4. Standard for Rail Transit Grade Crossing Warning System Design Criteria, Installation and Operation

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Abstract: This document provides guidance for rail transit systems for selecting, installing and operating highway rail transit grade crossing warning systems and includes minimum requirements for highway rail grade crossing warning devices, highway traffic signs and other highway traffic control appliances.

Keywords: active warning system, highway grade crossing, highway traffic sign, passive rail grade crossings, traffic control appliances, warning system

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Introduction

(This introduction is not a part of APTA RT-RGC-S-004-02, *Standard for Rail Transit Grade Crossing Warning System Design Criteria, Installation and Operation*.)

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 design criteria and procedures for installing and operating rail transit grade crossing warning systems.

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 rail transit system 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 Grade Crossing Warning System Design Criteria, Installation and Operation:*

Robert Banks, *Chair*

Nicholas Bahr
Robert Banks
Bill Browder
Richard Brown
Terry Byrne
Richard Campbell
Steven Carroll
K.C. Cooper
Rhonda Crawley
Charles "Ty" Dickerson
Daniel Foth
Susan Gilbert
Brian Gilleran
Robert Glass
Alex Goff
Ali Gord
Vernon Hartsock
Ken Kobetsky
Hans Korve
Quon Kwan
Robert Lauby
Chuck Maples
Michael McArdle
Harry McCall
Linda Meadow
John Mitchell
Paul O'Brien
Phil Olekszyk
Lorraine Pacocha
William Petit
Albert Powell
Linda Rhodes
Mark Robinson
Harry Saporta
John Sharkey
Ronald Swindell
Naor Wallach
Jack Webb
Terrell Williams
Robert Winans
Thomas Woll
Vanessa Young
Abdul Zohbi

The following members of the Rail Transit Standards Rail Grade Crossings Committee contributed to the review and approval process of the*: Standard for Rail Transit Grade Crossing Warning System Design Criteria, Installation and Operation:*

Ronald O. Swindell, *Chair*
Abdul Zohbi, *Vice Chair*

Robert Banks
Richard Brown
Lynda Bybee
Terry Byrne
Richard Campbell
Daniel Carrizales
Steven Carroll
Debra Chappell
Brian Clark
K.C. Cooper
Rhonda Crawley
Terrence Culhane
Jack Dickens
Charles "Ty" Dickerson
Manuel Galdo
Nocole Gamache
Wende Gannon
Chuck Gibson
Susan Gilbert
Brian Gilleran
Alex Goff
Jack Graham
Allison Grissom
Greg Hackbarth
Gerri Hall
Vernon Hartsock
Miriam Kloeppel
Hans Korve
Quon Kwan
John Lech
David Lozeau
Chuck Maples
Michael McArdle
Harry McCall
Linda Meadow
John Mitchell
Paul O'Brien
Lorraine Pacocha
William Petit
Jeffrey Power
Linda Rhodes
Mark Robinson
Harry Saporta
Paul Schneider
John Sharkey
Michael Small
Fred Small
James Stem
Naor Wallach
Jack Webb
Terrell Williams
Robert Winans
Vanessa Young

APTA Rail Transit Standards Rail Grade Crossing Inspection and Maintenance Committee project consultant:

Phil Olekszyk, *World Wide Rail, Inc.*

APTA Rail Transit Standards project team:

Maria Taylor, Program *Manager-Technical Services*
Saahir Brewington, *Program Manager-Standards*
Thomas Peacock, *Director-Operations & Technical Services*

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Standard for Rail Transit Grade Crossing Warning System Design Criteria, Installation and Operation

1. Overview

This standard prescribes minimum requirements for the design, procurement, installation, and implementation of highway rail gated grade crossing systems within rail transit systems and includes requirements for train detection, gate operation, lights, bells, highway traffic signs, signals, and pavement markings.

1.1 Scope

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

1.2 Purpose

The purpose of this standard is to verify highway rail grade crossing devices and 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 rail transit system (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

This standard shall be used in conjunction with the latest version 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.

23 CFR 665, Highways, Subpart F, Traffic Control Devices on Federal-Aid and Other Streets and Highways, 2002.

AREMA Signal Manual, Part 1.4.1, Identical Items "Boilerplate for All Manual Parts."

AREMA Signal Manual, Section 3, Highway Rail Grade Crossing Warning Systems.

AREMA Signal Manual, Part 3.1.10.

AREMA Signal Manual, Part 3.1.11.

AREMA Signal Manual, Part 3.1.15, E.8, Recommended Functional/Operating Guidelines for Control of Automatic Highway Rail Grade Crossing Warning Systems.

AREMA Signal Manual, Part 3.1.16,

AREMA Signal Manual, Part 3.1.25, Recommended Design Criteria and Functional Guidelines for Solid-State Highway rail Grade Crossing Warning Device Controllers.

AREMA Signal Manual, Part 3.1.29.

AREMA Signal Manual, Part 3.2.60.

AREMA Signal Manual, Part 3.2.61.

AREMA Signal Manual, Section 8.

AREMA Signal Manual, Part 11.2.1, Recommended General Practices for Electrical Surge Protection for Signal Systems.

AREMA Signal Manual, Part 11.3.3, Recommended Design Criteria for Surge Withstand Capability of Electronic Signal Equipment for Signal Systems.

AREMA Signal Manual, Part 11.5.1, Recommended Environmental Requirements for Electrical and Electronic RTS Signal System Equipment.

AREMA Signal Manual, Part 14.1, Recommended Wire Connectors, Terminals.

AREMA Signal Manual, Part 16.3.2, Recommended Application Design Guidelines for Isolation of Power Supplies used in Vital Signal Systems.

AREMA Signal Manual, Part 16.30.10, Recommended Vital Circuit Design Guidelines for Highway Traffic Signal Interconnection.

AREMA Signal Manual, Part 17.2.1, Recommended Quality Assurance Program for Electronic/Software Based Products Used in Vital Signal Applications.

AREMA Signal Manual, Part 17.3, Safety Assurance of Vital Electronic/Software-Based Equipment Used in Signal Applications, 2001.

AREMA Signal Manual, Part 17.3.1, Recommended Safety Assurance Program for Vital Electronic/Software-Based Equipment and Systems Used in Signal Applications.

AREMA Signal Manual, Part 17.4.1, Recommended Reliability and Maintainability Assurance Program for Vital Electronic/Software-Based Equipment and Systems Used in Signal Applications.

AREMA Signal Manual, Part 17.5.1, Recommended Configuration Management Program for Vital Electronic/Software-Based Equipment and Systems Used in Signal Applications.

Federal Register "Standards for Development and Use of Processor-Based Signal and Train Control Systems; Proposed Rule," August 10, 2001.

IEEE Std. 100-1996, 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.

Institute of Transportation Engineers Recommended Practice for "Preemption of Traffic Signals Near Railroad Grade Crossings-2004.

MUTCD, Section 1.A.10, Manual of Uniform Traffic Control Devices, General Provisions, Interpretations, Experiments and Changes

The above standards are available from the following sources:

AREMA Signal Manual

http://www.arema.org/pubs/pubs.htm

FHWA Manual on Uniform Traffic Control Devices

http://mutcd.fhwa.dot.gov/kno-millennium.htm

IEEE Standards

http://standards.ieee.org/faqs/order.html

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 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.

3.1.2 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.)

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

3.1.4 highway-rail grade crossing: (A) A location where a public highway, road, street, or private roadway, including associated sidewalks and pathways, crosses one or more railroad track at grade. **(B)** 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.

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

3.1.6 island: The portion of the highway rail grade crossing where the highway and/or pedestrian walkways directly cross the railroad tracks.

3.1.7 median: The area between two roadways of a divided highway measured from edge of traveled way to edge of traveled way, excluding turn lanes. The median width may be different between intersections, interchanges, and opposite approaches of the same intersection.

3.1.8 near side station stop: A station stop within the approach limits of a highway rail grade crossing.

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

3.1.10 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.

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

3.1.11 priority: Signal priority modifies the normal highway traffic signal operation process to better accommodate train operation at or adjacent to the traffic signal controlled intersection.

3.1.12 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.**

3.1.13 rail transit: All forms of non-highway ground transportation that operate on rail including light rail, streetcars, trolley, and rapid rail transit systems.

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

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

3.1.16 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.

3.1.17 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.

3.1.18 vital function: A safety critical function that requires fail-safe implementation. *See:* **fail-safe, safety critical.**

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

3.2 Acronyms

APTA	American Public Transportation Association
AREMA	American Railway Engineering and Maintenance-of-Way Association
ATCS	automated train control system
CFR	Code of Federal Regulations
EIA	Electronic Industries Association
IEEE	Institute of Electrical and Electronics Engineers
MUTCD	Manual on Uniform Traffic Control Devices
OEM	original equipment manufacturer
RF	radio frequency
RTS	rail transit system
RTV	rail transit vehicles

4. Functional/operating guidelines

4.1 Highway rail crossing warning systems

Highway rail grade crossing warning systems shall conform to *AREMA Signal Manual, Part 3.1.15* which discusses general requirements, controls for highway-rail grade crossing warning

systems and two (2) and four (4) quadrant gate systems..

4.1.1 Warning time

Highway rail grade crossing warning systems shall be maintained to operate in compliance with the design of the warning system, but in no event shall they provide less than 20 seconds warning time for the operation of through trains before grade crossings are 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 shall be able to stop the train prior to entering the intersection until it is verified that the warning system is active, and if so equipped, gates are in the fully horizontal position, and that the intersection is clear of highway and/or pedestrian traffic.

4.1.2 Near-side station stops

Operation of grade crossing warning systems may be delayed or bypassed for near-side station stops under any of the following conditions:

a) Transit Authority operating rules require that all trains (or other vehicles normally causing the warning system to operate) shall stop at the station. This includes stopping for the minimum dwell time if so designed, OR;

b) Vital functions are used to identify trains that must stop at the station by operating rule, OR;

c) For locations equipped with crossing gates, vital functions (implemented by a signal or train control system) shall provide a warning and/or prevent the train from entering the crossing until the gates are down.

Where electronic or processor-based systems are used, they shall conform to *AREMA Signal Manual, Part 17.3* and/or *IEEE Std. 1483-2000*.

Where near side station stops are adjacent to interconnected traffic signal controlled intersections, accommodations must be made to ensure adequate pedestrian and vehicle clearance intervals.

4.1.3 Audible warning devices

Each active crossing warning system shall be equipped with no less than one (1) crossing bell or other audible warning system in compliance with state requirements. Each bell shall conform to *AREMA Signal Manual 3.1.15.E.8, 3.2.60 & 61*. Additional ancillary audible devices may be used at the rail transit system's discretion.

4.1.4 Interconnection circuits

Interconnection circuits between highway traffic signals and highway rail grade crossing warning systems shall conform to *AREMA Signal Manual Part 3.1.10*. and *Part 16.30.10*. Serial communication interconnects shall also conform to *IEEE Std. 1570-2002*.

4.1.5 Adjacent track interconnected systems

Adjacent track interconnected highway rail grade crossing warning systems shall conform to AREMA Signal Manual Part 3.1.11.

4.1.6 Motion sensitive systems

Motion sensitive systems that control highway rail grade crossing warning systems shall conform to *AREMA Signal Manual Part 3.1.25*.

4.1.7 Constant warning time devices

Constant warning time devices that control highway rail grade crossing warning systems shall conform to *AREMA Signal Manual Part 3.1.26*.

4.2 Monitoring devices

Monitoring devices for highway rail grade crossing warning systems shall conform to *AREMA Signal Manual Part 3.1.29.*

4.2.1 Solid-state warning device controllers

Solid-state highway rail grade crossing warning device controllers shall conform to *AREMA Signal Manual Part 3.1.25*.

4.2.2 Track circuits

Track circuits shall conform to *AREMA Signal Manual, Section 8*.

4.2.3 Wayside-based train detection systems

Wayside based train detection systems (not based on track circuits) used to activate highway rail grade crossing warning devices shall be in conformance with AREMA Signal Manual Part 3.1.16.

4.2.4 Processor-Based Systems

Where new or novel technology is being used with processor-based systems, 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.

4.2.5 Highway rail crossing traffic control devices

Highway traffic control devices shall be in compliance with the *Manual of Uniform Traffic Control Devices (MUTCD).*

Deviations from *MUTCD* shall be in compliance *with MUTCD, Section 1.A.10*.

4.2.5.1 Preemption or priority at traffic signal controlled intersections

Rail transit vehicles may operate along or across streets that are part of a coordinated traffic signal system at speeds consistent with line of sight operation. In these settings, the rail transit vehicles (RTV) priority or preemption should take place within the overall background cycle. The goal of traffic signal priority should be to minimize the delay for rail transit vehicles. Additionally these strategies should balance (1) the maintenance of parallel and cross-street progressions and other traffic requirements, (2) the provision of safe clearances for errant motor vehicles and pedestrians, and (3) a minimal delay of preempted motor vehicle or pedestrian movements.

Information regarding the application of preemption at traffic signal controlled intersections can be found in the *Institute of Transportation Engineers Recommended Practice for, "Preemption of Traffic Signals Near Railroad Grade Crossings –2004.."*

The rail transit system shall coordinate preemption with the local authority having jurisdiction over traffic signal operation.

4.2.5.2 Preemption of interconnected traffic signal controlled intersections

Preemption may be used to clear highway vehicles and pedestrians from the trackway during the time the crossing warning system is activated, prior to the RTV entering the crossing.

Where near side station stops are adjacent to interconnected traffic signal controlled intersections, accommodations shall be made to ensure adequate pedestrian and vehicle clearance intervals.

4.2.5.3 Medians

Medians are an effective treatment to reduce violations of gated highway rail crossing warning systems. Where analysis indicates and roadway geometry permits, a median should separate traffic lanes. Roadway geometry or left turn requirements may require application of a shortened median or raised delineators to separate traffic lanes.

Dimensions and location of medians should be in compliance with local requirements.

Annex A

(Informative)

Bibliography

[B1] 49 CFR 234, Subpart D, Grade Crossing Signal Safety, http://www.fra.dot.gov/counsel/regs/cfr_49_oct1998/index.htm