1. Standard for Rail Transit System Highway Rail Grade Crossing Warning Device Inspection, Testing and Maintenance

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Abstract: This standard provides guidance for rail transit system staff concerned with the inspection, maintenance, and testing of highway rail grade crossing warning devices and includes minimum maintenance practices, testing procedures, and record keeping for rail transit grade crossings. This standard is based on the Rules and Regulations Governing Signal and Train Control Systems published by the Department of Transportation/Federal Railroad Administration Office of Safety.

Keywords: grade crossing, highway rail grade crossing, inspection, maintenance, testing, warning device

Introduction

(This introduction is not a part of APTA RT-RGC-S-001-02, *Standard for Rail Transit System Highway Rail Grade Crossing Inspection, Testing and Maintenance*.)

APTA rail transit safety standards represent an industry consensus on safety practices for rail transit systems to help achieve a high level of safety for passengers, employees, and the general public. This document was created by and for those parties concerned with its provisions; namely, rail transit systems (operating agencies), manufacturers, consultants, engineers, and general interest groups. This standard provides procedures for inspecting, maintaining, and testing RTS highway rail grade crossings.

APTA recommends this standard for:

- Individuals or organizations that inspect, maintain, and/or operate rail transit systems
- Individuals or organizations that contract with others for the inspection, maintenance, and/or operation of rail transit systems
- Individuals or organizations that influence how rail transit systems are inspected, maintained, and/or operated (including but not limited to consultants, designers, and contractors)

This standard intends to meet the following objectives:

- To ensure special life/safety equipment is operational and reliable
- To help rail transit systems incorporate safety considerations during the inspection and maintenance process
- To identify inspection criteria and maintenance standards that provide a high level of passenger and personnel safety

The application of any standards, practices, or guidelines contained herein is voluntary. In some cases, federal and/or state regulations govern portions of how a RTS operates. In such cases, the government regulations override any conflicting practices this document requires or recommends.

Participants

APTA greatly appreciates the contributions of the following members of the Rail Transit Standards Rail Grade Crossings Committee who provided the primary effort in drafting the *Standard for Rail Transit System Warning Device Highway Rail Grade Crossing Inspection, Testing and Maintenance:*

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Standard for Rail Transit System Highway Rail Grade Crossing Warning Device Inspection, Maintenance, and Testing

1. Overview

1.1 Scope

This document prescribes ***minimum*** requirements for inspecting, maintaining, and testing highway rail grade crossing warning devices installed and maintained on rail transit systems.

This standard applies to rail transit systems that operate and maintain highway rail grade crossing warning devices.

1.2 Purpose

The purpose of this standard is to verify highway rail grade crossing systems are operating safely and as designed through periodic testing, thereby increasing reliability and reducing the risk of hazards and failures.

1.3 Application

APTA member rail transit systems shall adopt this standard and meet or exceed it within 5 years from the date of publication. For major modifications, a plan shall be developed within 5 years to bring the rail transit system (RTS) into compliance with this standard.

1.4 Alternate practices

Individual rail transit systems may modify the practices in this standard to accommodate their specific equipment and mode of operation. APTA recognizes that some rail transit systems may have unique operating environments that make strict compliance with every provision of this standard impractical. As a result, certain rail transit systems may need to implement the standards and practices herein in ways that are more or less restrictive than this document prescribes. A RTS may develop alternates to the APTA standards so long as the alternates are based on a safe operating history and are described and documented in the system's safety program plan (or another document that is referenced in the system safety program plan).

Documentation of alternate practices shall:

a) Identify the specific APTA rail transit safety standard requirements that cannot be met

b) State why each of these requirements cannot be met

c) Describe the alternate methods used

d) Describe and substantiate how the alternate methods do not compromise safety and provide a level of safety equivalent to the practices in the APTA safety standard (operating histories or hazard analysis findings may be used to substantiate this claim)

2. References

The content of this standard is based on the Rules and Regulations Governing Signal and Train Control Systems published by the Department of Transportation, Federal Railroad Administration, Office of Safety. Specific reference is herein made to the Code of Federal Regulations, Title 49, Part 234 – Grade Crossing Signal Safety, Subpart D, as related to Maintenance, Testing and Inspection.

49 CFR 234 was specifically written to address Class One and other railroads or rail-transit operations that are connected to the general railroad system of transportation, and thereby under the jurisdiction of the FRA. Where necessary, these recommended standards have been modified and/or extended to address issues unique to rail transit properties not under FRA jurisdiction.

This standard shall be used in conjunction with the latest edition of the following publications. In the event that a conflict between this standard and a referenced document exists, this standard shall take precedence, to the extent not preempted by law. Provisions of the referenced documents not in conflict with this standard, shall apply as referenced herein.

49 CFR 234, Grade Crossing Signal System Safety, Subpart D, Maintenance, Inspection, and Testing, 2002.

AREMA Communication and Signal Manual of Recommended Practices, (www.arema.org) 2005. The following manual parts are specifically referenced in this standard.

AREMA Signal Manual of Recommended Practices, Volume I, Section 3: Highway Rail Grade Crossing Warning Systems

AREMA Signal Manual Recommended Practices, Volume I, Part 3.3.5, Recommended Instructions for Aligning Highway Grade Crossing Signal, Reflector Type Light Units.

AREMA Signal Manual of Recommended Practices, Volume I, Part 17.3: Safety Assurance of Vital Electronic/Software Based Equipment Used in Signal Applications.

AREMA Signal Manual – see AREMA Communication and Signal Manual of Recommended Practices.

IEEE Std 100-1996, the IEEE Standard Dictionary of Electrical and Electronic Terms, Sixth Edition.

IEEE Std 1483-2000, IEEE Standard for Verification of Vital Functions in Processor-Based Systems Used in Rail Transit Control

IEEE Std 1570-2002, Standard for The Interface Between the Rail Subsystem and the Highway Subsystem at a Highway Rail Intersection

Manual on Uniform Traffic Control Devices (MUTCD), published by Federal Highway Administration (FHWA) (http://mutcd.fhwa.dot.gov/)

3. Definitions and acronyms

For the purposes of this standard, the following definitions and acronyms apply. *IEEE Std 100-1996*[1] and the *AREMA Signal Manual* should be referenced for terms not defined in this clause.

3.1 Definitions

3.1.1 active grade crossing warning system: The system used to inform road users of the approach or presence of trains at highway-rail grade crossings which includes flashing light signals and necessary control equipment and may or may not include warning gates.

3.1.2 authority having jurisdiction: Entity that defines the contractual (including specification) requirements for the procurement of the highway-rail grade crossing equipment. Also, the entity responsible for maintenance and upkeep of the equipment.

3.1.3 closed loop design: A system design that adheres to the closed-loop principle and requires verification of requisite conditions before the permissive state or action can be initiated and requires that the requisite conditions remain continuously present for the permissive state or action to be maintained. In a closed loop design, a permissive state or action can not be initiated or maintained in the presence of detected failures. In addition, closed-loop design requires that failures to perform a logical operation, or absence of a logical input, output or decision do not cause an unsafe conditions, i.e. system safety does not depend upon the occurrence of an action or logical decision.

3.1.4 cutout circuit: Any circuit that overrides the operation of automatic warning systems including switch cutout circuits and devices that enable personnel to manually override the normal operation of automatic warning systems

[1] For references in italic, see Section 2.

3.1.5 entrance gate: A highway rail crossing traffic control gate that is used on the approach lanes of traffic toward a highway rail grade crossing.

3.1.6 exit gate: A highway rail crossing traffic control gate that is used on the exit lanes of traffic from a highway rail grade crossing.

3.1.7 fail-safe: A design philosophy applied to safety critical systems that prohibits hardware failures or software errors from causing a system to assume or maintain an unsafe state.

3.1.8 fail-safely: The implementation of a function in a fail-safe manner.

3.1.9 gate down: A crossing gate is in the "down" or lowered position when it is horizontal in accordance with the pre-determined design from vertical (typically 85 to 92 degrees depending on specific gate mechanism adjustment and other factors).

3.1.10 gate up: A crossing gate is in the "up" or raised position when it is vertical in accordance with the pre-determined design from horizontal (typically 85 to 92 degrees depending on specific gate mechanism adjustment and other factors).

3.1.11 highway: A public way for purposes of travel, including the entire area within the right-of-way. *Syn:* **street**.

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3.1.12 highway-rail grade crossing: 1) A location where a public highway, road, street, or private roadway, including associated sidewalks and pathways, crosses one or more railroad track at grade. 2) The general area where a highway and a railroad's right of way cross at the same level, within which are included the railroad tracks, highway, and traffic control devices for highway traffic traversing that area.

3.1.13 highway rail intersection: *See:* **highway rail grade crossing**.

3.1.14 interconnection: The electrical connection between the railroad active warning system and the traffic signal controller assembly for the purpose of preemption.

3.1.15 operations control center (OCC): That facility from which train control, train dispatching, and/or train supervision takes place for the entire rail transit system or for specific segments of a system if there is more than one control center. *Syn:* **rail control center, rail operations center, rail service control center, train command center.**

3.1.16 original equipment manufacturer (OEM): The enterprise that initially designs and builds a piece of equipment.

3.1.17 personal protective equipment (PPE): All clothing and other work accessories designed to create a barrier against workplace hazards. Examples include safety goggles, blast shields, hard hats, hearing protectors, gloves, respirators, aprons, and work boots.

3.1.18 preemption: The transfer of normal operation of traffic signals to a special control mode

that interrupts the normal sequence of traffic signal phases to accommodate train operation at, or adjacent to, the traffic signal controlled intersection.

3.1.19 rail transit system (RTS): The organization or portion of an organization that operates rail transit service and related activities. *Syn:* **operating agency, operating authority, transit agency, transit authority, transit system.**

3.1.20 road/roadway: That portion of a highway improved, designed, or ordinarily used for vehicular travel and parking lanes, but exclusive of the sidewalk, berm, or shoulder even though such sidewalk, berm, or shoulder is used by persons riding bicycles or other human-powered vehicles. In the event a highway includes two or more separate roadways, the term roadway as used herein refers to any such roadway separately, but not to all such roadways collectively.

3.1.21 safe: Having acceptable risk of the occurrence of a hazard.

3.1.22 safety: Freedom from those conditions that can cause death, injury, or occupational illness, damage to the environment, or damage to or loss of equipment or property.

3.1.23 safety assurance: A characteristic of system implementation that assures a level of safe operation.

3.1.24 safety critical: A term applied to a system or function for which correct performance is critical to the safety of personnel and/or equipment or a system or function for which incorrect performance may result in an unacceptable risk of a hazard. *See:* **fail-safe.**

NOTE-Such a designation may require the incorporation of additional special safety design features.

NOTE-Vital functions are a subset of safety-critical functions.

3.1.25 Street: see **highway**.

3.2 Acronyms

AAR	Association of American Railroads
ac	alternating current
AFLS	automatic flashing light signals
APTA	American Public Transportation Association
AREMA	American Railway Engineering and Maintenance of Way Association
CFR	Code of Federal Regulations
dc	direct current
DOT	United States Department of Transportation
GCP	grade crossing predictor
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
LED	light emitting diode

FHWA	Federal Highway Administration (of the DOT)
FRA	Federal Railroad Administration (of the DOT)
FTA	Federal Transit Administration (of the DOT)
MUTCD	Manual of Uniform Traffic Control Devices
OEM	original equipment manufacturer
RTS	rail transit system
XR	crossing relay

4. Provisions for inspection, maintenance, and testing

4.1 Training

The RTS and/or their maintenance contractors shall develop and execute training programs that provide employees with the knowledge and skills necessary to safely and effectively perform the tasks outlined in this standard.

4.2 Responsibility

The RTS shall appoint a specific technically qualified employee or group of employees to be responsible for performing highway rail grade crossing warning device tests.

4.3 Materials

No consumable materials are required for inspecting, maintaining, and testing grade crossing warning devices unless otherwise specified by the OEM and/or RTS.

4.4 Tools

No consumable materials are required for inspecting, maintaining, and testing grade crossing warning devices unless otherwise specified by the OEM and/or RTS.

4.5 Personal protective equipment

Personal protective equipment, as required by the RTS, shall be worn at all times during testing.

4.6 Safety

Provide proper protection and/or de-energize appropriate circuits while performing Inspection, Maintenance, and Testing procedures.

RTS safety rules, procedures, and practices shall be followed at all times during testing.

4.7 Plans

Detailed circuit and layout plans depicting the current “as-in-service” condition are required for inspecting, maintaining, and testing rail grade crossing warning systems. Plans shall be kept at each highway rail grade crossing warning system location in a waterproof and secure container. Plans shall be legible and correct, and contain no more than one (1) set of field revisions.

The RTS shall maintain a complete set of all circuit, layout, and other related engineering plans for all RTS-maintained highway rail grade crossing warning device installations and keep the set on file at a central office location.

4.8 Protection of insulated wire

Insulated wire shall be protected from mechanical injury. The insulation shall not be punctured for test purposes.

A splice in underground wire shall have insulation resistance at least equal to that of the wire.

4.9 Normal functioning of system

Inspection, maintenance, and/or testing shall not interfere with the normal functioning of any system or device unless alternate safety measures have been implemented for highway users, pedestrians, or other personnel whose safety usually depends on the normal functioning of the system or device being inspected, maintained, or tested.

4.10 Correction of deficiencies

When any essential component of a highway rail grade crossing warning system fails to perform its intended function, the cause shall be determined and the faulty component adjusted, repaired, or replaced without undue delay.

Until repair of an essential component is completed, a RTS shall take appropriate action under a previously developed and approved operating plan to ensure safety.

Deficiencies identified during grade crossing warning system testing shall be corrected and documented in accordance with OEM and/or RTS requirements.

4.11 Documentation (record keeping)

Inspection, maintenance, and testing activities (including recording device readings or downloads) and results and repairs shall be documented on forms such as the examples in Annex B or an equivalent. Electronic record keeping may be used as an alternative to written records. When using electronic record keeping, a process shall be in place that prevents electronic records from being modified at a later date.

Each record shall show the name of the RTS, AAR/DOT inventory number (if available) or alternate identification means, location and date, equipment tested, results of tests, repairs, replacements, adjustments made, and condition in which the apparatus was left.

Each record shall include the printed name (and ID number if applicable) of the employee making the test, be signed or electronically coded by the employee making the test and shall be filed in the office of a supervisory official having jurisdiction. Each record shall be maintained until the next record for that test is filed but in no case for less than one year for the date of the test. Printed names and initials are specifically prohibited from all inspection and test reports.

5. Frequency of inspection and testing

Grade crossing warning system inspection, maintenance, and testing shall be performed as specified in Table 1 below or as otherwise deemed necessary by the RTS. For details on tasks for the systems, devices, or components listed in the table, see the corresponding section of this document

Annex A contains an example monthly, quarterly, and annual test procedures.

Table 1 – Minimum frequencies for inspection, maintenance and testing tasks

System, device, or component	**Action**	**Frequency of action** *(minimum)*	**Section**
Grade crossing warning system	Test for proper operation	– When systems are placed in service – Monthly – When systems are modified, repaired, or disarranged	6.1, 6.2
	Test for prescribed warning time *Electronic devices that accurately determine actual warning time may be used in performing such tests	– Annually – When the system is modified because of a change in train speeds, change in train detection system, or other major alterations to the grade crossing	6.1
Standby power	Test for proper operation	Annually	6.3
Grounds on energy buses that furnish power to circuits that affect the safety of warning system operation	Test for proper operation	– When the energy bus is placed in service – Monthly thereafter	6.5
LED unit and lamp operating voltages	Test for proper operation and voltages	– When units are installed – Annually	6.8
Warning bells and other stationary audible warning devices	Test for proper operation	– When the devices are placed in service – Monthly – When devices are modified, repaired, or disarranged	6.10

System, device, or component	Action	Frequency of action *(minimum)*	Section
Highway traffic signal pre-emption interconnections (if applicable)	Test or observe in operation for proper operation	Monthly *Preferably, the highway authority will participate in joint testing at least annually.	6.11
Highway traffic signal operation (when used for controlling highway traffic movement across a highway rail grade crossing)	Test for proper operation	Monthly in conjunction with the appropriate highway authority	
Vehicle intrusion detection systems	Test for proper operation	Monthly *Where the highway authority has maintenance responsibility for testing vehicle intrusion detection systems, this test shall be made in conjunction with the appropriate highway authority.	6.22
Alternating current centrifugal type relays	Test for proper operation	Annually	6.23
Alternating current vane -type relays	Test for proper operation	Once every two years	6.23
Direct current polar -type relays	Test for proper operation	Once every two years	6.23
Relays with soft iron magnetic structure	Test for proper operation	Once every two years	6.23
All other relays that affect the proper functioning of a crossing warning system	Test for proper operation	Once every four years	6.23
Cutout circuits (includes both switch cutout circuits and devices which enable personnel to manually override the normal operation of automatic warning systems)	Test for proper operation	Quarterly	6.17
Hold-clear devices	Test for proper operation	Annually	
Timing relays and devices (including solid state timers)	Test for proper operation	Annually	6.23
Insulation	Test for proper resistance	– When wires or cables are installed – Every ten years thereafter	6.24

System, device, or component	Action	Frequency of action *(minimum)*	Section
		– NOTE: When insulation resistance of wire or cable is found to be less than 500,000 ohms, prompt action shall be taken to repair or replace the defective wire or cable. Until such defective wire or cable is replaced, insulation resistance tests shall be made annually.	
Flashing light units	Inspect for proper alignment	– When units are installed – Annually	6.6
	Check frequency of flashes	– When units are installed – Annually	6.6
	Inspect for proper visibility, dirt, and damage to roundels and reflectors	Monthly	6.6
Gate arms and gate mechanisms	Inspect and/or observe movement for proper operation	Monthly	6.9
Insulated rail joints	Visually inspect condition	Quarterly	6.16
Bond wires	Visually inspect condition	Quarterly	
Track connections	Visually inspect condition	Quarterly	

6. Requirements

Observe the operation of the warning devices under actual train movements as often as possible. Note the results, direction, track, and train, if known, in the comments section. Prior to testing, obtain permission of the operation control center. When tests are complete, make sure all circuits and equipment are operable and in the normal state. After completion of work on safety related equipment, the center authorizing the work shall be informed of the completion.

The inspections and tests set forth in this section are the minimum requirements for highway rail grade crossings located on in-service tracks and shall be made to determine if the warning system and its component parts are maintained in a condition to perform their intended function.

Any electronic device, relay, or other electromagnetic device or other component that fails to meet the requirements of tests required by this part shall be removed from service and shall not be restored to service until its operating characteristics are in accordance with the limits within which such device or relay is designed to operate. Proper precautions must be taken during inspection and testing to ensure railway and highway safety.

For specific instructions regarding the inspection and maintenance of the highway rail grade crossing equipment, see the OEM installation specification and manuals.

6.1 Activation of warning system

A highway rail grade crossing warning system shall be maintained to operate in accordance with the design of the warning system, but in no event shall it provide less than 20 seconds warning time for the normal operation of through trains before the grade crossing is occupied by rail traffic.

Alternative warning times may be authorized by the RTS for special conditions such as near-side station stops. For these conditions, the train operator must be able to stop the train prior to entering the intersection until it is verified that the warning system is active, gates, if so equipped, are in the fully horizontal position, and the intersection is clear of highway and/or pedestrian traffic.

6.2 Warning system apparatus

The electromagnetic, electronic, and/or electrical apparatus of each highway rail grade crossing warning system shall be maintained to operate as designed in accordance with OEM and/or RTS requirements.

Highway rail grade crossing warning system apparatus shall be secured against unauthorized entry.

6.3 Standby power system

The RTS shall provide a backup power supply with the capacity to operate the warning system for a reasonable length of time during a period of primary power interruption, where that power interruption does not affect normal train operations. The designated capacity shall be specified on the plans required in Section 4.7. Determining the capacity of the standby source will be at the discretion of each individual RTS.

Reviewing the following factors as a minimum may be useful in determining the standby source capacity:

- The power demands of each particular location (taking into account urban or rural)
- The likelihood of discovery of the primary power outage (i.e. Electronic notification devices, power-off indication, employee discovery, etc.)
- The availability and proximity of maintenance employees (including time of day)
- The number of trains that are operated over the crossing

6.4 Control circuits

All control circuits that affect the safe operation of a highway rail grade crossing warning system shall operate on the fail-safe principle. All equipment and control circuit design shall be in strict compliance with the *AREMA Signal Manual of Recommended Practices, Volume I, Section 3* and other applicable sections of *Volumes 1, 2, 3 and 4.* Where electronic or processor-based systems are used, they shall conform to *AREMA Signal Manual Part 17.3* and/or *IEEE 1483-2000*. Where new or novel technology is being used, or where highway-rail grade crossing equipment provides safety-critical data to a signal or train control system, rail transit properties should consider guidance provided by 49 CFR 234.275. New or novel technology refers to a technology not previously recognized for use in commercial service as of March 7, 2005 and includes such technology as that incorporated in new designs which do not use conventional track circuits.

6.5 Grounds

Each circuit that affects the proper functioning of a highway rail grade crossing warning system shall be kept free of any ground or combination of grounds that will permit a current flow of 75 percent or more of the release value of any relay, electromagnetic device, or electronic device in the circuit. This requirement does not apply to: circuits that include running rail; alternating current power distribution circuits that are grounded in the interest of safety; and common return wires of grounded common return single break circuits.

6.6 Flashing light units

Each flashing light assembly shall include light emitting diode (LED) units or approved lamps designed for railway signal use, and be properly positioned, aligned, and visible to a highway user approaching the crossing, in accordance with Manual on Uniform Traffic Control Devices and/or *AREMA Signal Manual*.

Each flashing light or LED unit shall be maintained to prevent dust and moisture from entering the interior of the unit, and may be equipped with side “tell tale” indicators. If equipped with roundels and reflectors, they shall be kept clean and in good condition at all times to ensure maximum light unit visibility.

All light or LED units shall flash alternately. The number of flashes per minute for each light

unit shall be 35 minimum and 65 maximum, with the optimum number of 45 flashes per minute, if possible.

6.7 Gate arm lights and light cable

Each gate arm light or LED unit shall be designed specifically for use on a gate arm, and maintained in such condition to be properly visible to approaching highway users. Light or LED units, and required wire, shall be properly secured to the gate arm.

6.8 Lamp or LED unit voltage

The voltage at each LED or lamp unit shall be maintained within the OEM-recommended value. However, in no case shall the voltage be less than 85 percent of the prescribed rating for the lamp or LED unit.

6.9 Gate arms

Each gate arm, when in the lowered position, shall extend across each approaching lane of highway (or pedestrian) traffic and shall be maintained so that it is clearly viewed by approaching highway (or pedestrian) users. Each gate arm shall start its downward motion not less than three seconds after the flashing lights begin to operate and shall assume the horizontal position at least five seconds before the arrival of any normal train movement through the crossing. At those crossings equipped with four quadrant gates, the timing requirements of this section apply to entrance gates only.

6.10 Highway crossing bell or audible warning system

Where required, each highway rail grade crossing shall be equipped with at least one (1) crossing bell or other audible warning system (mechanical or electronic) mounted on one of the flasher/gate masts.

6.11 Highway traffic signal preemption

A clear and known demarcation point shall be employed in the grade crossing instrument cabinet to quickly determine whether a problem is caused by the traffic signal system or the highway rail grade crossing warning device system.

All serial digital interconnections between the highway subsystem and the rail subsystem shall comply with *IEEE 1570-2002*.

6.12 Train detection apparatus

Train detection apparatus shall be maintained to detect a train or (shunting) railcar in any part of a train detection circuit as designed in accordance with OEM requirements.

If the presence of sand, rust, dirt, grease, or other foreign matter is known to prevent effective shunting, the RTS shall take appropriate action, per a previously approved RTS system safety plan, to safeguard highway users.

6.13 Shunting

Each highway rail grade crossing train detection circuit shall detect the application of a shunt of 0.06-ohm resistance (or greater if determined by the authority having jurisdiction) when the shunt is connected across the track rails of any part of the circuit.

6.14 Fouling wires

Each set of fouling wires in a highway rail grade crossing train detection circuit shall consist of at least two discrete conductors. Each conductor shall be maintained to ensure sufficient conductivity and proper operation of the train detection apparatus when the train detection circuit is shunted. Installation of a single duplex wire with a single plug acting as fouling wires is prohibited. Existing installations with single duplex wires and a single plug for fouling wires may continue to be used until they require repair or replacement.

6.15 Non-insulated rail joints

Each non-insulated rail joint located within the limits of a highway rail grade crossing train detection circuit shall be bonded by means other than joint bars and the bonds shall be maintained to ensure electrical conductivity.

6.16 Insulated rail joints

Each insulated rail joint used to separate train detection circuits of a highway rail grade crossing shall be maintained so that current can not flow between rails separated by the insulation in an amount that may cause a train detection circuit failure.

6.17 Reverse switch cut-out circuit

A switch, when equipped with a switch circuit controller connected to the point and interconnected with warning system circuitry, shall be maintained so that the warning system can only be cut out when the switch point is within one-half inch of full reverse position.

6.18 Wire tagging

Each wire shall be tagged or otherwise marked so that it can be identified at each terminal. Tags and other marks of identification shall be made of insulating material and arranged so that the tags and wires do not interfere with moving parts of the apparatus. This requirement applies to each wire at each terminal in all housings including switch circuit controllers and terminal or junction boxes. This requirement does not apply to flashing light units, gate arm light units, and other auxiliary light units. The local wiring on a solid state crossing controller rack does not require tags if the wiring is an integral part of the solid-state equipment.

6.19 Wire on pole line and aerial

Each wire on a pole line shall be securely attached to an insulator that is properly fastened to a cross arm or bracket supported by a pole or other support. Wire shall not interfere with, or be interfered with by, other wires on the pole line. Aerial cable shall be supported by messenger wire. An open-wire transmission line operating at voltage of 750 volts or more shall be placed not less than 4 feet above the nearest cross arm carrying active warning system circuits.

6.20 Signs visible to highway users

Each sign mounted on a highway rail grade crossing signal post (or otherwise under the jurisdiction of the RTS) shall meet *MUTCD* or other applicable standards, be maintained in good condition and be visible to the highway user.

Signs not under the jurisdiction of the RTS that are not maintained in good condition shall be reported to the appropriate highway authority (or authority having jurisdiction).

6.21 Signs or light units visible to railway users

Signs or light units designed to be visible to the rail vehicles shall be maintained in good condition and be visible to the rail vehicle operator.

6.22 Vehicle intrusion circuits

If applicable and the responsibility of the RTS, vehicle intrusion circuits shall be maintained in accordance with OEM requirements.

6.23 Timing relays and timing devices

The timing of each timing relay and timing device (including solid state timers) shall be maintained between 90 and 110 percent of the predetermined time interval. The predetermined time interval shall be shown on the plans or marked on the timing relay or timing device. Timing devices that perform internal functions associated with motion detectors, motion sensors, and grade crossing predictors are not subject to the requirements of this section.

All relays used shall be classified for use in railway signal applications, and meet the specifications of the *AREMA Signal Manual*.

6.24 Insulation resistance test

Insulation resistance tests shall be made between all conductors and ground, between conductors in each multiple conductor cable, and between conductors in trunking.

Wires, cables, and insulation shall be dry when insulation resistance tests are performed.

A circuit with a conductor having an insulation resistance of less than 200,000 ohms shall not be used.

Annex A

(Informative)

Example test procedures for automatic highway grade crossing warning systems

A.1 Monthly standard test

A.1.1 Purpose

This test is to determine that all equipment used in connection with active, rail-highway at-grade crossing warning systems is in good working order and functioning as intended. This test will comply with the requirements for monthly testing as stated in the body of this standard.

Inspect and test highway grade crossing signal apparatus in accordance with instructions indicated below. All inspections and tests and any corrective action taken, must be recorded. Defective components shall be repaired, adjusted, or replaced as required.

A.1.2 Frequency

At least once a month or when disarranged.

A.1.3 Responsibility

As assigned by the RTS.

A.1.4 Method

Prior to testing, obtain permission of the operations control center (OCC). When tests are complete, make sure all circuits and equipment are operable and in the normal state. Notify the OCC when inspection and tests are complete.

A.1.4.1 Main crossing locations

A.1.4.1.1 Make a visual inspection of the devices to determine that all locks, cables, wires, hoods, backgrounds, signs, masts, gate arms, gate arm lights, bells and flashing light signal units are in the proper location and condition.

A.1.4.1.2 Observe line control, track relays or GCP LED’s to ascertain proper operation of crossing.

A.1.4.1.3 Record the number and type of cells. Measure voltages of all batteries while cells are on charge and record values. Voltages must be in accordance with the values shown in Annex D or manufacturers instructions for the type of cell. If not, rectifiers should be adjusted.

A.1.4.1.4 Open ac power feed to place installation on standby battery. Ensure that crossing continues to operate properly.

A.1.4.1.5 Activate the crossing warning system (If a solid state crossing controller is used, use test switch, where provided, to operate warning system). Verify that there are no burned out lamps and that auxiliary devices, such as crossing bells and "no turn" signals, are operating properly. Where traffic signal pre-emption circuits are employed, verify highway circuit interconnection functions when crossing relay is de-energized by using voltmeter or by observing traffic signal operation. Where traffic signals are solely used for crossing warning, verify that the traffic signal(s) operates as intended.

a) Observe if lamps or LED units appear to have normal brilliance after operating flashers a minimum of two minutes or at crossings equipped with gates, operating the gates for three (3) successive cycles may be used in lieu of the two (2) minutes.

b) Measure voltage of main battery banks at the crossing while charge is off and batteries are supplying the load and record values. The value should be within normal limits as identified in Annex D.

c) Check the visibility and alignment of the flashing light signal units to determine that they provide warning as intended by design. Inspect flasher units for signs of damage or fatigue. Unless otherwise specified on signal plans or signal special instructions, alignment should be in accordance with the applicable practices in the *AREMA Signal Manual, Part 3.3.5*. Correct alignment as required.

d) Clean or replace roundels and reflectors as required (Wipe dust off flasher roundels using a soft cloth and water if necessary). A visual external inspection of flashing light signal unit is an acceptable means of compliance. If the signal displays a proper light and appears to be properly sealed, it is not necessary to open the light unit.

   Any foliage or obstruction that affects the visibility of the devices should be removed, if possible, and noted in the comments section. Any foliage or obstruction that cannot be readily removed should be reported to the signal supervisor, reported to highway authorities as soon as practical, and noted in the remarks column. The reporting employee and the signal supervisor should have a clear understanding as to who is going to contact the highway authority.

e) Check flashers and bells to ensure that they operate between three (3) to six (6) seconds before the gates start their downward movement.

f) Check electric gates to see that gates start to assume the horizontal 3 to 6 seconds after flashing lights start to operate and reach full horizontal position 10 to 15 seconds after starting down.

g) Check electric gates to see that gates rise to full upright position in 8 to 12 seconds after the gates are permitted to clear.

h) Restore ac power and crossing protection to normal operation and determine that rectifiers are being charged and that batteries are drawing a charging current.

A.1.4.1.6 Inspect gate arms and mechanisms for signs of damage, stress, miss-adjustment or improper operation.

A.1.4.1.7 Inspect main and overlay track batteries at the highway location for height of electrolyte, tightness of connections and cleanliness.

A.1.4.1.8 Measure and test all battery bank and power supply energy buses at the main crossing location.

A.1.4.1.9 If motion sensors or predictors are used, indicate the appropriate readings, and or comments, on the form. Where applicable, verify the time and date settings. Reset the time and date if it varies by more than two minutes and note the changes in the comments section.

A.1.4.2 Crossing start locations

A.1.4.2.1 Open ac power feed to place location on standby battery.

A.1.4.2.2 Measure voltage of battery banks at the location while charge is off and batteries are supplying the load for a period of two (2) minutes and record values.

A.1.4.2.3 Inspect batteries at the location for height of electrolyte, tightness of connections and cleanliness.

A.1.4.2.4 Measure and test all battery bank and power supply energy buses at each crossing start location.

A.1.4.2.5 Restore ac power and ensure that the overlay track circuit assumes normal operation.

A.1.5 Reporting

The completion of all tests shall be documented on the prescribed test forms and shall be signed by the employee completing tests including the date that the testing was completed

A.2 Quarterly standard test

A.2.1 Purpose

This test is to determine that all equipment used in connection with active, rail-highway at-grade crossing warning protection systems is in good working order and functioning as intended. This test will comply with the requirements for quarterly testing as stated in the body of this standard.

Inspect and test highway grade crossing signal apparatus in accordance with outline indicated below. All inspections and tests and any corrective action taken, must be recorded. Defective components shall be repaired, adjusted, or replaced as required.

A.2.2 Frequency

At least once every three months or when disarranged.

A.2.3 Responsibility

As assigned by the RTS.

A.2.4 Method

Prior to testing, obtain permission of the OCC. When tests are complete, make sure all circuits and equipment are operable and in the normal state. Notify the OCC when inspection and tests are complete.

All monthly tasks shall be performed and the following tasks shall also be performed.

a) Inspect and test all crossing cutout switches.

   – Where circuit controllers are in service on outlying switches perform operating and shunt tests to verify that the crossing override system operates as intended.

b) Inspect all insulated rail joints, rail joint bonds, track connections, fouling wires and bond wires within the approaches to the crossing. In non-signaled territory not all turnouts require fouling – only turnouts where the fouling area is designed to activate the warning device. Refer to circuit plans to determine which turnouts require fouling.

A.2.5 Reporting

The completion of all tests shall be documented on the prescribed test forms and shall be signed by the employee completing tests including the date that the testing was completed

A.3 Annual standard test

A.3.1 Purpose

This test is to determine that all equipment used in connection with active, rail-highway at-grade crossing warning protection systems is in good working order and functioning as intended. This test will comply with the requirements for annual testing as stated in the body of this standard.

Inspect and test highway grade crossing signal apparatus in accordance with outline indicated below. All inspections and tests and any corrective action taken, must be recorded. Defective components shall be repaired, adjusted, or replaced as required.

If crossing system is interconnected with nearby traffic signals, the annual inspection may be coordinated with a joint inspection by the highway agency in charge of the traffic signals.

A.3.2 Frequency

At least once a year or when disarranged.

A.3.3 Responsibility

As assigned by the RTS.

A.3.4 Method

Prior to testing, obtain permission of the OCC. When tests are complete, make sure all circuits and equipment are operable and in the normal state. Notify the OCC when inspection and tests are complete.

All monthly tasks shall be performed and the following tasks shall also be performed.

a) Check visibility, alignment and position of signals and signage.

b) Verify that circuit plans and tagging are correct and legible.

c) Check rate of flashers. The number of flashes per minute for each flashing light unit shall be from a minimum of thirty-five (35) to a maximum of sixty-five (65) Flashes Per Minute.

d) Disable the flasher relay by removing the control wire, or by removing the flashing control from the solid-state controller. Verify that one lamp on each cross arm remains lit with the flasher disabled.

   Re-enable the flashing control.

e) Inspect all LED light units or lamps for blackening of glass, replacing as required with an LED unit or lamp of equal voltage and wattage ratings. Clean the reflectors and the inside of roundels, replace as required. If LED light units are used, inspect, clean, or replace per manufacturer's instructions.

f) Locations designed for 25-watt bulbs in the flashing light signal heads shall have 25-watt bulbs. Locations not upgraded for 25-watt bulbs are designed for 18-watt bulbs only. AFLS heads must have the appropriate wattage bulb installed before making tests. Check and record the voltage at each lamp with ac power on. The LED or lamp voltage (ac on) at each lamp shall not be less than eighty-five (85%) percent or more than one hundred (100%) percent of the rated lamp voltage. The preferred lamp voltage is between 95% and 100% of the rated voltage. [During annual tests, measuring the lamp voltage at the base of the mast is acceptable if it is known that at least 85% of the voltage is at the lamp. However if this method is used, the minimum acceptable voltage at the base should be noted in the crossing's records at the time of installation or during a previous annual

inspection. For instance, it may be necessary to have 8.8 volts at the base to insure at least 8.5 volts at the lamp.] Once the lamp with lowest lamp voltage is determined, turn the ac power off for two (2) minutes, to insure that the voltage on that lamp is at least 85% of rated lamp voltage. Close the test switch in the XR (XRGP) circuit. The warning devices should stop operating.

g) Check voltage at lamps after ac power has been off and flashers have operated for 2 minutes. Flasher relay should be de-energized when voltage readings are taken.

h) Ac power should then be restored and transformer taps adjusted to provide proper voltage. Gate arm lamp voltages should be checked at junction box or gate mechanism terminal board.

i) Check time delay of timing relay circuit circuits. Time shall be between 90% and 110% of that shown on plan.

j) Check gate arm torque adjustment in accordance with manufacturers instruction to insure that gate arms are free from friction or other interference. Test to be completed as required or when gate mechanism or arm has been modified.

   – Observe that no obstruction interferes with gate operation or obscures view of lamps to approaching highway traffic.

k) Where warning system uses directional stick relays, check operation for each track in each direction and after tests are completed, observe that the direction stick relays are de-energized.

l) Hold clear devices and mechanisms must be visually inspected and tested to ensure proper operation.

m) Open crossing pushbutton enclosures and inspect contacts for signs of corrosion, moisture, loose or frayed wires or other signs of damage.

n) Record both gate-down delay time and time it takes gate to go from full vertical to full horizontal.

o) Where provided, check event recorder or crossing analyzer (if present) for the display of the correct time and date.

p) For warning systems not using constant warning time devices:

   – Place a track shunt on outermost limit of first track circuit constituting the grade crossing start for all routes leading into the crossing and verify that grade crossing warning system activates.

q) For installations using constant warning time devices:

   – Individually open one end of each termination shunt constituting the grade crossing

start for all routes leading into the crossing and verify that grade crossing warning systems activate.

r) Information programmed into an electronic constant warning time device or other unit shall be verified against the circuit plans or program cards. The signal supervisor must immediately be notified of variations, so that corrections to the program or plans/cards can be made.

s) Determine the warning time at authorized speed (indicate that speed is from timetable, bulletin, or general order) by one of the following methods:

- OBSERVATION: If train going maximum authorized speed was observed, measure warning time and record on form.

- RECORDING: If crossing is equipped with recorder that records time and speed, enter warning time for train going maximum speed.

- CALCULATION/SIMULATION: This method can be used most easily for overlay or other fixed start lengths. If the start length is measured or confirmed to be the length shown on plans, and confirmed that a shunt is effective at the entering end of the approach track circuit, use Annex E to determine warning time.

  Warning time (seconds) = approach length (feet) / train speed (feet per second)

Alternatively, determine the warning time from the table. In either case, round the warning time down to the next lower second.

A.3.5 Reporting

The completion of all tests shall be documented on the prescribed test forms and shall be signed by the employee completing tests including the date that the testing was completed

Annex B

(Informative)

Example for recording tests

Form to be modified to include space for printed name and ID number.

RECORDING MARK

C - Test complete. Equipment in satisfactory condition

*A - Adjustment made & test complete. Equipment in satisfactory condition.

*R - Repairs or replacement needed. Equipment left in satisfactory condition

* N - Does not apply
Explain on back of form

HIGHWAY/RAIL GRADE CROSSING INSPECTION FORM

* - Test must be made when placed in service, modified or disarranged, and at the time period specified below thereafter

APTA - DRAFT

Signature_____

			MONTHLY										3 MONTH		1 YEAR						2 YEAR	4 YEAR	10 YEAR	
			5.1	5.2	5.3.3	5.4.1	5.4.2	5.5.1	5.5.2	5.7	5.8	5.9	5.13	5.14	5.3.1	5.3.2	5.4.3	5.6	5.10.3.2	5.11	5.10.3.1	5.10.2	5.12.1	
CITY	STREET	DATE	GROUND TEST	STANDBY POWER	FLASHING/LIGHT VISIBILITY	GATE ARM & GATE MECHANISM INSPECTION	GATE ARM MOVEMENT	WARNING SYSTEM OPERATION	WARNING BELL & STATIONARY AUDIBLE WARNING SYSTEMS	HIGHWAY TRAFFIC PRE-EMPTION	HIGHWAY TRAFFIC SIGNAL CONTROL	VEHICLE INTRUSION DETECTION SYSTEMS	CUT-OUT CIRCUITS	INSULATED JOINT, BOND WIRE, & TRACK VISUAL INSPECTION	FLASHING LIGHT UNIT ALIGNMENT & FLASH RATE	LAMP VOLTAGE	HOLD CLEAR DEVICES	WARNING TIME	AC CENTRIFUGAL RELAY	TIME RELAYS & TIME DEVICES	AC VANE, DC POLAR, SOFT IRON MAGNETIC STRUCTURE RELAYS	RELAYS	INSULATION RESISTANCE	LINE NO
																								1
																								2
																								3
																								4
																								5
																								6
																								7
																								8
																								9
																								10
																								11
																								12
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																								14

Annex C

(Informative)

Normal battery voltage limits

Type	No. Cells	Voltage Limits
Lead Acid	5	9.9 to 11.25
(Edison EMP series, GNB, etc.)	6	11.88 to 13.5
	7	13.86 to 15.75
(1.98 to 2.28 volts per cell)	8	15.84 to 18.0
Nickel cadmium	8	10.08 to 11.68
(Nife RP series, Edison ED series, etc.)	9	11.34 to 13.14
	10	12.6 to 14.6
(1.26 to 1.46 volts per cell)	11	13.86 to 16.06
	12	15.12 to 17.52
Nickel iron	8	10.8 to 12.0
(1.35 to 1.5 volts per cell)	9	12.15 to 13.5
	10	13.5 to 15.0
	11	14.85 to 16.5
	12	16.2 to 18.0

Annex D

(Informative)

Warning times vs. speed and required approach distance

Speed		20 sec	22 sec	24 sec	25 sec	26 sec	28 sec	30 sec	32 sec	34 sec	35 sec
m.p.h.	Feet per sec	Start length in feet									
5	7.333	147	161	176	183	191	205	220	235	249	264
10	14.667	293	323	352	367	381	411	440	469	499	528
15	22.000	440	484	528	550	572	616	660	704	748	792
20	29.333	587	645	704	733	763	821	880	939	997	1056
25	36.667	733	807	880	917	953	1027	1100	1173	1247	1320
30	44.000	880	968	1056	1100	1144	1232	1320	1408	1496	1584
35	51.333	1027	1130	1232	1284	1335	1438	1540	1643	1746	1848
40	58.667	1174	1291	1408	1467	1526	1643	1760	1878	1995	2112
45	66.000	1320	1452	1584	1650	1716	1848	1980	2112	2244	2376
49	71.867	1438	1582	1723	1797	1869	2013	2156	2300	2444	2588
50	73.333	1467	1614	1760	1834	1907	2054	2200	2347	2494	2640
55	80.667	1614	1775	1936	2017	2098	2259	2420	2582	2743	2904

Speed		20 sec	22 sec	24 sec	25 sec	26 sec	28 sec	30 sec	32 sec	34 sec	35 sec
m.p.h.	Feet per sec	Start length in feet									
60	88.000	1760	1936	2112	2200	2288	2464	2640	2816	2992	3168
65	95.333	1907	2098	2288	2384	2479	2670	2860	3051	3242	3432
70	102.667	2054	2259	2464	2567	2670	2875	3080	3286	3491	3696
75	110.000	2200	2420	2640	2750	2860	3080	3300	3520	3740	3960
79	115.867	2318	2550	2781	2897	3013	3245	3476	3708	3940	4172