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**Recommended Functional/Operating Guidelines for Wayside Based Train  
Detection Systems Not Based on Track Circuits Used to Activate Grade Crossing  
Warning Systems**

Revised 2025 (6 Pages)

**A. Purpose**

This Manual Part recommends functional/operating guidelines for wayside based train detection systems not based on track circuit systems used to activate grade crossing warning systems.

**B. General**

1. System shall conform to Manual Part 3.1.15, Recommended Functional/Operating Guidelines for Control of Grade Crossing Warning Systems.
2. System shall withstand voltage surges in sensor(s), input, output, and power supply leads when protected as described in Manual Part 11.2.1, Recommended General Practices for Electrical Surge Protection of Signal Systems, and as required by the manufacturer.
3. Device(s) shall meet surge withstand requirements of Manual Part 11.3.3, Recommended Design Criteria for Surge Withstand Capability of Electronic Signal Equipment for Signal Systems.
4. System shall conform to Manual Part 1.5.15, Recommended Practice for Electrical Interfaces between Signal, Train Control and Grade Crossing Equipment.
5. Device shall conform to Manual Part 1.5.10, Recommended Instructions for Painting and Protective Coatings.
6. System shall conform to Manual Part 11.5.1, Recommended Environmental Requirements for Electrical and Electronic Railroad Signal System Equipment. Each component of the system shall conform to the appropriate class for the environment in which it is located.
7. System shall conform to Manual Part 11.5.2, Recommended Electromagnetic Compatibility Immunity and Emissions Testing for Signaling Products.

**C. Definitions**

The following definitions are only intended to be used within this Manual Part:

Approach Limits

Minimum distance from grade crossing island required for detecting occupancy in order to allow the minimum or prescribed warning time to be provided.

#### Island

That portion of the grade crossing where the highway directly crosses the railroad tracks.

#### Island Occupancy

For detection purposes, a train is said to be occupying the island when it is a minimum of 20 feet and a maximum of 100 feet from either edge of where the highway crosses the tracks.

#### Basic Detection System

Determines occupancy within approach or island limits not affected by train movement or direction.

#### Directional Logic System

Basic detection system with additional logic allowing system to differentiate between approaching and departing trains for through train moves.

#### Motion Sensing System

Directional logic system with additional capability to differentiate between moving trains (Greater than 2 mi/h) and stopped trains (Less Than 2 mi/h); and the ability to provide direction of motion.

#### Estimated Time of Arrival (ETA) System

Motion detection system with additional capability to predict the estimated time to arrival of an approaching train at the island.

#### Train

Any combination of locomotives or rail cars including single cars and/or locomotives.

#### On-Track Maintenance Equipment

Maintenance equipment traveling on the rails that may or may not shunt a track circuit (e.g., hi-rail pickup trucks).

### **D. Mechanical Design**

1. Systems intended for installation in wayside instrument housings should be housed in a metal enclosure suitable for shelf, backboard, or Electronic Industries Alliance (EIA) rack.
2. System packaging should utilize field replaceable plug or terminal connected modules to facilitate testing and maintenance.
3. Electrical and/or mechanical keying of plug-in modules shall be employed to prevent unsafe operation due to incorrect substitution of modules. Identification of plug-in modules and their respective location should be provided.
4. All field replaceable modules of the same type should be interchangeable without adversely affecting the location-specific programming of the system.
5. All connections to external safety-critical apparatus and dc power, where safety is assured by physical isolation between connectors, should conform to Manual Part 14.1, Recommended Wire Connectors, Terminals.

**E. Electrical Design**

1. Systems operated with power supplied by the railroad should conform to Manual Part 1.5.15, Recommended Practice for Electrical Interfaces between Signal, Train Control, and Grade Crossing Equipment.  
  
Systems powered from an alternative power source should consider reliability of power along with system availability, including backup power sources.
2. System shall be designed not to introduce earth ground into vital power sources. See Manual Part 16.3.2, Recommended Application Design Guidelines for Isolation of Power Supplies Used in Vital Signal Systems.
3. System shall be capable of providing separate outputs for approach warning operation and island occupancy.
4. If provided, the system should support a serial interface per IEEE 1570 – 2002 (2008) Standard for the Interface between the Rail Subsystem and the Highway Subsystem at a Highway Rail Intersection.
5. If provided, the system should support serial communications with other grade crossing devices via ATCS communications protocol layers three through seven.
6. System shall provide an alarm output to indicate system failure.
7. System shall provide monitoring indications (not requiring an external device for viewing) for the following system attributes, as a minimum.

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Additional diagnostic information may be provided either on the system, or viewable on an external device.

- a. Train occupying approach limits
  - b. Train occupying island limits
  - c. System functional
  - d. Warning system activated (if provided within system)
8. System shall be capable of interfacing to and operating warning devices described in Manual Part 3.1.1, Recommended Functional/Operating Guidelines for Grade Crossing Warning Devices.

**F. System and Safety Assurance**

1. Off-track detection devices shall be designed in accordance with the following Manual Parts, or equivalent.
  - a. Manual Part 17.2.1, Recommended Quality Assurance Program for Electronic and/or Software Based Products Used in Vital Signal Applications.
  - b. Manual Part 17.3.1, Recommended Safety Assurance Program for Electronic/Software Based Products Used in Safety-Critical (Vital) Applications.
  - c. Manual Part 17.4.1, Recommended Reliability and Maintainability Assurance Program for Electronic/Software Based Products Used in Vital Signal Applications.
  - d. Manual Part 17.5.1, Recommended Configuration Management Program for Electronic/Software Based Products Used in Vital Signal Applications.
2. Hazards considered unacceptable in design of off-track detection devices include, at a minimum, the following:
  - a. Failure to detect the presence and/or motion of a train.
  - b. Failure to provide detection or operation allowing the minimum or prescribed warning time to be achieved.

The required safe failure state of this equipment is to indicate continuous train detection (i.e. cause the warning devices to be activated).

3. Where a system is not developed to fail-safe, closed loop principles, a risk analysis must be performed, in addition to a safety analysis, to demonstrate that the overall crossing risk is not increased.

**G. Other Design Requirements**

1. Executive and vital system software, including all self-checks, shall not be designed for user modification. They shall be installed in the system in a manner that shall prevent unintentional changes.
2. Location-specific application parameters should be programmable by the user and shall be stored in a manner not subject to loss due to power interruption, or system reset. The railroad will provide appropriate safeguards through their operational procedures for modification of application parameters.
3. System shall automatically reset (nominally within 60 seconds) and attempt a restart after a condition causing system shutdown. Potential hazards due to repeated restarts shall be considered in the required safety analysis.
4. System shall not generate any permissive outputs until initialization software and hardware tests have been completed to determine that the system is operating properly as designed.
5. System should have internal diagnostics to permit troubleshooting.

**H. Operation**

1. System shall support required minimum or prescribed warning times per Manual Part 3.1.15, Recommended Functional/Operating Guidelines for Control of Automatic Grade Crossing Warning Systems, for all train speeds greater than or equal to 2 mi/h, including the effects of train speed changes within approach limits.
2. System shall be capable of detecting a train of any configuration (e.g. single or multiple locomotives, single or multiple cars).
3. System shall be capable of operating safely with any type of movement, i.e. through moves, stopping and starting within approach or island limits (for any length of time), switching moves (including reverse moves), etc.
4. System shall maintain awareness of train presence at any point within approach or island limits, including conditions of system reset or power loss.
5. System shall not interfere with track circuits or other signal circuits.
6. For system providing motion sensing or ETA prediction, it shall provide a user configurable timeout period of 5 to 20 seconds before recovery of

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approach warning indication after warning has been initiated but motion is no longer detected or ETA is greater than minimum or prescribed warning time.

7. System should restore island status (e.g. outputs) within nominally 2 seconds (maximum of 6 seconds) after a receding move has cleared the island limit.
8. A train occupying the island limits must remain continually detected regardless of whether it is stopped, and for any length of time.
9. Manufacturer must specify the maximum train operating speed for which the system may be used. The operating railroad will verify that normal operations do not exceed this limit, and that exceptional operations are governed by railroad operating rules.
10. Manufacturer shall define whether system can differentiate between trains and on-track maintenance equipment (e.g. tampers, hi-rail vehicles).  
  
For systems that cannot differentiate vehicles, consideration should be given to reset methods to prevent false activation or adverse conditions.
11. Operation of the island detection system shall not depend upon previous knowledge of an approaching train.
12. Equipment connected via RF links shall utilize addressing and message structure intended for use in vital applications. The railroad shall have a configuration plan to prevent duplicate addresses from being assigned.
13. For systems incorporating crossing control functions, those functions shall be in accordance with Manual Part 3.1.25, Recommended Functional/Operating Guidelines for Solid-State Grade Crossing Warning Device Controllers.
14. System shall detect only those vehicles within the gauge of the track.