

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
INTERSECTION WARNING SYSTEM (IWS)

SUP:DG

1 of 12

ITS:APPR:CLC:DBP:12-15-09

a. Description. This section describes wireless vehicle detection system (VDS), flashing beacons, and system controllers (SC) (including logic control software) which are to be provided as part of an IWS. The work consists of providing all labor, materials, equipment, and software necessary to furnish, install, test, integrate, configure, and provide a warranty for a fully-functional and operational IWS. The work also includes all documentation and training necessary to operate and maintain the equipment and software.

The IWS is based on notification of vehicle occupancy at a two-way stop intersection. Wireless vehicle data will be processed by a SC that will determine occupancy and activate 2 flashing beacons based on real-time local conditions. The VDS, flashing beacons, SC, and IWS software are described in this special provision. The vehicle detectors and flashing beacons are required to complete the IWS and are described and paid for under separate special provisions.

This work must be done in accordance with the standard specifications, except as modified herein. The Plans indicate the quantity, location, sensor types and components required for each site, and the power available at these locations.

1. General. The IWS is comprised of the following components.

A. System Controller (SC). Provides remote (in-field) logic processing of all vehicle detector inputs and provides an output to the flashing beacon activation via the Input/Output (I/O) relay panel.

B. Vehicle Detection System (VDS). Detects the occupancy, and class of vehicles for each discrete travel lane and direction. See the Special Provision for Wireless Vehicle Detection System for requirements.

C. Optical Flashing Beacon. Flashing beacon units provide a visible means of alerting motorists as to the presence of an event.

D. Input/Output Relay Panel and Beacon Controller. Receives a contact closure input from the SC and serves as an on/off switch for the flashing beacon.

E. Power/Data Equipment. Provide power/data cabling between the field sensors/devices and the SC.

2. Summary.

A. Furnish, install, integrate, test, train, and provide a warranty for all equipment, software, components and communications necessary to provide complete functionality without additional expense to the Department which meets or exceeds all testing

requirements as noted on the Plans and in accordance with this special provision.

B. Furnish and install the required communications pathways with all accessories to the specified communications demark points as shown on the Plans.

3. Requirements of Regulatory Agencies. Comply with the latest edition of the following codes or standards.

- A. American National Standards Institute Standard C2 (ANSI).
- B. Lightning Protection Institute (LPI) Standards 175.
- C. MIL-E-5400T General Specification for Electronic Equipment, Aerospace.
- D. National Electrical Manufacturers Association (NEMA).
- E. National Fire Protection Association (NFPA) 70 - National Electrical Code (NEC).
- F. NFPA 780 - Lightning Protection Code.
- G. Underwriters Laboratories Standards 96 and 96A (UL).

4. Definitions.

- A. AC. Alternating Current is an electric power designator.
- B. IWS. Intersection Warning System.
- C. Demark. Demarcation point of the communications network.
- D. EMI. Electromagnetic Interference.
- E. FB. Flashing Beacon.
- F. IEEE. Institute of Electrical and Electronic Engineers.
- G. IP. Internet Protocol.
- H. ITS. Intelligent Transportation Systems.
- I. I/O. Input/Output.
- J. Kbps. 1000 bits per second.
- K. LAN. Local Area Network.
- L. Mbps. 1 Million bits per second.
- M. NEMA. National Electrical Manufacturers Association.
- N. NTCIP. National Transportation Communications for ITS Protocol.

- O. RH. Relative Humidity.
- P. RMM. Remote Maintenance Monitoring.
- Q. RS-232. Recommended Standard 232. Low speed, short distance serial communication interface specification.
- R. RS-485. Recommended Standard 485. High speed, long distance serial communication interface specification.
- S. SC. System Controller.
- T. UPS. Uninterruptible Power Supply.
- U. VDS. Wireless Vehicle Detection System.

b. Materials.

1. Integrate and test all equipment installed to provide complete ITS functionality in all respects. Current versions, patches, releases, license requirements, and related configuration/development options are all the responsibility of the Contractor and will not be paid for separately.

2. General Requirements.

A. All materials furnished, assembled, fabricated, or installed under this section must be new, corrosion resistant, and in accordance with the details shown on the Plans and in this special provision.

B. The IWS must provide local control 24 hours a day, automatically as shown on the Plans and must include an interface for access to critical system functions. Must implement security features minimizing unauthorized access.

C. Integrate the IWS to provide full functionality of VDS, FB, and field processing as specified herein.

D. Connect vehicle detectors via wireless access point (AP) to a SC located within the field cabinet centrally located between the FBs as shown on the Plans.

E. Install sensors, devices, and infrastructure in accordance with manufacturer's guidelines and recommendations.

F. Available power for the IWS is noted on the Plans. Provide necessary power and service disconnects to isolate the IWS equipment for maintenance and emergency operations.

G. Electrical components must operate on 120 volts alternating current (VAC) (± 10 percent) 60 hertz (Hz) electricity. Provide power supplies that provide the required operating voltage, regulated voltage as needed and rectify current in accordance with actual equipment needs. Provide appropriate direct current (DC) conversion for any

equipment requiring DC power. All power transformers must be “fastening mechanism” type. No “plug-in” types will be provided. Corded transformers must be mountable with the ability to neatly secure power cords.

H. Outdoor enclosures housing electronic equipment must withstand hose-directed water, exposure to sand, dust, fungus, and salt atmosphere per MIL-E-5400T, Paragraphs 3.2.24.7, 3.2.24.8, and 3.2.24.9. All connections will be completely watertight.

I. Equipment must protect personnel from exposure to high voltage, as applicable, during equipment operation, adjustments, and maintenance.

J. Comply with all working clearances and dedicated spaces per NEC Articles 110, 384 and 800-5, as well as all current NEC articles, and Federal, State, and Local regulations as applicable.

K. Protect electronic equipment by lightning protection, surge protection (power and communications), grounding, and bonding (see special provision and Plans).

L. Connect the following equipment and structures via a single point system to the grounding system as shown on the Plans.

(1) Pole, pole mounted (or pad mounted) cabinet, equipment, and foundation (rebar).

(2) SC, field cabinet, and equipment.

M. Construct poles and structures to assure survivability in accordance with equation EQ. 3-1 for wind pressure as specified in the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Structural Supports Highway Sign, Luminaries and Traffic Signals. Use the following parameters in EQ. 3-1 calculations.

(1) Basic Wind Speed. $V = 90$ miles per hour (MPH).

(2) Gust Effect Factor. $G = 1.14$.

(3) Velocity Conversion Factor. $C_v = 1.00$.

(4) Wind Importance Factor. $I_r = 1.00$.

N. Self Start. The IWS must have an automated reset system, which in case of a power failure or other interruption of normal operation, allows the system to return to normal operation.

O. On-Site Testing. The IWS must be capable of on-site testing, for the purpose of a field technician to conduct maintenance checks of the system operation.

P. EMI Protection. Minimize susceptibility of the IWS to EMI enabling the IWS to operate successfully in the complex electromagnetic environment. The IWS must not cause interference to existing systems.

3. Functional and Performance Requirements.

A. Wireless Vehicle Detection System (VDS).

(1) The VDS detects and/or counts vehicles using battery powered magnetometers utilizing wireless communications to transmit detection information. The VDS will be paid for under the Special Provision for Wireless Vehicle Detection System.

(2) The VDS must determine vehicle occupancy, over each travel lane before and after the stop sign utilizing vehicle detector data. In addition, all data sent to the SC must be in real-time and not as a collected average. The occupancy of the vehicles detected represents a single detection point before the stop sign and multiple detection points after the stop sign.

(3) The VDS includes an Access Point (AP) and a contact closure unit that transmits vehicle data to the SC.

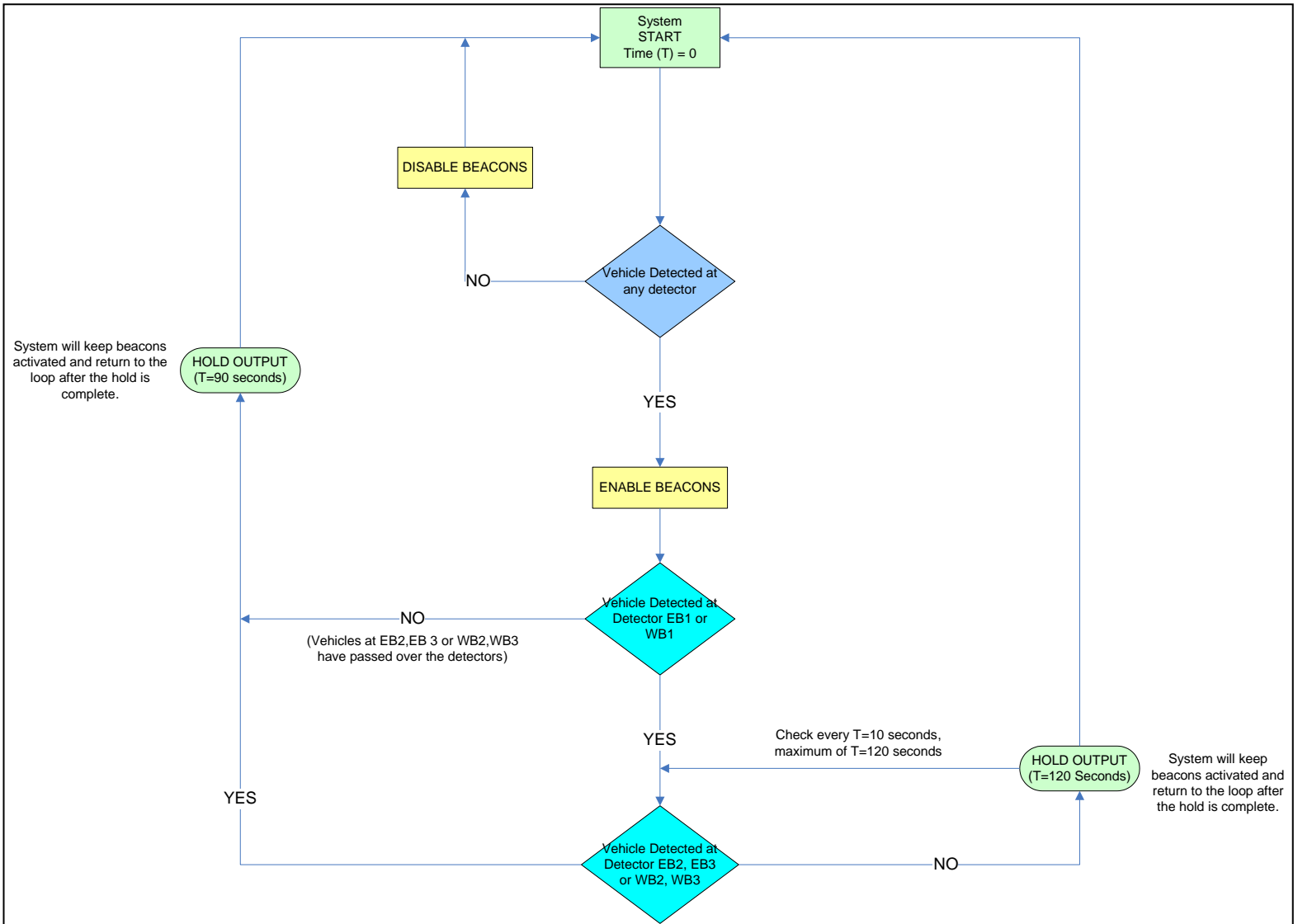
(4) The contact closure unit must communicate with SC using a minimum of 1 cable, with two #22 American Wire Gauge (AWG) wires. Additional equipment may be necessary for transport of data over long range distances.

B. System Controller and Software. The SC is defined as the on-site digital I/O logic processor, which is responsible for receiving and processing ITS device/sensor data inputs and providing outputs automating flashing beacon control. The SC hardware and software provided for this project must meet the following minimum specifications.

(1) Supply, install, test and integrate a SC to be mounted in a field cabinet or enclosure as shown in the Plans.

(2) SC software must be capable of interpreting the input from the VDS and sending an output to the I/O relay panel to activate the FB. The message logic to be implemented in the software within the SC for all locations is shown in Figure 1.

Figure 1 Intersection Warning System Logic Flow Diagram



(3) Provide SC capable of multi-tasking operations to optimize data acquisition from all connected field sensors and devices.

(4) The SC includes sufficient I/Os to fully support and correctly interpret the specified sensor arrays and communications devices specified.

(a) Each SC must be capable of collecting and processing real-time data from four Digital Inputs to four Digital Outputs.

(b) The SC must be able to expand the number of devices and sensors by providing four additional digital input and output ports.

(5) The SC software must be field upgradeable.

(6) The SC must incorporate "watch-dog" circuitry and monitor its own operation and reset itself if the SC software enters an indeterminate state.

(7) The SC must provide the ability to upgrade via software, or firmware flash not requiring a hardware change to update from one software revision to another.

(8) SC will have the capability to retaining logic configuration in the event of a power outage.

(9) The SC must incorporate a graphical user interface (GUI) for set-up, configuration calibration and maintenance functionality through the Ethernet interface port. The SC must have the capability to be reset manually on-site.

(10) All SC electronics must provide stable operation over a temperature range of 10 degrees F to 140 degrees F and 20 to 90 percent RH non-condensing.

C. Input/Output Relay Panel and Beacon Controller.

(1) The FB must communicate with SC by way of an I/O relay panel that accepts contact closures.

(2) The relay panel must have an electromechanical dual in-line package (DIP) relay and must serve as a switch.

(3) The relay panel must be powered by a 120 VAC power source that can handle 2 Amps.

(4) The relay panel must be wired to receive a contact closure input from the SC. The wire size must be no larger than a #18 AWG and no smaller than #22 AWG.

(5) The output of the relay panel must be wired to provide a 120 VAC power source with minimum wire size of #14 AWG to each of the flashing beacons. Two wires must be delivered to each beacon or as noted on plans and wiring diagrams.

(6) The relay panel must accept up to a minimum of two inputs and provide a minimum of two outputs and provide expansion capabilities for additional I/Os.

(7) The relay panel must default in the closed position allowing no output to the

flashing beacons and must be opened when a contact closure input is received from the SC.

(8) Must provide stable operation over a temperature range from 10 degrees F to 140 degrees F.

D. System Training.

(1) Submit course materials including training schedules, syllabus, and materials for the training to be approved by MDOT at least 30 working days prior to the start of any training course. MDOT will then have 14 calendar days to review and either approve or provide comments on course material.

(2) Training courses will be scheduled at MDOT facilities, and must be held in the MDOT North or Superior Regions.

(3) Instructors will have previous classroom teaching experience, and be proficient and knowledgeable in the subject being taught.

(4) Provide each student a handout of lecture notes and a copy of each manual discussed in the training.

(5) The Contractor/Vendor must provide any training materials used in the courses to MDOT either on its website or other electronic methods to be made easily accessible to MDOT trainees.

(6) Each training session will be video recorded and placed on DVD for the Department. The video recording must provide a clear visual and audio record of each training session. A minimum of 10 copies of each training session must be provided to the department.

(7) Provide three training sessions as follows.

(a) Software Operations. One session of 8 hour training on Operator Interface software for up to 10 MDOT personnel in the class.

(b) Field Equipment and Components. One session of 8 hour classroom style training for up to 10 MDOT maintenance personnel or designees.

(c) Site Maintenance, Calibration, and Troubleshooting. One session of 8 hour field training at one of the IWS sites for up to four MDOT personnel, consisting of troubleshooting induced failures, calibration, subsequent repair, and remote maintenance monitoring.

E. Submittals.

(1) All submittals will be in accordance with the Special Provision for Basic Methods and Materials for ITS Work.

(2) Submit the following product information to the Engineer for approval, prior to ordering or fabrication of any materials.

- (a) Cut sheets for all sensors, equipment and components to be installed.
- (b) Shop drawings showing all IWS structural elements and attachments including but not limited to pole support arms and foundations.
- (c) Acceptance Testing Plan (ATP). Contractor must develop an ATP which demonstrates all capabilities required in the overall IWS. The ATP may be part of product submittal or may follow within 2 weeks of approval by Engineer of product submittal. The ATP must be provided to and approved by the Engineer before beginning any work which may be affected by the Engineer's approval or the Engineer's requested changes.
- (3) Provide MDOT with a list of all required interface protocols for all devices and equipment.
- (4) Provide all sensor and equipment documentation and manuals. This includes five sets of complete schematics, operating manuals, and maintenance manuals for each device/equipment type. The maintenance manuals include complete sub-component parts listing and diagnostics procedures.
- (5) Provide traffic maintenance plans and project schedules.

F. Warranty.

- (1) All warranty work must be in accordance with the Special Provision for Basic Methods and Materials for ITS Work and as modified herein.
- (2) The warranty includes preventative maintenance (PM) as specified by the original equipment manufacturer (OEM) and not less than once per year per site through final system acceptance. PM work will occur not earlier than September 1 and not later than October 31 each year.
- (3) Contractor hereby acknowledges and agrees that the State retains all right, title and interest in and to all data, documentation and copies thereof furnished hereunder or created as a result of the Contract including all copyright and other proprietary rights therein. The State may utilize licensed software, embedded software, or customized software provided for any purpose and at any time without compensation to the Contractor other than as specifically provided herein. No such equipment, licensed software, specifications, data, documentation or related information will be deemed to have been given in confidence and any statement or legend to the contrary will be void and of no effect.
- (4) Provide 10 years of firmware and software upgrades to the Department. This includes any bug fixes found after the initial integration and acceptance along with updates to keep the SC current with the latest NTCIP standards during the 10 year time frame. Written confirmation must be provided to the Department clearly stating intent and full ability to provide this service before the system will be accepted by MDOT.

c. Construction. All elements included in this specification, including power and communications, must comply with the construction requirements stated in the standard

specifications, this special provision, and any applicable state and local regulations.

1. Installation.

A. Pre-delivery Site Evaluation.

(1) Document all aspects of the Pre-Delivery Site Evaluation in the Site Evaluation Report.

(2) Meet with the Engineer within 30 days following the issuance of the notice to proceed (NTP) to conduct an evaluation of all proposed IWS sites.

(3) Each IWS site noted in the Plans will be reviewed by the Contractor for conformance with manufacturer's recommendations for optimal horizontal and vertical location, field of view, maintenance access, and potential sub-optimal conditions. The pre-delivery site evaluation must include review of all environmental and pavement conditions, including seasonal foliage, which may have adverse affect on the accuracy of the IWS data.

(3) Within 7 days following completion of the field investigations, deliver to the Engineer a pre-delivery site evaluation report describing the analysis made and identifying any and all recommended modifications to the design documents. The IWS sensor or equipment supplier must acknowledge acceptance in writing with the design of each IWS site. The Engineer will review the report and notify the Contractor in writing of any design modifications required for approval.

(4) Provide all labor, tools, materials, equipment, and transportation required to conduct and complete this evaluation.

B. Power must be installed and operational prior to installation of IWS devices, cabinets, or relater equipment.

C. No installation of IWS sensors, devices, cabinets, or related equipment is permitted without the prior installation of a site communications drop.

D. Installation of the pole, structure, foundation, grounding system, and all other IWS components must be in conformance with the manufacturer's requirements for the IWS as specified, including as it may be upgraded over its operational life.

E. Damage will not be accepted on any part or equipment (new or existing) during installation. Replace damaged parts or equipment at no additional cost to the project.

F. Wiring joints and splices will be permitted only as approved by the Engineer or as shown on the Plans.

G. Electrically bond all pole and/or tower mounting adapters as specified in the Contract Documents.

H. Install air terminals as indicated on the Plans and in accordance with the contract documents.

I. Protect, with the appropriate surge protector the power, control, and return conductors along with all site equipment as specified by the sensor and/or equipment manufacturer.

2. Testing.

A. Develop the test plan in accordance with the Special Provision for Basic Methods and Materials for ITS Work.

B. Use test equipment with accuracy greater than the devices being tested in order to verify the parameters being tested meet the specifications.

C. Operation of the IWS must be demonstrated via connection of testing equipment (e.g., laptop computer and monitor) to the associated site.

D. The IWS testing includes the following tests.

(1) Pre-Construction Testing. This test is to demonstrate within 60 days after the NTP, the operation of the IWS as a fully integrated system as required by this specification and the anticipated use by MDOT.

(2) Post-Construction Testing. This test is to demonstrate after the completion of each IWS site construction, the IWS operates as required by this specification and the anticipated use by MDOT. Testing of the IWS must consist of a demonstration.

(3) All capabilities and parameters indicated in this special provision. This will include requirements to provide methods of physical simulation of weather phenomenon and will include.

(a) Vehicle Occupancy Data.

(b) Flashing Beacon operation.

(c) Device operation per the respective special provision testing requirements.

(d) Perform a daytime demonstration at each site.

(e) Perform a nighttime demonstration at each site.

(4) Warranty period to begin at the conclusion of the ATP.

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

Contract Item (Pay Item)	Pay Unit
System Controller	Each
Input/Output Relay Panel and Beacon Controller	Each

The above listed pay items include all necessary materials, equipment, and components to

furnish, install, integrate, test, warrant, and make fully operational as noted on Plans and in accordance with this special provision. The following provides a summary for the pay items listed above:

System Controller. Includes the controller and logic software installed in the field cabinet, interface with all local sensors, interface with I/O relay panel, all mounting hardware, cabling, ancillary equipment, integration, testing, documentation, and training.

Input/Output Relay Panel and Beacon Controller. Includes the relay panel installed in the field cabinet, interface with the SC, interface with all FB, all mounting hardware, cabling, testing, documentation, and training.