MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
HEMISPHERICAL VIDEO DETECTION

a. Description. This work consists of installing or removing a single hemispherical video detection system and/or camera which detects vehicles on multiple roadway approaches at an intersection using only video images of vehicle traffic and is compatible with solid state pre-timed or actuated traffic signal control equipment and cabinet environments.

As applicable, this work includes installing or removing the necessary wiring, mounting brackets, mounting hardware, conduit, cable connectors, grounding and any other material required to ensure a complete installation or removal as specified for a location.

b. Material. Provide materials, as directed by the Engineer, necessary to provide a complete and operating job. Provide materials in accordance with sections 918 and 921 of the Standard Specifications for Construction and this special provision.

1. System Requirements.

A. System Hardware. Provide a hemispherical video detection system that is composed of these principal items:

(1) Hemispherical camera(s);

(2) A field communications link consisting of a single Category 5 (CAT5)e cable between each camera and the video imaging vehicle detection system (VIVDS) processor;

(3) VIVDS processor along with a video monitor or associated equipment required to setup the VIVDS processor and software to communicate to the VIVDS processor.

B. System Software. Provide a VIVDS processor that is either *NEMA TS 2 TYPE 1* or *NEMA TS 2 TYPE 2* with a recommended standard (RS) 485 synchronous data link control (SDLC). Ensure the VIVDS processor has at least four processing cores of 2.8 Gigahertz (GHz) or greater, a minimum of 3 Gigabyte (GB) random access memory (RAM), and at least 32GB of onboard storage.

2. Functional Capabilities.

A. Provide system software that is able to detect either approaching or departing vehicles in multiple traffic lanes and have a minimum of 24 detector outputs per VIVDS processor. Ensure each zone and output is user definable through interactive graphics by drawing arbitrarily shaped polygons using the field setup computer or central control. Ensure the user is able to redefine previously defined detection zones.

B. Ensure the VIVDS processor provides real time vehicle detection (within 500 milliseconds (ms) of vehicle arrival).

C. Ensure the system can detect the presence of vehicles in up to 64 detection zones per camera.

D. Ensure detection zones are sensitive to the direction of vehicle travel and the direction to be detected by each detection zone is user programmable.

E. Ensure the VIVDS processor unit can compensate for minor camera movement (up to 2 percent of the field of view at 400 feet) without falsely detecting vehicles and that the camera movement is measured on the unprocessed video input to the VIVDS processor.

F. Provide a camera that operates while directly connected to VIVDS processor unit.

G. Ensure the video detection system operates with the monitoring equipment (monitor and/or laptop) disconnected or on-line once the detector configuration has been downloaded or saved into the VIVDS processor.

H. Ensure when the monitoring equipment is directly connected to the VIVDS processor, it can view vehicle detections in real time as they occur on the field setup computer's color video graphics adapter (VGA) display or the video monitor.

I. Provide a VIVDS processor that supports 1 or 2 omnidirectional view cameras. If equipped with 1 omnidirectional view camera, ensure the VIVDS processor is also capable of simultaneously supporting up to four more traditional view cameras for special needs such as advance detection or underpass detection.

3. Vehicle Detection.

A. Detection Zone Placement.

(1) Provide a hemispherical video detection system with flexible detection zone placement anywhere within the combined field of view of the image sensors. Ensure that preferred presence detector configurations are arbitrarily shaped polygons, including simple boxes, drawn across lanes of traffic or placed in line with lanes of traffic.

(2) Ensure a single detector is able to replace one or more conventional detector loops.

B. Detection Zone Programming.

(1) Ensure that a graphical interface video image of the roadway is used for the placement of detection zones.

(2) Ensure the monitor shows images of the detection zones superimposed outlined or filled, with a visible change indicating detection on the video image of traffic while the VIVDS processor is running verifying proper operation of the detection

system. Provide a VIVDS processor with a display that will indicate proper operation of the detection zones with the absence of video.

(3) Ensure the detection zones are created using the mouse or keypad to draw detection zones on the monitor and are capable of being sized and shaped to provide optimal road coverage and detection. Ensure that detector configurations can be uploaded to the VIVDS processor and that the detector configuration that is currently running can be retrieved from the VIVDS processor.

(4) Ensure that the mouse or keypad can be used to edit previously defined detector configurations so as to fine tune the detection zone placement, size and shape. Ensure that detection continues to operate from the detector configuration that is currently called while fine-tuning is being done.

(5) Ensure that the hemispherical video detection system is sensitive to the direction of vehicle travel with the direction to be detected by each detection zone to be user programmable. Ensure the vehicle detection zone does not activate from cross-street traffic, wrong way traffic, or from a vehicle traveling any direction other than the one specified for detection occupies the detection zone.

(6) Ensure detection zones have the option for the user to define that calls can be made with a side entrance (90 degrees or less angled entrance).

C. Design Field of View. Ensure the hemispherical video detection system can reliably detect vehicle presence in the design field of view. Ensure the design field of view is defined as the sensor view when the image sensor is mounted 30 feet or higher above the roadway, when the camera is adjacent (within 15 feet) to the edge of the nearest vehicle travel lane, and when the length of the detection area is not greater than 5 times the mounting height of the image sensor. Within this design field of view, ensure the VIVDS processor unit is capable of setting up a single detection zone for point detection (equivalent to the operation of a 6 foot by 6 foot inductive loop). Ensure a single camera, placed at the proper mounting height, is able to monitor up to and including 5 traffic lanes simultaneously. Ensure a single omnidirectional camera, placed at the proper mounting height, is able to monitor detection zones in at least intersection approaches.

D. Detection Performance. Ensure detection accuracy of the video detection system is comparable to properly operating inductive loops. Detection accuracy must include the presence of any vehicle in the defined detection zone regardless of the lane, which the vehicle is occupying. Occlusion produced by vehicles in the same or adjacent lanes is not considered a failure of the VIVDS processor, but a limitation of the camera placement. 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. When specified on the plans, furnish up to 24 continuous hours of recorded video of all installed intersection cameras within the 30 day test period for verification of proper camera placement, field of view, focus, detection zone placement, processor setup and operation. The video from each camera must show vehicle detections for all zones.

4. VIVDS Processor.

A. Provide a VIVDS processor that is shelf mountable.

B. Provide a VIVDS processor that has a modular electrical design.

(1) The VIVDS processor must operate within a range of 89 to 135 volts alternating current (VAC), 60 Hertz (Hz) single phase. Ensure power to the VIVDS processor is from the transient protected side of the AC power distribution system in the traffic control cabinet in which the VIVDS processor is installed.

(2) Ensure communications to the field setup computer are through an Ethernet port. Ensure this port is able to download the real time detection information needed to show detector actuations.

(3) Ensure the VIVDS processor has an Ethernet connection on the front of the unit for the connection to the first camera. If a second camera is installed at the intersection, the camera will connect with the VIVDS processor through a connector mounted on the side of the processor.

(4) Provide a unit that is equipped with a single VGA video output. Ensure this output is capable of displaying the operation and detections of the VIVDS processor.

(5) Ensure the change log for all software upgrades and/or changes are presented on a readily assessable internet site with unencumbered public access.

(6) The unit software and the supervisor software must include diagnostic software to allow testing the VIVDS functions. This must include the capability to set and clear individual detector outputs and display the status of inputs to enable setup and troubleshooting in the field.

C Provide camera interface panel capable of being mounted to sidewalls of a controller cabinet for protection of the VIVDS processor and camera CAT5e connection. The panel must consist of, as a minimum, two CAT5e cable surge protection connections.

D. Environmental Requirements.

(1) Provide a VIVDS processor that is designed to operate reliably in the adverse environment found in the typical roadside traffic cabinet.

(2) Ensure that the VIVDS processor meets the environmental requirements set forth by the latest *NEMA TS1* and *TS2* standards as well as the environmental requirements for Type 170, Type 179 and 2070 controllers.

(3) Ensure the operating temperature is from -30 degrees Fahrenheit (F) to +165 degrees F at 0 percent to 95 percent relative humidity, non-condensing.

5. Hemispherical Camera Assembly.

A. Provide a hemispherical camera that:

(1) Uses high resolution, color image sensors as the video source for real time vehicle detection;

(2) Uses cameras that are approved for use with the VIVDS processor unit by the

supplier of the hemispherical video detection system.

(3) As a minimum, provides the following capabilities:

(a) Ensure images are produced with a complementary metal-oxide semiconductor (CMOS) sensing element with horizontal resolution of at least 2580 lines and vertical resolution of at least 1920 lines. Ensure images are output in digital format as Motion Joint Photographic Experts Group (MJPEG) image.

(b) Ensure the useable video and resolvable features in the video image are produced when those features have luminance levels as low 1.0 lux for color, for night use and as high as 10,000 lux during the day.

(c) Ensure the camera includes an electronic shutter control based upon average scene luminance and is equipped with fixed field of view and fixed focus lens which does not require opening the camera enclosure. Ensure the fixed focus lens is always in focus without any required end-user adjustments.

B. Provide a camera and lens assembly that is housed in an environmental enclosure that provides the following capabilities:

(1) Ensure the enclosure is waterproof and dust tight to the *NEMA* 4 specifications.

(2) Ensure the enclosure allows the camera to operate satisfactorily over an ambient temperature range from -30 degrees F to +165 degrees F while exposed to precipitation as well as direct sunlight.

(3) Ensure the enclosure includes a provision for connection of the CAT5e cable. Ensure input power to the environmental enclosure is included in the Ethernet interface.

(4) Provides a thermostatically controlled heater at the front of the enclosure to prevent the formation of ice and condensation. The heater must not interfere with the operation of the camera electronics, and it must not cause interference with the video signal.

(5) Ensure the enclosure is light colored or unfinished and is designed to minimize solar heating. Any plastics used in the enclosure must include ultra violet inhibitors.

(6) Ensure the total weight of the image sensor in the environmental enclosure is less than 10 pounds.

(7) Provides waterproof quick disconnect connectors to the camera for the CAT5e connection.

(8) Provides camera mounting hardware that allows for vertical or horizontal mounting to the camera enclosure.

6. Field Communication Link.

A. Provide a field communications link that supports a two way communications

connection from the camera to the VIVDS processor.

B. In locations where the plans indicate CAT5e cable is required as the primary communications link, ensure this cable is burial grade as well as suitable for above ground direct sunlight applications.

C. Ensure all connection cables are continuous from the equipment cabinet to the camera connector.

D. Install lightning and transient surge suppression devices on the processor side of the field communications link to protect the peripheral devices. Ensure the suppression devices are all solid state. The devices must present high impedance to, and must not interfere with, the communications lines during normal operation. The suppression devices must not allow the peak voltage on any line to exceed 300 percent of the normal operating peak voltage at any time. The response time of the devices must not exceed 5 nanoseconds.

7. Warranty. Provide materials with a 3 year manufacturer's warranty, transferable to the MDOT, 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. Install and/or remove the hemispherical video detection system and/or hemispherical video detection camera as indicated on the plans or as directed by the Engineer. All work must comply with sections 819 and 820 of the Standard Specifications for Construction, the applicable "typical" signal construction detail, and this special provision. Storage and/or disposal of the removed material is included and must comply with section 204 of the Standard Specifications for Construction or as directed by the Engineer.

1. Ensure the hemispherical video detection system is installed as recommended by the manufacturer and documented in installation materials provided by the manufacturer.

2. Ensure the camera equipment is not installed until all other signal equipment has been installed and inspected for correctness. Premature installations of camera equipment that need to be moved in order to make the system operate will be moved at the Contractor's cost. This movement will not qualify for extra payment or for time extensions. Deliver the VIVDS processor to the MDOT Statewide Signal shop or the inspecting agency representing MDOT for setup and installation in the controller cabinet.

3. Install or remove the hemispherical video detection system as indicated on the plans which includes the VIVDS processor, hardware, fittings, cable, connectors, grounding and all other material required to complete the work.

4. Install or remove the hemispherical video detection camera as indicated on the plans which includes the video detection camera, enclosure, mounting bracket, hardware, cable, connectors, and other material required to complete the work.

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**

Hemispherical Video Detection Camera .....Each
Hemispherical Video Detection System .....Each
Hemispherical Video Detection Camera, Rem .....Each
Hemispherical Video Detection System, Rem .....Each
Hemispherical Video Detection Camera, Salv .....Each
Hemispherical Video Detection System, Salv .....Each

1. **Hemispherical Video Detection Camera** includes everything necessary to ensure a complete and operating job, which detects vehicles on multiple roadway approaches at an intersection, as shown on the plans or as directed by the Engineer.

2. **Hemispherical Video Detection System** includes everything necessary to ensure a complete and operating job, as shown on the plans or as directed by the Engineer.

3. **Hemispherical Video Detection Camera, Rem** includes removing, storing and disposing of removed material for a hemispherical video detection camera.

4. **Hemispherical Video Detection System, Rem** includes removing, storing and disposing of removed material for a hemispherical video detection system.

5. **Hemispherical Video Detection Camera, Salv** includes removing an existing hemispherical video detection camera, storing the removed materials on site, and reinstalling materials at a location shown on the plans.

6. **Hemispherical Video Detection System, Salv** includes removing an existing hemispherical video detection system, storing the removed materials on site, and reinstalling materials at a location shown on the plans.