MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
RADAR VEHICLE DETECTION RADIUS

a. Description. This work consists of furnishing and installing a Radar Vehicle Detection Radius (RADIUS). The RADIUS must utilize a single radar sensor per intersection approach (up to four sensors) to detect and track vehicles at distances up to 600 feet for stop bar and advanced detection. Ensure the sensor system uses vehicle information from the radar sensor to provide precise detection for simultaneous stop bar presence detection and advanced detection. The sensor system must also include a video camera for surveillance purposes only.

b. Materials. Ensure the RADIUS consists of up to four radar sensors, equipped with two detection processors (DP) capable of processing up to two sensors each, one Central Control Unit (CCU) (either 19-inch rack or shelf-mount form factor), input/output extension modules (EM), surge suppressors, high-definition multimedia interface (HDMI) monitor and a pointing device, or any combination thereof.

1. RADIUS Hardware.

A. Hardware Requirements.

(1) Ensure the RADIUS is made in the United States of America in compliance with title 23 CFR 635.410 “Buy America” regulations.

(2) Ensure the DP is a single-rack detector card width and furnishes provision for up to two sensors per DP. It may be possible for DPs to be embedded in the CCU to furnish a single cabinet interface.

(3) Ensure each DP is supplied with communications and video from the RADIUS sensor via Category 5 (CAT5) specification cables plugged into the front of the CCU. Ensure the interface connectors are registered jack 45 (RJ-45) type.

(4) Furnish a LED indicator to indicate the presence of a video signal.

(5) Furnish detection status LEDs on the front panel of the DP. Where the DPs are integrated into the CCU, display the detection LEDs virtually on the setup tool software.

(6) Conformally coat DP printed circuit boards in accordance with *NEMA* specifications.

(7) Ensure the DP utilizes non-volatile memory technology to store on-board firmware and operational data.

(8) Ensure the CCU enables the loading of modified or enhanced software through either the Ethernet or front- panel universal serial bus (USB) port and without removing or modifying the CCU hardware. The upgrade will affect both the CCU and DP hardware when connected into a single system.

(9) Ensure the DP and EM are powered by 12 or 24 VDC.

(10) Ensure the RADIUS operates satisfactory in a temperature range from -30 °F to +165 °F and a humidity range from 0 percent relative humidity (RH) to 95 percent RH, non-condensing as set forth in the *NEMA* specifications.

B. Video Imaging Camera.

(1) The video imaging camera is intended for surveillance purposes only.

(2) Ensure the camera has a fixed focal length lens with fixed focus.

(3) Ensure the camera sensor produces a useable video image of the vehicle bodies under all roadway lighting conditions, regardless of time of day. Ensure the minimum range of scene luminance over which the camera can produce a useable video image is the minimum range from nighttime to daytime, but not less than the range 0.003 luminous emittance (lux) to 10,000 lux.

(4) Ensure the camera sensor luminance signal-to-ratio is more than 50 decibels (dB) with the automatic gain control (AGC) disabled.

(5) Ensure the camera sensor employs three-dimensional dynamic noise reduction to remove unwanted image noise.

(6) Ensure the camera sensor employs wide dynamic range technology to compensate for wide dynamic outdoor lighting conditions. Ensure the dynamic range is greater than 100 dB.

C. Radar Sensor.

(1) Ensure the radar sensor operates in the 24 Gigahertz (GHz) frequency band and operates on 1 of 7 available enumerated channels that is user selectable.

(2) Ensure detection range for the Stop Bar Only Sensor is up to 325 feet. Ensure detection range for the Stop Bar and Advanced Sensor is up to 600 feet.

(3) Ensure the radar sensor can track up to 64 independent objects simultaneously.

(4) Ensure object speed detection is within a range of 0 to 150 mph.

(5) Ensure the radar sensor can detect vehicles in 1 to 6 traffic lanes.

(6) House the radar sensor in a weather-tight sealed enclosure in accordance with ingress protection 67 specifications. The housing must allow the radar to be adjusted to allow proper alignment between the sensor and the traveled road surface.

(7) Ensure when mounted outdoors in the enclosure, the radar operates in a temperature range from -30 °F to +165 °F and a humidity range from 0 percent RH to 100 percent RH.

(8) Ensure the radar sensor is powered by 48 VDC. Ensure power consumption is 8 watts typical.

(9) Ensure the maximum distance between the sensor and the CCU is 1000 feet utilizing an outdoor rated shielded CAT5 or CAT6 cable.

D. Central Control Unit (CCU).

(1) Supply the CCU in two form factors. Users may choose one form factor for use within their controller cabinet system.

(a) Standard One Rack Unit 19-inch rack format. Ensure there are brackets to allow the CCU to be mounted under shelves where a 19-inch frame is not available.

(b) Shelf Mount format, TS2 version. Ensure the CCU will stand up on available shelf space within the cabinet. Ensure all connections are made from the front of the CCU, and no external processors will be required.

(2) Ensure the 19-inch Rack-mount CCU is powered from an 110 volt (V) or 230 V, 50 hertz (Hz) or 60 Hz supply. Ensure CCU power consumption does not exceed 20 watts.

(3) Power the Shelf-mount format CCU from a 48 VDC power supply. Ensure CCU power consumption does not exceed 150 watts.

(4) Furnish 2 USB (A) ports on the front of the CCU unit. These ports can be utilized for various functions. For example, keyboard and mouse functions during system configuration, USB storage devices can be utilized for bin data and video collection. Ensure the USB ports does not require special mouse software.

(5) Ensure EM are available for additional outputs. Ensure the EM is available in both 2 and 4 channel configurations.

(6) Ensure the CCU utilizes non-volatile memory technology to store on-board firmware and operational data.

(7) Ensure the CCU operates in a temperature range from -30 °F to +165 °F and a humidity range from 0 percent RH to 95 percent RH, non-condensing as set forth in *NEMA* specifications.

(8) Ensure the CCU incorporates power surge suppression both on the input power and on the power supplied to the sensors. Ensure the CCU is appropriately grounded to the cabinet ground rod using #14 AWG as a minimum.

(9) Furnish four ports for connection to RADIUS sensors or camera sensors for

the CCU. Ensure the connector is a RJ-45 type.

(10) Furnish four ports for connection to Detection Processors (rack-mount version) for the CCU. Ensure the connector is a RJ-45 type.

(11) Ensure the CCU provides an output to a monitor. Ensure the port is HDMI.

(12) Ensure the CCU is provided with an Ethernet communications port. Ensure the Ethernet port is compliant with *Institute for Electrical and Electronics Engineering (IEEE)* 802.3 and uses a RJ-45 type connector mounted on the front of the CCU. This port will allow the user to remotely configure the system and/or to extract data.

(13) Ensure the CCU provides a synchronous data link control (SDLC) connection to the Traffic Controller. Ensure the connector is a D-15 type, in compliance with *NEMA TS-2* specifications.

(14) Ensure the CCU has an indicator when the SDLC port is active, the unit has power, and when the unit is online.

(15) Ensure the CCU provides a wireless fidelity (Wi-Fi) connection. Ensure the connection is over standard 2.4 GHz connection. Enable and disable the Wi-Fi connection by a switch on the CCU. Ensure the CCU provides an indicator when the Wi-Fi connection is active.

(16) Ensure the CCU provides a connection for a removable antenna. Ensure the antenna connection is a subminiature version A Male type.

(17) Ensure the CCU provides system status via an on-board Organic LED display. Ensure the display indicates various system parameters, such as sensor health and DP health, and firmware version. Ensure the display is enabled with a switch on the CCU. The display will automatically disable 15 minutes after the button is pressed.

2. RADIUS Software.

A. Include system software that detects the presence of individual vehicles and for single or multiple lanes. Detection zones are defined using only an embedded software application. A monitor, a keyboard and a pointing device are used to place zones. Ensure a minimum of 32 radar detection zones plus 5 trip lines per sensor are available.

B. Program detection zones via an embedded application displayed on a video monitor and a pointing device connected to the CCU. Ensure the menu facilitates placement of detection zones and setting of zone parameters or to configure system parameters. Ensure a separate computer is not required for programming detection zones or to view system operation. All programming function must occur on live video images and radar blips, no snapshots or still images are allowed.

C. Ensure the RADIUS software stores up to five completely independent detection zone patterns in non-volatile memory. The RADIUS can switch to any one of the five different detection patterns within 1 second of user request via menu selection with the pointing device. Ensure each configuration is uniquely labeled and able to be edited by

the user for identification. Display the currently active configuration indicator on the monitor.

D. Ensure the RADIUS detects vehicles in real time as they travel across each radar detection zone.

E. Ensure the RADIUS accepts new detection patterns from an external computer through the Ethernet port. Furnish with the system a Windows-based software designed for local or remote connection, providing video capture, real-time detection indication and detection zone modification capability.

F. Ensure the RADIUS can automatically switch to any one of the stored configurations based on the time of day and is programmable by the user.

G. Ensure the RADIUS sends its detection patterns to an external computer through the Ethernet port.

H. Ensure the RADIUS defaults to a safe condition, such as a constant call on each active detection channel, in the event of unacceptable interference or loss of the video and/or radar sensor signal.

I. Ensure up to 32 detection zones per sensor input are supported and each detection zone can be sized to suit the site and the desired vehicle detection region.

J. When a vehicle is detected within a detection zone, ensure a visual indication of the detection is activated on the video and radar overlay display to confirm the detection of the vehicle for the zone.

K. Ensure detection accuracy (a minimum of 95 percent) is enforced for the entire design field of view on a lane by lane and on a time period basis.

L. Ensure the RADIUS provides dynamic zone reconfiguration to enable normal operation of existing detection zones when one zone is being added or modified during the setup process. Ensure the new zone configuration does not go into effect until the configuration is saved by the operator.

M. Ensure detection zone setup does not require site specific information such as latitude and longitude to be entered into the system.

N. Ensure the RADIUS processes the radar signals from each sensor at 75 millisecond intervals. Multiple processors must process all radar signals simultaneously.

O. Ensure the RADIUS processes the video input from each camera at 30 frames per second. Multiple camera processors must process all video inputs simultaneously.

P. Ensure detection zone outputs are individually configurable to allow the selection of presence, pulse, extend, and delay outputs. Ensure timing parameters of pulse, extend, and delay outputs are user definable between 0.1 to 25.0 seconds.

Q. Up to eight detection zones per sensor view must have the capability to count the number of vehicles detected. Store the count value internally for later retrieval through

the Ethernet port. Ensure the zone can also calculate and store average speed and lane occupancy at user-selectable bin intervals of 10 seconds, 20 seconds, 1 minute, 5 minutes, 10 minutes, 15 minutes, 30 minutes, and 60 minutes.

R. In addition to the count type zone, ensure the RADIUS calculates average speed and lane occupancy for all the video detection zones independently. Ensure these values are stored in non-volatile memory for later retrieval.

S. Ensure the radar sensor has the capability to control the output of each radar detection zone based on a minimum or maximum speed. The minimum speed can be set from 0 mph to 249 mph. The maximum speed can be set between 1 mph to 250 mph.

T. Ensure the RADIUS can show phase status (green, yellow, or red) for up to eight phases. Ensure these indications can be color coded.

3. User Interfaces. This section sets forth the minimum requirements for the RADIUS to furnish to stream up to four simultaneous video streams over an Ethernet interface.

A. Ensure the user interface provides capabilities to enable multiple rack-mounted detection processors to be locally and remotely accessed from a single point via an Ethernet connection.

B. Ensure the device allows the operator to view four videos simultaneously or any one video by controls embedded in the RADIUS.

C. Ensure local user access to detection programming is limited to the detection processor unit that is currently being displayed on the monitor.

D. Ensure all local programming and setup parameters for the detection processor is user accessible through the interface unit without requiring the user to swap user interface cables between detection processors.

E. Ensure remote access to the device is through the built-in Ethernet port via access software running on a Microsoft Windows based personal computer.

F. Ensure a Windows operating system (OS) remote access firmware is also available for remote setup and diagnostics of the interface units.

G. Support streaming video technology using H.264 standards to allow the user to monitor video detection imagery over the Ethernet interface. Motion Joint Photographic Experts Group streaming video will not be allowed.

H. Ensure the interface unit allows eight independent streams, one from each detection processor, to be transported via Ethernet to four independent streaming video players simultaneously in D1 resolution.

I. Ensure the interface allows the user to select the resolution of the displayed streamed video.

J. Ensure the interface unit supports the streaming and display of four concurrent streams in D1 resolution.

K. Ensure the interface allows the user to change the unit's Ethernet network settings of IP address, subnet mask, remotely or on-site.

L. Allow the user to upload new application firmware through the use of the interface, remotely or on-site.

M. Ensure a Windows OS based application is provided to remotely view video streams from the RADIUS.

N. Ensure a Windows based personal computer application is available to remotely access each configured RADIUS on the agency's network. The application must allow the user to choose multiple intersection locations to be displayed simultaneously on the screen. Intersections can be displayed in alphanumeric order. Groups of intersections can be configured to be displayed simultaneously to allow the user to monitor particular corridors of detection. Multiple groups may be configured in the application.

4. Warranty. Furnish materials with a manufacturer's warranty, transferable to the Department or the local agency responsible for the project, that the supplied materials are free from all defects in materials and workmanship. Furnish the warranty and other applicable documents from the manufacturer, and a copy of the invoice showing the date of shipment, to the Engineer prior to acceptance.

c. Construction. Furnish and install a RADIUS as shown on the plans or as directed by the Engineer. Ensure that the RADIUS is installed as documented by installation materials provided by the manufacturer. Complete this work in accordance with sections 818 and 820 of the Standard Specifications for Construction, the applicable typical signal construction detail, and this special provision.

Recommended sensor/camera placement height is 21 to 33 feet above the roadway and/or as shown on the plans, and over the traveled way on which vehicles are to be detected. For optimum detection, the sensor/camera should be centered above the traveled roadway. Ensure sensor/camera placement and field of vision are unobstructed and as noted in the installation documentation provided by the supplier.

When RADIUS system is called for, deliver all equipment internal to the controller cabinet to the MDOT Statewide Signal shop or to the inspecting agency for setup and installation in the controller cabinet.

Do not install the RADIUS equipment until all other signal equipment has been installed and inspected. Obtain the Engineer's approval prior to beginning multi-sensor installation. Correct multi-sensor installation that was completed prior to the approval of the Engineer, and which is found to be non-optimal placement of the sensor/cameras at no additional cost to the contract. The Engineer will not authorize extra payment or time extensions for work required to reorient or move the sensor(s).

The supplier must provide a limited 3-year warranty on the RADIUS. During the warranty period, ensure technical support is available from the supplier via telephone within 4 hours of the time a call is made by a user, and this support is available from factory-certified personnel or factory-certified installers. During the warranty period, ensure updates to CCU or DP software are available from the supplier without charge.

d. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay items:

Pay Item	**Pay Unit**
Radar Vehicle Detection Radius System	Each
Radar Vehicle Detection Radius, Stop Bar Sensor	Each
Radar Vehicle Detection Radius, Stop Bar Advance Sensor	Each

1. **Radar Vehicle Detection Radius System** includes furnishing and installing the radar system, interface unit, contact closure hardware, Bus Interface Unit, cable, connectors, and other appurtenant material required to complete the work.

2. **Radar Vehicle Detection Radius, Stop Bar Sensor** includes furnishing and installing the radar sensor, enclosure, mounting bracket, hardware, cable, connectors, and other appurtenant material required to complete the work.

3. **Radar Vehicle Detection Radius, Stop Bar Advance Sensor** includes furnishing and installing the radar sensor, enclosure, mounting bracket, hardware, cable, connectors, and other appurtenant material required to complete the work.