol shall support:

- Sensor ID
- True presence information for each lane being monitored

## **7.2 Data Buffering**

The RVSD shall store 24,000 (or more) Interval (bin) data packets that record volume, average speed, eighty-fifth percentile speed, occupancy, and class for each detection zone with at least ten zones and no groups per packet in non-volatile memory.

## **8.0 Power Requirements**

The RVSD shall consume less than 9 watts with a DC input between 12 VDC and 28 VDC.

The equipment shall be designed such that the failures of the equipment shall not cause the failure of any other unit of equipment. Automatic recovery from power failure shall be within 15 seconds after resumption of power.

## **9.0 Windows CE®-based Software**

The RVSD shall also include graphical user interface software that displays all configured lanes and the current traffic pattern using a graphical traffic history representing at least the last 1.5 seconds of detected traffic. This graphical traffic history shall also allow the option of displaying the measured speed or length of a detected vehicle.

The graphical interface shall operate on Windows CE, Windows 98, Windows 2000, Windows NT 4.0 and Windows XP Pro in the .NET framework. The software shall:

- Automatically select the correct baud rate and serial communication port from up to 15 serial communication ports
- Operate over a TCP/IP connection
- Support a dial-up modem connection
- Give the operator complete control over the configuration process
- Give the operator 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 the RVSD's non-volatile memory over any supported communication channel including TCP/IP networks.

#### **10.0 RF Design**

The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time.

ALL TRANSMIT MODULATED SIGNALS SHALL BE GENERATED BY MEANS OF DIGITAL CIRCUITRY, SUCH AS A DIRECT DIGITAL SYNTHESIZER, THAT IS REFERENCED TO A FREQUENCY SOURCE THAT IS AT LEAST 50 PARTS PER MILLION (PPM) STABLE OVER THE SPECIFIED TEMPERATURE RANGE, AND AGES LESS THAN 6 PPM PER YEAR. ANY UPCONVERSION OF A DIGITALLY-GENERATED MODULATED SIGNAL SHALL PRESERVE THE PHASE STABILITY AND FREQUENCY STABILITY INHERENT IN THE DIGITALLY-GENERATED SIGNAL. THESE SPECIFICATIONS ENSURE THAT, DURING OPERATION, THE RVSD STRICTLY CONFORMS TO FCC REQUIREMENTS AND THAT THE RADAR SIGNAL QUALITY IS MAINTAINED FOR PRECISE ALGORITHMIC QUALITY.

THE RVSD ANTENNAE SHALL BE DESIGNED ON PRINTED CIRCUIT BOARDS, ELIMINATING THE NEED FOR RF CONNECTORS AND CABLING THAT RESULT IN DECREASED RELIABILITY. PRINTED CIRCUIT ANTENNAE ARE LESS PRONE TO PHYSICAL DAMAGE DUE TO THEIR EXTREMELY LOW MASS.

THE ANTENNAE PARAMETERS SHALL MEET THE FOLLOWING TWO-WAY CRITERIA TO ENSURE QUALITY PERFORMANCE:

- 6 dB Elevation Beam Width: > 65 degrees
- 3 dB Azimuth Beam Width: < 6 degrees
- Side Lobes: < -40 dB

#### **11.0 Enclosure**

The RVSD shall be enclosed in a Lexan polycarbonate, ultraviolet-resistant material and shall be classified as watertight according to the NEMA 250 Standard.

The enclosure shall be classified "f1" outdoor weatherability in accordance with UL 746C.

The RVSD shall be able to withstand a drop of up to five ft. without compromising its functional and structural integrity.

## 12.0 Input File Cards

The RVSD manufacturer shall provide an optional input file card compatible with 170, 2070, NEMA TS1, and NEMA TS2 input file racks. The input file card shall translate per vehicle data packets or real-time true presence packets from the RVSD into corresponding contact closure outputs. Operators shall be able to assign any contact closure output channel to any lane or detection zone. These settings shall be saved in non-volatile memory on the input file card for complete recovery in case of power failure.

The input file card shall support Dual Loop (Speed Trap) emulation, as well as the following modes of operation:

- **Pulse** (a single 125 ms output pulse for each vehicle)
- **Presence** (an output pulse corresponding to the duration of each vehicle in the detection zone with a resolution of 2.5 ms)
- **Actuation** (true presence output in real time with 2.5 ms resolution)
- **Single Loop Speed** (duration of the pulse corresponds directly to the speed of the vehicle,  $\text{speed (mph)} = 13.64/\text{duration in seconds}$ )

The input file card shall receive data packets over an RS-485 bus at any of the following baud rates: 9600, 19200, 38400, 57600 and 115200. The input file card shall also auto-baud and auto-detect an RVSD over wired and wireless communication channels that have a maximum latency of 500 ms.

The Input file card shall comply with the NEMA TS2-1998 Traffic Controller Assemblies with NTCIP Requirements (Section 2.8 specification). Documentation and results of the NEMA TS2-1998 test shall be provided.

Additionally, the input file card shall comply with the EN 61000-4-5 Class 4 lightning surge protection test specification. Documentation and results of the EN 61000-4-5 Class 4 test shall be provided.

## 13.0 Manufacturing Requirements

The RVSD shall be manufactured and assembled in the U.S.A. The internal electronics of the RVSD shall utilize automation for surface mount and wave solder assembly, and shall comply with the requirements set forth in IPC-A-610C Class 3, Acceptability of Electronic Assemblies.

The RVSD shall undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Testing shall include:

- Functionality testing of all internal sub-assemblies
- Unit level burn-in testing of duration 48 hours or greater
- Final unit functionality testing prior to shipment

Test results and all associated data for the above testing shall be provided, for each purchased RVSD by serial number, upon request. Additionally, manufacturing quality data shall be maintained for each purchased RVSD by serial number and shall be made available upon request.

Externally, the RVSD shall be modular in design to facilitate easy replacement in the field. The total weight of the RVSD shall not exceed five pounds.

All external parts shall be made of corrosion resistant material, and all materials shall be protected from fungus growth and moisture deterioration.

#### **14.0 FCC**

Each RVSD shall be Federal Communications Commission (FCC) certified under CFR 47, Part 15, section 15.249 as an intentional radiator. This certification shall be displayed on an external label on each device according to the rules set forth by the FCC.

The RVSD shall transmit in the 24.00 – 24.25 GHz or another approved frequency band with 250 MHz of bandwidth available and shall comply with the appropriate requirements.

The manufacturer shall provide documentation proving compliance to all FCC specifications.

#### **15.0 NEMA 4X Testing**

The RVSD enclosure shall conform to test criteria set forth in the NEMA 250 Standard for Type 4X enclosures. Third party enclosure test results shall be provided for each of the following 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)

#### **16.0 NEMA TS2-1998 Testing**

The RVSD shall comply with the applicable standards stated in the NEMA TS2-1998 Standard. Third party test results shall be made available for each of the following tests:

- Shock pulses of 10g, 11 ms half sine wave
- Vibration of 0.5 Grms up to 30 Hz
- 300 V positive/negative pulses applied at one 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

#### **17.0 Support**

Installers and operators of the RVSD shall be 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, technical support shall be available to provide ongoing operator assistance.

#### **17.1 Training**

Training shall consist of comprehensive classroom labs and on-hand, in-the-field, installation and configuration training.

**Classroom Lab** training shall involve presentations outlining and defining the RVSD, its functions, and the procedures for proper operation. These presentations shall be followed by hands-on labs in which trainees shall practice using the equipment to calibrate and configure a virtual device. To facilitate the classroom presentation and hands-on labs, the vendor shall provide the following items for the duration of training:

- Knowledgeable trainer or trainers thoroughly familiar with the RVSD and its processes.
- Presentation materials, including visual aids, printed manuals and other handout materials for each student.
- Computer files, including video and raw data, to facilitate the virtual calibration and configuration of the RVSD.
- Laptop computers or Windows CE hand-held devices with the necessary software, and all necessary cables, connectors, etc.
- All other equipment necessary to facilitate the virtual calibration and configuration of the RVSD.

**Field Training** shall provide each trainee with the hands-on opportunity to install and configure the RVSD at roadside. Training shall be such that each trainee will mount and align the RVSD correctly.

## **17.2 Technical Assistance**

A manufacturer's technical representative shall be available to assist with the physical installation, alignment, and auto-configuration of each supplied RVSD. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of devices should such services be required.

## **18.0 Documentation**

The manufacturer shall supply the following documentation and specification test results at the time of the bid submittal. The following documents shall be attached:

- Auto-configuration documentation
- Volume accuracy data, including performance analyses for:
  - Free-flowing traffic
  - Congested traffic
  - Traffic with a lane roughly eight ft. beyond a concrete barrier
  - 20 foot and 240 foot lateral offset (simultaneous)
- Speed accuracy test data for both per-vehicle and average speed
- Occupancy accuracy test data
- Vehicle classification test data
- EN 61000-4-5 Class 4 Lightning Surge Protection test results
- FCC CFR 47 certification
- NEMA 250 Standard for Type 4X Enclosure third-party test data
- NEMA TS2-1998 Standard third-party test data

## **19.0 Warranty**

The RVSD shall be warranted free from material and workmanship defects for a period of two (2) years from date of shipment.

**BID SUBMITTAL:**

Your written bid must be mailed in ***a sealed*** envelope or box, or else delivered by hand or courier service (UPS, Federal Express, etc.) to be *received on or before the date and time specified on the front page of this bid document*, at the office of:

Ms. Amy Bailey  
Missouri Department of Transportation  
General Services - Procurement  
830 MoDOT Drive; P.O. Box 270  
Jefferson City, MO 65102

All documents must be sealed and the outermost wrapping should be clearly marked "**CONTRACT FOR FURNISHING "RADAR VEHICLE SENSING DEVICES"**".

**DELIVERY:**

Bids shall be quoted with delivery F.O.B Missouri Department of Transportation at Jefferson City, Missouri 65109. Bidder agrees to furnish and deliver any or all the items on which prices were quoted within THIRTY (30) days after receipt of formal purchase order.

**COMPLIANCE WITH BID REQUIREMENTS:**

Failure to comply with the requirements published in this bid may result in the bid being subject to rejection. Product that does not meet specifications will cause all of the shipments to be returned at the bidders expense. ***Failure to comply with the specification requirements may result in bid being subject to rejection.***

**VENDOR NAME REGISTRATION:**

On all bid documents, the bidder must use the firm name under which he/she is registered to do business in the state of Missouri. The bidder must ensure that his/her firm name is registered with the office of the Secretary of State. Failure to use the correct firm name on all bid documents will result in delaying the contract award.

**NON-EXCLUSIVITY:**

The Missouri Department of Transportation reserves the right to obtain like or similar products of this or other manufacturers when use of such products is deemed in the best interest of MoDOT.

**ADDITIONAL DOCUMENT SUBMITTAL REQUIREMENTS:**

For the bid to be considered the attachments "Preference in Purchasing Products" and the "Missouri Domestic Products Procurement Act" must be submitted to this office prior to any contract being awarded for this bid.

# PREFERENCE IN PURCHASING PRODUCTS

DATE: \_\_\_\_\_

The bidders attention is directed to Section 34.076 RSMo 2000 which gives preference to Missouri corporations, firms, and individuals when letting contracts or purchasing products.

Bids/Quotations received will be evaluated on the basis of this legislation.

**All vendors submitting a bid/quotation must furnish ALL information requested below.**

**FOR CORPORATIONS:**

State in which incorporated: \_\_\_\_\_

**FOR OTHERS:**

State of domicile: \_\_\_\_\_

**FOR ALL VENDORS:**

List address of Missouri offices or places of business:

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**THIS SECTION MUST BE COMPLETED AND SIGNED:**

**FIRM NAME:** \_\_\_\_\_

**ADDRESS:** \_\_\_\_\_

**CITY:** \_\_\_\_\_ **STATE:** \_\_\_\_\_ **ZIP:** \_\_\_\_\_

**BY (signature required):** \_\_\_\_\_

**Federal Tax I.D. #:** \_\_\_\_\_ **if no Federal Tax I.D. # - list Social Security #:** \_\_\_\_\_

NOTE: For bid/quotation to be considered, the "Preference in Purchasing Products" form must be on file in the General Services (Procurement) Division and must be dated in the current calendar year.

# MISSOURI DOMESTIC PRODUCTS PROCUREMENT ACT

The bidder's attention is directed to the Missouri Domestic Products Procurement Act, Sections 34.350 to 34/359, RsMO, which requires all manufactured goods or commodities used or supplied in the performance of this contract or any subcontract to be manufactured or produced in the United States.

Section 34.355, RsMO, requires the vendor or contractor to certify his compliance with Section 34.353 and, if applicable, Section 34.359, RsMO, at the time of bidding **and** prior to payment. Failure to comply with Section 34.353, RsMO, during the performance of the contract **and** to provide certification of compliance prior to payment will result in nonpayment for those goods or commodities.

Section 34.353.2, RsMO, specifies that it does not apply where the total contract is less than Twenty-Five Thousand Dollars (\$25,000.00). If your total bid is Twenty-Five Thousand Dollars (\$25,000.00) or more, you **must** complete this form as directed below.

**Failure to complete and return this document with this bid will cause the State to presume the manufactured goods or products listed in the bid are not manufactured or produced in the United States, and the bid will be evaluated on that basis. Please read the certification appearing below on this form.**

- [ ] If all the goods or products specified in the attached bid which the bidder proposes to supply to the State shall be manufactured or produced in the "United States" as defined in Section 34.350, RsMO, check the box at left.
  
- [ ] If only one item of any particular goods or products specified in the attached bid is manufactured or produced in the "United States" as defined in Section 34.350, RsMO, check the box at left and list the items (or item number) here:  


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- [ ] If any or all of the goods or products specified in the attached bid which the bidder proposes to supply to the State are **not** manufactured or produced in the "United States" as defined in Section 34.350, RsMO, then: (a) check the box at left; (b) list below, by item (or item number), the country other than the United States where each good or product is manufactured or produced; and (c) check the boxes to the left of the paragraphs below if applicable and list the corresponding items (or item numbers) in the spaces provided.

Item (or item number)	Location Where Item Manufactured or Produced

(attach an additional sheet if necessary)

- [ ] The following specified goods or products cannot be manufactured or produced in the United States in sufficient quantities or in time to meet the contract specifications. Items (or item numbers): \_\_\_\_\_  


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- [ ] The following specified goods or products must be treated as manufactured or produced in the United States, in accordance with an existing treaty, law, agreement, or regulation of the United States, including a treaty between the United States and any foreign country regarding export-import restrictions or international trade. Items (or item numbers): \_\_\_\_\_  


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### CERTIFICATION

**By submitting this document, completed as directed above, with a bid, the bidder certifies under penalty of making false declaration (Section 575.060, RsMO) that the information contained in this document is true, correct and complete, and may be relied upon by the State in determining the bidders qualifications under and in compliance with the Missouri Domestic Products Procurement Act.**

**The bidder's failure to complete and return this document with the bid as directed above will cause the State to presume the manufactured goods or products listed in the bid are not manufactured or produced in the United States, and the bid will be evaluated on that basis pursuant to Section 34.353.3(2), RsMO.**

## 1.0 General

This item shall govern the purchase and installation of aboveground Radar Vehicle Sensing Devices (RVSD). Test results and other documentation demonstrating RVSD performance and capabilities shall be provided.

The RVSD shall:

<b>Requirement</b>	<b>Section</b>
Auto-configure and auto-calibrate up to ten lanes of traffic	<b>3.0</b>
Provide volume ( $\pm 5\%$ ), individual vehicle speed ( $\pm 4$ mph), eighty-fifth percentile speed ( $\pm 3$ mph), occupancy ( $\pm 10\%$ ), and classification data under nominal traffic conditions and in all weather conditions over a range of 9 ft. to 250 ft. from the RVSD; and perform accurately without requiring cleaning or maintenance	<b>4.0</b>
Have a range resolution of four ft. or less and therefore use a bandwidth of 240 MHz or more	<b>5.0</b>
Be mountable in a side-fire position with an offset of nine ft. or more	<b>6.0</b>
Communicate over RS-232 and RS-485 at user-selectable baud rates, and support several data protocols	<b>7.0</b>
Consume less than 9 Watts with a DC input between 12 VDC and 28 VDC	<b>8.0</b>
Provide easy-to-use, Windows CE based installation software that communicates over serial and TCP/IP connections	<b>9.0</b>
Use the latest in modern integrated PCB antenna and RF circuit design techniques	<b>10.0</b>
Be enclosed in a water-resistant, UV-protected enclosure	<b>11.0</b>
Provide an optional input file card compatible with 170, 2070, NEMA TS1 and NEMA TS2 input file racks	<b>12.0</b>
Adhere to strict manufacturing standards	<b>13.0</b>
Be FCC certified	<b>14.0</b>
Have an enclosure that passes third party NEMA 4X environmental testing	<b>15.0</b>
Have passed third party testing for the NEMA TS2 –1998 Environmental specification	<b>16.0</b>
Be supported with necessary training and customer support	<b>17.0</b>
Be supported by the appropriate test results and documentation provided by the manufacturer at the time of the bid submittal	<b>18.0</b>
Be warranted for a period of two (2) years from date of shipment	<b>19.0</b>

## **2.0 Product Description**

The Radar Vehicle Sensing Device shall be a non-intrusive device. The RVSD shall also:

- Be easy to install
- Automatically configure up to ten lanes of traffic by determining lane boundaries and detection thresholds
- Utilize a digitally-generated, modulated signal to accurately detect vehicle volume, speed, and occupancy in all weather conditions without performance degradation
- Operate accurately in side-fire installations
- Be remote accessible
- Provide multiple connectivity options for easy integration into legacy systems
- Support a variety of data protocols
- Be manufactured to the strictest industry standards
- Utilize automated assembly processes 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.

## **3.0 Auto-Configuration**

The RVSD shall have a method for automatically configuring the detection device. This auto-configuration method shall execute on a processor internal to the RVSD and shall not require an external PC or other processor. This auto-configuration method shall automatically define traffic lanes or detection zones by detecting the relative position of vehicles within the RVSD's field of view.

The RVSD shall include a transceiver capable of detecting multiple vehicles present within its field of view. The RVSD shall also include a processor or computer with executable instructions that estimates the position of each of the vehicles, records the position of the vehicles, generates a probability density function estimation from each position of the vehicles, and defines traffic lanes from that probability density function estimation. The vehicle probability density function represents the probability that a vehicle will be located at any range.

The auto-configuration method shall automatically, with no user intervention, assign lane or zone boundaries and detection thresholds using the statistical representation of the relative vehicle positions. The auto-configuration method shall not prohibit the ability of the user to manually adjust the RVSD configuration. Documentation demonstrating the auto-configuration process shall be provided.

#### 4.0 Sensor Performance

The RVSD shall provide accurate, real-time volume, average speed and occupancy data. A single RVSD shall detect up to ten lanes of traffic simultaneously. Detections shall be correctly categorized into four length-based classifications. True vehicle detections shall occur within a range of 9 ft. to 250 ft. from the RVSD.

The RVSD shall maintain accurate performance in all weather conditions, including: rain, freezing rain, snow, wind, dust, fog and changes in temperature and light. The device shall not rely on temperature compensation circuitry and shall be capable of continuous operation over an ambient temperature range of -40° C to 75° C, and a relative humidity range of 5 percent to 95 percent (non-condensing). RVSD operation shall continue in rain or snow up to ten centimeters per hour.

Test data demonstrating or proving performance shall be provided.

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

The number of missed vehicles and false detections shall be recorded. Errors shall be calculated 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 percent. Such performance analysis shall be provided for the following environments:

- Free flowing traffic (speeds greater than 45 mph)
- Congested traffic (speeds from 15 to 40 mph)
- Traffic with a lane roughly five ft. beyond a concrete barrier
- 20 foot and 240 foot lateral offset (simultaneous performance)

**Speed** shall be a measured quantity using a dual antenna radar speed trap; and shall not be derived from a presence measurement as this has been shown to produce biases during congestion. Average speed data shall be accurate within three mph for each lane, and 90 percent of individual vehicle speed estimates shall be within four miles per hour for any direction of traffic and for all conditions.

**Occupancy data** shall be accurate within 10 percent of truth for any direction of travel on a roadway. For example, if the true occupancy in a lane is 20 percent, then the measured occupancy shall be between 18 and 22 percent. Lane occupancy shall be accurate within 20 percent in similar conditions. Test data verifying this performance shall be provided.

**Classification data** shall be accurately determined for 80 percent of detected vehicles. Vehicles shall be separated into four user-definable classifications. Test data verifying this performance shall be provided.

#### **4.1 Performance Maintenance**

The RVSD shall not require cleaning or adjustment to maintain performance. It also shall not rely on battery backup to store configuration information.

Once the sensor is calibrated, it shall not need recalibration to maintain performance unless the roadway configuration changes. In that case, the RVSD's remote connectivity shall allow operators to reconfigure and recalibrate the sensor automatically.

#### **5.0 Range Resolution**

To achieve the specified accuracy in a variety of conditions, the resolution shall not be larger than ten ft. null to null and four ft. at the half-power level. This requires a functional bandwidth of 240 MHz. This reduces the problem of vehicle responses getting drowned out by brighter vehicles in adjacent lanes and improves performance for moving and stopped vehicles near barriers. This resolution allows event based detection as opposed to zone based detection. Event based detection will correctly detect lane changing vehicles.

#### **6.0 Mounting and Installation**

To achieve the specified accuracy and reliability, the RVSD shall be installed according to the following conditions:

- Two RVSD units shall not be mounted so that they are pointed directly at each other.
- An RVSD shall not be placed within 20 ft. of another RVSD unless each device is configured to operate on a different RF channel using the installation software.

#### **6.1 Mounting Assembly**

The RVSD shall be mounted directly onto a mounting assembly fastened to a pole, overhead mast-arm, or other solid structure. The mounting assembly shall provide the necessary degrees of rotation to ensure proper installation. It shall be constructed of weather resistant materials and shall be able to support a 20-pound load.

## 6.2 Side-Fire Mounting

The RVSD shall be mounted according the following table, based on a recommended offset of 20 ft. or more from the first detection zone:

**Mounting Height Guidelines**

Offset from first detection lane (feet)	Recommended Mounting Height (feet)	Minimum Mounting Height (feet)	Maximum Mounting Height (feet)	
10	12	9	15	
11	12	9	16	
12	13	10	16	
13	13	11	17	
14	14	11	17	
15	15	12	18	
16	15	12	18	
17	16	13	18	
18	17	14	19	
19	17	14	19	
20	18	15	20	
21	18	15	21	
22	18	16	22	
23	19	16	23	
24	19	16	24	
Recommended Offset	25	20	17	25
	26	20	17	26
	27	21	18	27
	28	21	18	28
	29	21	18	29
	30	22	19	30
	31	22	19	31
	32	22	19	32
	33	23	19	33
	34	23	19	34
	35	23	20	35
	36	23	20	36
37	23	20	37	
38	24	21	38	
39	24	21	39	
40	25	22	40	
41	25	22	41	
42	26	22	42	
43	26	22	43	
44	27	23	44	
45	27	23	45	
46	28	23	46	
47	28	24	47	
48	29	24	48	
49	29	24	49	
50 ft. to 180 ft.	30	25	Height must be less than the offset (i.e. if offset = 80 ft., the maximum height is also 80 ft.)	

**NOTE: Depending on the site and type of traffic, the sensor may tend to over count or under count. If the sensor is over counting, reduce the height of the sensor by 3 ft and reconfigure the sensor. If the sensor is under counting, increase the height of the sensor by 3 ft. Reducing the height of the sensor normally improves performance.**

The RVSD shall be mounted 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, the RVSD is tilted off of vertical by 10-20 degrees. The RVSD shall be aligned so that the side-to-side (azimuth) angle is within approximately  $\pm 2$  degrees of perpendicular to the flow of traffic. Software shall be available to verify the accuracy of the azimuth pointing angle.

If multiple RVSD units are pointed in the same direction, each shall be configured to operate on a different RF channel.

A distance of 40 ft. (or more), along the direction of the roadway, shall separate the RVSD's if they are located on opposing sides of a roadway.

When possible, the RVSD pole placement shall be selected where there is no guardrail or other type of barrier between the pole and the first lane of traffic.

When possible, the RVSD pole placement shall be selected where there are no large planar surfaces (sound barrier, building, parked vehicles, etc.) that run parallel to the monitored roadway within 70 ft. of the pole location.

It is recommended that the manufacturer be consulted to verify 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.

### **6.3 Cabling**

The RVSD shall be supplied with a connector cable of the appropriate length for each installation site.

The connector shall meet the MIL-C-26482 specification. The backshell shall be an environmentally sealed shell that offers excellent immersion capability, and is designed to interface with the appropriate MIL-C-26482 connector. All conductors that interface with the connector shall be encased in a single jacket; and the outer diameter of this jacket shall be within the backshell's cable O.D. range to ensure proper sealing. The backshell shall have a clamp bar-style strain relief with enough strength to support the cable slack under extreme weather conditions. Recommended connectors are Cannon's KPT series; and recommended backshells are Glenair Series 37 cable sealing backshells. The MIL-C-26482 connector shall provide contacts for all data and power connections.

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

- Shielded, twisted pairs with a drain wire
- Nominal Capacitance Conductor to Conductor @ 1Khz  $\leq$  26pF/Ft
- Nominal Conductor DC Resistance @ 20 Deg C  $\leq$  15 ohms/1000Ft
- Single continuous run with no splices allowed
- Terminated only on the two farthest ends of the cable.
- The operational baud rate and cable length shall not exceed the following limits:

Baud Rate	*Cable Length
115.2Kbps	300Feet
57.6Kbps	600Feet
38.4Kbps	800Feet
19.2Kbps	1000Feet
9.6Kbps	2000Feet

**NOTE: These represent maximum data rates. The data rate used should be the minimum data rate required for operation.**

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

- Shielded, twisted pairs with a drain wire
- Nominal Capacitance Conductor to Conductor @ 1Khz  $\leq$  26pF/Ft
- Nominal Conductor DC Resistance @ 20 Deg C  $\leq$  15 ohms/1000Ft
- Single continuous run with no splices allowed
- The RS-232 Driver must be able to source and sink +/- 7mA or more
- The operational baud rate and cable length shall not exceed the following limits:

Baud Rate	*Cable Length
115.2Kbps	40Feet
57.6Kbps	60Feet
38.4Kbps	100Feet
19.2Kbps	140Feet
9.6Kbps	200Feet

**NOTE: These represent maximum data rates. The data rate used should be the minimum data rate required for operation.**

If 12 VDC is being supplied for the RVSD, the power cable shall be Belden 9331 or an equivalent cable with the following specifications:

- Two shielded, twisted pairs with two drain wires connected in parallel
- Nominal Capacitance Conductor to Conductor @ 1Khz  $\leq$  26pF/Ft
- Nominal Conductor DC Resistance @ 20 Deg C  $\leq$  15 ohms/1000Ft
- The cable length shall not exceed 100 ft.

If 24 VDC is being supplied for the RVSD, the power cable shall be Belden 9331 or an equivalent cable with the following specifications:

- Two shielded, twisted pairs with two drain wires connected in parallel
- Nominal Capacitance Conductor to Conductor @ 1Khz  $\leq$  26pF/Ft
- Nominal Conductor DC Resistance @ 20 Deg C  $\leq$  15 ohms/1000Ft
- The cable length shall not exceed 600 ft.

If a cable length of 600 ft. to 2000 ft. is required, the power cable shall be an ANIXTER 2A-1002 or equivalent cable that meets the following requirements:

- 10 AWG Conductor Size/Gauge
- Two Conductor count
- Stranded Cable Type
- Bare Copper material
- 600 Volt range
- 90° Centigrade Temperature rating
- PVC/Nylon Insulation material
- PVC – Polyvinyl chloride jacketing material
- 40 Amps per conductor

Both communication and power conductors can be bundled together in the same cable as long as the above-mentioned conditions are met.

#### 6.4 Lightning Surge Protection

Lightning surge protection that meets or exceeds the EN 61000-4-5 Class 4 specifications shall be installed no farther than 40 ft. along the RVSD cable from the RVSD unit. To ensure the continued operation of the RVSD in the presence of electrical surges, all connections to the RVSD shall be protected including power, RS-232 communication lines, RS-485 communication lines, and ground.

#### 6.5 Power Supply

The AC-to-DC power converter, supplying the DC voltage for the RVSD, shall provide the following:

Power Rated	>15 W @25°C / 10> W@74°C minimum per RVSD unit
Operating Temperature Range	From -34°C to +74°C
Operating Humidity Range	From 5% to 95% @25°C non-condensing
Input Voltage	From 85 V (AC) to 264 V (AC) or 120 V (DC) to 370 V (DC)
Input Frequency	From 47 Hz to 63 Hz
Output Voltage	24 VDC ±4%
Hold Up Time	>20 ms at 120 V (AC)
Withstand Voltage	Input to Output: 2 kV, Input to Ground: 1.5 kV
Safety Standards	UL 60950, EN60950
EMC Standards	EN55022 Class B and EN61000-3-2, 3
Brown-Out Protection	In brown-out conditions (i.e. <85VAC input) the output voltage shall be less than 1 VDC

#### 7.0 Communication

The RVSD shall provide two or more communication ports that can be accessed simultaneously using any RVSD-supported protocol. This will enable multiple operators to collect data from the RVSD at the same time without interrupting or interfering with each other.

The RVSD shall provide both RS-232 and RS-485 communication. Both communication ports shall support all of the following baud rates: 9600, 19200, 38400, 57600 and 115200. Additionally, the RS-232 port shall be full-duplex and shall support true RTS/CTS hardware handshaking for interfacing with various communication devices.

## 7.1 Data Protocols

The RVSD shall support three different data protocols for all lanes being monitored: Interval (bin) data, Event (per vehicle) data, and Real-time True Presence data. The data protocol document shall be provided free of charge.

The Interval (bin) data packet protocol shall support:

- One or more detection zones of data per packet
- Sensor ID
- 32-bit or larger time stamps in one second or smaller increments that indicate the end of time interval
- Total volumes of more than 65536 (necessary for time intervals greater than 10 minutes)
- Speed values in either “Miles Per Hour” or “Kilometers Per Hour”
- Occupancy in 0.1 percent increments
- Four types (or more) of vehicle classifications with volumes per class

The Event (per vehicle) data packet protocol shall support:

- Sensor ID
- 32-bit time stamps in 2.5 millisecond increments or less that indicate the time the vehicle left the detection zone
- Speed values in either “Miles Per Hour” or “Kilometers Per Hour”
- Resolution of vehicle duration in the detection zone in 2.5 ms increments or less
- Four types (or more) of vehicle classification

The Real-time True Presence data packet protocol shall support:

- Sensor ID
- True presence information for each lane being monitored

## 7.2 Data Buffering

The RVSD shall store 24,000 (or more) Interval (bin) data packets that record volume, average speed, eighty-fifth percentile speed, occupancy, and class for each detection zone with at least ten zones and no groups per packet in non-volatile memory.

## 8.0 Power Requirements

The RVSD shall consume less than 9 watts with a DC input between 12 VDC and 28 VDC.

The equipment shall be designed such that the failures of the equipment shall not cause the failure of any other unit of equipment. Automatic recovery from power failure shall be within 15 seconds after resumption of power.

## 9.0 Windows CE®-based Software

The RVSD shall also include graphical user interface software that displays all configured lanes and the current traffic pattern using a graphical traffic history representing at least the last 1.5 seconds of detected traffic. This graphical traffic history shall also allow the option of displaying the measured speed or length of a detected vehicle.

The graphical interface shall operate on Windows CE, Windows 98, Windows 2000, Windows NT 4.0 and Windows XP Pro in the .NET framework. The software shall:

- Automatically select the correct baud rate and serial communication port from up to 15 serial communication ports
- Operate over a TCP/IP connection
- Support a dial-up modem connection
- Give the operator complete control over the configuration process
- Give the operator 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 the RVSD's non-volatile memory over any supported communication channel including TCP/IP networks.

## 10.0 RF Design

The circuitry shall be void of any manual tuning elements that could lead to human error and degraded performance over time.

All transmit modulated signals shall be generated by means of digital circuitry, such as a direct digital synthesizer, that is referenced to a frequency source that is at least 50 parts per million (ppm) stable over the specified temperature range, and ages less than 6 ppm per year. Any upconversion of a digitally-generated modulated signal shall preserve the phase stability and frequency stability inherent in the digitally-generated signal. These specifications ensure that, during operation, the RVSD strictly conforms to FCC requirements and that the radar signal quality is maintained for precise algorithmic quality.

The RVSD antennae shall be designed on printed circuit boards, eliminating the need for RF connectors and cabling that result in decreased reliability. Printed circuit antennae are less prone to physical damage due to their extremely low mass.

The antennae parameters shall meet the following two-way criteria to ensure quality performance:

- 6 dB Elevation Beam Width: > 65 degrees
- 3 dB Azimuth Beam Width: < 6 degrees
- Side Lobes: < -40 dB

## 11.0 Enclosure

The RVSD shall be enclosed in a Lexan polycarbonate, ultraviolet-resistant material and shall be classified as watertight according to the NEMA 250 Standard.

The enclosure shall be classified "f1" outdoor weatherability in accordance with UL 746C.

The RVSD shall be able to withstand a drop of up to five ft. without compromising its functional and structural integrity.

## 12.0 Input File Cards

The RVSD manufacturer shall provide an optional input file card compatible with 170, 2070, NEMA TS1, and NEMA TS2 input file racks. The input file card shall translate per vehicle data packets or real-time true presence packets from the RVSD into corresponding contact closure outputs. Operators shall be able to assign any contact closure output channel to any lane or detection zone. These settings shall be saved in non-volatile memory on the input file card for complete recovery in case of power failure.

The input file card shall support Dual Loop (Speed Trap) emulation, as well as the following modes of operation:

- **Pulse** (a single 125 ms output pulse for each vehicle)
- **Presence** (an output pulse corresponding to the duration of each vehicle in the detection zone with a resolution of 2.5 ms)
- **Actuation** (true presence output in real time with 2.5 ms resolution)
- **Single Loop Speed** (duration of the pulse corresponds directly to the speed of the vehicle,  $\text{speed (mph)} = 13.64/\text{duration in seconds}$ )

The input file card shall receive data packets over an RS-485 bus at any of the following baud rates: 9600, 19200, 38400, 57600 and 115200. The input file card shall also auto-baud and auto-detect an RVSD over wired and wireless communication channels that have a maximum latency of 500 ms.

The Input file card shall comply with the NEMA TS2-1998 Traffic Controller Assemblies with NTCIP Requirements (Section 2.8 specification). Documentation and results of the NEMA TS2-1998 test shall be provided.

Additionally, the input file card shall comply with the EN 61000-4-5 Class 4 lightning surge protection test specification. Documentation and results of the EN 61000-4-5 Class 4 test shall be provided.

## 13.0 Manufacturing Requirements

The RVSD shall be manufactured and assembled in the U.S.A. The internal electronics of the RVSD shall utilize automation for surface mount and wave solder assembly, and shall comply with the requirements set forth in IPC-A-610C Class 3, Acceptability of Electronic Assemblies.

The RVSD shall undergo a rigorous sequence of operational testing to ensure product functionality and reliability. Testing shall include:

- Functionality testing of all internal sub-assemblies
- Unit level burn-in testing of duration 48 hours or greater
- Final unit functionality testing prior to shipment

Test results and all associated data for the above testing shall be provided, for each purchased RVSD by serial number, upon request. Additionally, manufacturing quality data shall be maintained for each purchased RVSD by serial number and shall be made available upon request.

Externally, the RVSD shall be modular in design to facilitate easy replacement in the field. The total weight of the RVSD shall not exceed five pounds.

All external parts shall be made of corrosion resistant material, and all materials shall be protected from fungus growth and moisture deterioration.

#### **14.0 FCC**

Each RVSD shall be Federal Communications Commission (FCC) certified under CFR 47, Part 15, section 15.249 as an intentional radiator. This certification shall be displayed on an external label on each device according to the rules set forth by the FCC.

The RVSD shall transmit in the 24.00 – 24.25 GHz or another approved frequency band with 250 MHz of bandwidth available and shall comply with the appropriate requirements.

The manufacturer shall provide documentation proving compliance to all FCC specifications.

#### **15.0 NEMA 4X Testing**

The RVSD enclosure shall conform to test criteria set forth in the NEMA 250 Standard for Type 4X enclosures. Third party enclosure test results shall be provided for each of the following 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)

## 16.0 NEMA TS2-1998 Testing

The RVSD shall comply with the applicable standards stated in the NEMA TS2-1998 Standard. Third party test results shall be made available for each of the following tests:

- Shock pulses of 10g, 11 ms half sine wave
- Vibration of 0.5 Grms up to 30 Hz
- 300 V positive/negative pulses applied at one 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

## 17.0 Support

Installers and operators of the RVSD shall be 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, technical support shall be available to provide ongoing operator assistance.

### 17.1 Training

Training shall consist of comprehensive classroom labs and on-hand, in-the-field, installation and configuration training.

**Classroom Lab** training shall involve presentations outlining and defining the RVSD, its functions, and the procedures for proper operation. These presentations shall be followed by hands-on labs in which trainees shall practice using the equipment to calibrate and configure a virtual device. To facilitate the classroom presentation and hands-on labs, the vendor shall provide the following items for the duration of training:

- Knowledgeable trainer or trainers thoroughly familiar with the RVSD and its processes.
- Presentation materials, including visual aids, printed manuals and other handout materials for each student.
- Computer files, including video and raw data, to facilitate the virtual calibration and configuration of the RVSD.
- Laptop computers or Windows CE hand-held devices with the necessary software, and all necessary cables, connectors, etc.
- All other equipment necessary to facilitate the virtual calibration and configuration of the RVSD.

**Field Training** shall provide each trainee with the hands-on opportunity to install and configure the RVSD at roadside. Training shall be such that each trainee will mount and align the RVSD correctly.

## **17.2 Technical Assistance**

A manufacturer's technical representative shall be available to assist with the physical installation, alignment, and auto-configuration of each supplied RVSD. Technical support shall be provided thereafter to assist with troubleshooting, maintenance, or replacement of devices should such services be required.

## **18.0 Documentation**

The manufacturer shall supply the following documentation and specification test results at the time of the bid submittal. The following documents shall be attached:

- Auto-configuration documentation
- Volume accuracy data, including performance analyses for:
  - Free-flowing traffic
  - Congested traffic
  - Traffic with a lane roughly eight ft. beyond a concrete barrier
  - 20 foot and 240 foot lateral offset (simultaneous)
- Speed accuracy test data for both per-vehicle and average speed
- Occupancy accuracy test data
- Vehicle classification test data
- EN 61000-4-5 Class 4 Lightning Surge Protection test results
- FCC CFR 47 certification
- NEMA 250 Standard for Type 4X Enclosure third-party test data
- NEMA TS2-1998 Standard third-party test data

## **19.0 Warranty**

The RVSD shall be warranted free from material and workmanship defects for a period of two (2) years from date of shipment.

Missouri Highways and Transportation Commission  
Standard Bid/Proposal Provisions, General Terms and Conditions and Special Terms and Conditions

**STANDARD SOLICITATION PROVISIONS**

- a. The Missouri Department of Transportation (MoDOT) reserves the right to reject any or all bids/quotes/proposals, and to accept or reject any items thereon, and to waive technicalities. In case of error in the extension of prices in the bid/quote/proposal, unit prices will govern.
- b. All bids/quotes/proposals must be signed with the firm name and by a responsible officer or employee. Obligations assumed by such signature must be fulfilled.
- c. By virtue of statutory authority, a preference will be given to materials, products, supplies, provisions and all other articles produced, manufactured, made or grown, within the State of Missouri.
- d. Time of delivery is a part of the consideration and, if not otherwise stated in the solicitation documents, must be stated in definite terms by the Bidder/Offeror and must be adhered to. If time varies on different items, the Bidder/Offeror shall so state.
- e. If providing bids/quotes/proposals for commodities, the Bidder/Offeror will state brand or make on each item. If bidding or proposing other than the make, model or brand specified, the manufacturer's name, model number or catalog number must be given.
- f. **For bids/proposals of \$25,000** or more, no bids/proposals by telephone, telegram or telefax will be accepted. If provided, these bids/proposals should be returned in the MoDOT solicitation return envelope.
- g. If a solicitation return envelope is provided by MoDOT, the bid/quote/proposal should be returned in the envelope provided with the Bid/RFQ/RFP Request Number plainly indicated thereon.
- h. The date specified for the returning of bids/quotes/proposals is a firm deadline and all bids/quotes/proposals must be received at the designated office by that time. The Department does not recognize the U.S. Mail, Railway Express Agency, Air Express, or any other organization, as its agent for purposes of accepting proposals. All proposals arriving at the designated office after the deadline specified will be rejected.

**GENERAL TERMS AND CONDITIONS**

**General Performance**

- a. This work is to be performed under the general supervision and direction of the Missouri Department of Transportation (MoDOT) and, if awarded any portion of the work, the Contractor agrees to furnish at his own expense all labor and equipment required to complete the work, it being expressly understood that this solicitation is for completed work based upon the price(s) specified and is not a solicitation for rental of equipment or employment of labor by MoDOT, and MoDOT is to have no direction or control over the employees used by the Contractor in performance of the work.

**Deliveries**

- a. Unless otherwise specified on the solicitation documents or purchase order, suppliers shall give at least 24 hours advance notice of each delivery. Delivery will only be received between the hours of 8:00 a.m. to 3:00 p.m., Monday through Friday. Material arriving after 3:00 p.m. will not be unloaded until the following workday. No material will be received on Saturday, Sunday or state holidays.
- b. If the prices bid herein include the delivery cost of the material, the Contractor agrees to pay all transportation charges on the material as FOB - Destination. Freight costs must be included in the unit price bid and not listed as a separate line item.
- c. Any demurrage is to be paid by the Contractor direct to the railroad or carrier.

**Nondiscrimination**

- a. The Contractor shall comply with the Regulations relative to nondiscrimination in federally-assisted programs of the Department of Transportation, Title 49, Code of Federal Regulations, Part 21, as they may be amended from time to time, (hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this contract.
- b. All solicitations either by competitive bidding or negotiation made by the Contractor for work to be performed under a subcontract, including procurements of materials or leases of the Contractor's obligations under this contract and the Regulations, will be relative to nondiscrimination on the grounds of race, color, or national origin.
  - 1) **Sanctions for Noncompliance:** In the event of the Contractor's noncompliance with the nondiscrimination provisions of this contract, MoDOT shall impose such contract sanctions as it or the Federal Highway Administration may determine to be appropriate, including, but not limited to:
    - i. withholding of payments to the Contractor under the contract until the Contractor complies, and/or,
    - ii. cancellation, termination or suspension of the contract, in whole or in part.

**Contract/Purchase Order**

- a. By submitting a bid/quote/proposal, the Bidder/Offeror agrees to furnish any and all equipment, supplies and/or services specified in the solicitation documents, at the prices quoted, pursuant to all requirements and specifications contained therein.
- b. A binding contract shall consist of: (1) the solicitation documents, amendments thereto, and/or Best and Final Offer (BAFO) request(s) with any changes/additions, (2) the Contractor's proposal and/or submitted pricing, and (3) the MHTC's acceptance of the proposal and/or bid by purchase order or post-award contract.
- c. A notice of award does not constitute an authorization for shipment of equipment or supplies or a directive to proceed with services. Before providing equipment, supplies and/or services, the Contractor must receive a properly authorized purchase order and/or notice to proceed.
- d. The contract expresses the complete agreement of the parties and performance shall be governed solely by the specifications and requirements contained therein. Any change, whether by modification and/or supplementation, must be accomplished by a formal contract amendment signed and approved by and between the duly authorized representative of the Contractor and the duly authorized representative of the MHTC, by a modified purchase order prior to the effective date of such modification. The Contractor expressly and explicitly understands and agrees that no other method and/or no other document, including correspondence, acts, and oral communications by or from any person, shall be used or construed as an amendment or modification.

Missouri Highways and Transportation Commission  
Standard Bid/Proposal Provisions, General Terms and Conditions and Special Terms and Conditions

**Subcontracting**

- a. It is specifically understood that no portion of the material or any interest in the contract, shall be subcontracted, transferred, assigned or otherwise disposed of, except with the written consent of MoDOT. Request for permission to subcontract or otherwise dispose of any part of the work shall be in writing to MoDOT and accompanied by documentation showing that the organization which will perform the work is particularly experienced and equipped for such work.
- b. Consent to subcontract or otherwise dispose of any portion of the work shall not be construed to relieve the Contractor of any responsibility for the production and delivery of the contracted work and the completion of the work within the specified time.
- c. All payments for work performed by a subcontractor shall be made to the Contractor to whom the contract was awarded and the purchase order issued.

**Invoicing and Payment**

- a. MoDOT is exempt from paying Missouri Sales Tax, Missouri Use Tax and Federal Excise Tax. However, the Contractor may themselves be responsible for the payment of taxes on materials they purchase to fulfill the contract. A Federal Excise Tax Exemption Certificate will be furnished to the successful Bidder/Offeror upon request.
- b. Each invoice should be itemized in accordance with items listed on the purchase order and/or contract. The statewide financial management system has been designed to capture certain receipt and payment information. Therefore, each invoice submitted must reference the purchase order number and must be itemized in accordance with items listed on the purchase order. Failure to comply with this requirement may delay processing of invoices for payment.
- c. Unless otherwise provided for in the solicitation documents, payment for all equipment, supplies, and/or services required herein shall be made in arrears. The Missouri Highways and Transportation Commission (MHTC) shall not make any advance deposits.
- d. The MHTC assumes no obligation for equipment, supplies, and/or services shipped or provided in excess of the quantity ordered. Any authorized quantity is subject to the MHTC's rejection and shall be returned at the Contractor's expense.
- e. The MHTC reserves the right to purchase goods and services using the state-purchasing card.

**Applicable Laws and Regulations**

- a. The contract shall be construed according to the laws of the State of Missouri. The Contractor shall comply with all local, state, and federal laws and regulations related to the performance of the contract.
- b. The Contractor must be registered and maintain good standing with the Secretary of State of the State of Missouri and other regulatory agencies, as may be required by law or regulations. Prior to the issuance of a purchase order and/or notice to proceed, the Contractor may be required to submit to MoDOT a copy of their current Authority Certificate from the Secretary of State of the State of Missouri.
  - 1) Prior to the issuance of a purchase order and/or notice to proceed, all **out-of-state** Contractors **providing services** within the state of Missouri must submit to MoDOT a copy of their current Transient Employer Certificate from the Department of Revenue, in addition to a copy of their current Authority Certificate from the Secretary of State of the State of Missouri.
- c. The contractor shall only utilize personnel authorized to work in the United States in accordance with applicable federal and state laws and Executive Order 07-13 for work performed in the United States.
- d. The exclusive venue for any legal proceeding relating to or arising, out of the contract shall be in the Circuit Court of Cole County, Missouri.

**Preferences**

- a. In the evaluation of bids/quotes/proposals, preferences shall be applied in accordance with Chapter 34 RSMo. Contractors should apply the same preferences in selecting subcontractors.
- b. By virtue of statutory authority, RSMo. 34.076 and 34.350 to 34.359, a preference will be given to materials, products, supplies, provisions and all other articles produced, manufactured, made or grown within the State of Missouri. Such preference shall be given when quality is equal or better and delivered price is the same or less.
  - 1) If attached, the document entitled "**PREFERENCE IN PURCHASING PRODUCTS**" should be completed and returned with the solicitation documents.
  - 2) If attached, the document entitled "**MISSOURI DOMESTIC PRODUCTS PROCUREMENT ACT**" should be completed and returned with the solicitation documents. **Applies if bid is Twenty-Five Thousand Dollars (\$25,000.00) or more.**
- c. In the event of a tie of low bids, the MHTC reserves the right to establish the method to be used in determining the award

**Remedies and Rights**

- a. No provision in the contract shall be construed, expressly or implied, as a waiver by the MHTC of any existing or future right and/or remedy available by law in the event of any claim by the MHTC of the Contractor's default or breach of contract.
- b. The Contractor agrees and understands that the contract shall constitute an assignment by the Contractor to the MHTC of all rights, title and interest in and to all causes of action that the Contractor may have under the antitrust laws of the United States or State of Missouri for which causes of action have accrued or will accrue as the result of or in relation to the particular equipment, supplies, and/or services purchased or produced by the Contractor in the fulfillment of the contract with the MHTC.
- c. In the event a Contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the Contractor may request MoDOT to enter into such litigation to protect the interests of the MHTC, and, in addition, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

Missouri Highways and Transportation Commission  
Standard Bid/Proposal Provisions, General Terms and Conditions and Special Terms and Conditions

**Cancellation of Contract**

- a. The MHTC may cancel the contract at any time for a material breach of contractual obligations or for convenience by providing the Contractor with written notice of cancellation. Should the MHTC exercise its right to cancel the contract for such reasons, cancellation will become effective upon the date specified in the notice of cancellation sent to the Contractor.
- b. If the MHTC cancels the contract for breach, the MHTC reserves the right to obtain the equipment, supplies, and/or services to be provided pursuant to the contract from other sources and upon such terms and in such manner as the MHTC deems appropriate and charge the Contractor for any additional costs incurred thereby.

**Bankruptcy or Insolvency**

- a. Upon filing for any bankruptcy or insolvency proceeding by or against the Contractor, whether voluntary or involuntary, or upon the appointment of a receiver, trustee, or assigned the benefit or creditors, the Contractor must notify MoDOT immediately. Upon learning of any such actions, the MHTC reserves the right, at its sole discretion, to either cancel the contract or affirm the contract and hold the Contractor responsible for damages.

**Inventions, Patents, and Copyrights**

- a. The Contractor shall defend, protect, and hold harmless the MHTC, its officers, agents, and employees against all suits of law or in equity resulting from patent and copyright infringement concerning the Contractor's performance or products produced under the terms of the contract.

**Inspection and Acceptance**

- a. No equipment, supplies, and/or services received by MoDOT pursuant to a contract shall be deemed accepted until MoDOT has had reasonable opportunity to inspect said equipment, supplies, and/or services.
- b. All equipment, supplies, and/or services which do not comply with the specifications and/or requirements or which are otherwise unacceptable or defective may be rejected. In addition, all equipment, supplies, and/or services which are discovered to be defective or which do not conform to any warranty of the Contractor upon inspection (or at any later time if the defects contained were not reasonably ascertainable upon the initial inspection) may be rejected.
- c. The MHTC reserves the right to return any such rejected shipment at the Contractor's expense for full credit or replacement and to specify a reasonable date by which replacements must be received.
- d. The MHTC's right to reject any unacceptable equipment, supplies, and/or services shall not exclude any other legal, equitable or contractual remedies the MHTC may have.

**Warranty**

- a. The Contractor expressly warrants that all equipment, supplies, and/or services provided shall: (1) conform to each and every specification, drawing, sample or other description which was furnished to or adopted by MoDOT, (2) be fit and sufficient for the purpose expressed in the solicitation documents, (3) be merchantable, (4) be of good materials and workmanship, and (5) be free from defect.
- b. Such warranty shall survive delivery and shall not be deemed waived either by reason of the MHTC's acceptance of or payment for said equipment, supplies, and/or services.

**Status of Independent Contractor**

- a. The Contractor represents itself to be an independent Contractor offering such services to the general public and shall not represent itself or its employees to be an employee of the MHTC. Therefore, the Contractor shall assume all legal and financial responsibility for taxes, FICA, employee fringe benefits, workers' compensation, employee insurance, minimum wage requirements, overtime, etc., and agrees to indemnify, save and hold the MHTC, its officers, agents and employees harmless from and against any and all losses (including attorney fees) and damage of any kind related to such matters.

**Indemnification**

- a. The Offeror shall defend, indemnify and hold harmless the Commission, including its members and department employees, from any claim or liability whether based on a claim for damages to real or personal property or to a person for any matter relating to or arising out of the Offeror's performance of its obligations under this Agreement.