APTA STANDARDS DEVELOPMENT PROGRAM

STANDARD

American Public Transportation Association
1300 I Street, NW, Suite 1200 East, Washington, DC 20006

APTA RT-RGC-S-004-03, Rev. 2

Published: June 8, 2003

First Revision: December 8, 20025

Second Revision: December 6, 2017

APTA Rail Transit Grade Crossing Working Group

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

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

Summary: 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.

Scope and purpose: This standard applies to rail transit systems that operate and maintain highway rail grade crossing systems. The purpose of this standard is to verify that 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.

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Introduction

This introduction is not part of APTA RT-RGC-S-004-03, Rev. 2, *"Rail Transit Grade Crossing Warning System Design Criteria, Installation and Operation."*

APTA recommends the use of this Rail Standard by:

- individuals or organizations that operate rail transit systems;
- individuals or organizations that contract with others for the operation of rail transit systems; and
- individuals or organizations that influence how rail transit systems are operated (including but not limited to consultants, designers and contractors).

Note on 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 impossible. 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 may develop alternates to 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:

- identify the specific APTA rail transit safety standard requirements that cannot be met;
- state why each of these requirements cannot be met;
- describe the alternate methods used; and
- 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).

It must be noted that rail transit is not directly comparable to railroads (Amtrak, commuter, freight rail, etc.). Rail transit systems differ greatly in the types of service, vehicles and technology employed, with some systems operating fully automated trains on exclusive rights-of-way and others operating on streets mixed with traffic. Rail transit demands a unique approach to solving its problems, and the APTA Rail Transit Standards Program was developed to accomplish this complex task.

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

1. Application

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

2. Functional/operating guidelines

2.1 Highway rail crossing warning systems

Highway rail grade crossing warning systems shall conform to the requirements in the AREMA "Communications & Signals Manual," Part 3.1.15, which discusses general requirements, controls for highway-rail grade crossing warning systems and two- and four-quadrant gate systems.

2.1.1 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 s 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, that gates (if so equipped) are in the fully horizontal position and that the intersection is clear of highway and/or pedestrian traffic.

2.1.2 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.

2.1.3 Audible warning devices

Each active crossing warning system shall be equipped with no less than one crossing bell or other audible warning system in compliance with state requirements. Each bell shall conform to AREMA Signal Manual, 3.1.15., 3.2.60 and 3.2.61. Additional ancillary audible devices may be used at the rail transit system's discretion.

2.1.4 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. 1570-2008.

2.1.5 Adjacent track interconnected systems

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

2.1.6 Motion-sensitive systems

Motion-sensitive systems that control highway rail grade crossing warning systems shall conform to AREMA Signal Manual, Part 3.1.20.

2.1.7 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.

2.2 Monitoring devices

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

2.2.1 Solid-state warning device controllers

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

2.2.2 Track circuits

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

2.2.3 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.

2.2.4 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.

> **NOTE:** "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 that do not use conventional track circuits.

2.2.5 Highway rail crossing traffic control devices

Highway rail crossing 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.

2.2.5.1 Preemption or priority at traffic signal controlled intersections

Rail transit vehicles (RTVs) 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 vehicle's 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 "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.

2.2.5.2 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.

2.2.5.3 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.

2.2.6 Standby power

Standby power shall conform to AREMA Communications and Signal Manual, 3.1.28.

2.2.7 Control circuits

Control circuits shall conform to AREMA Communications and Signal Manual Volume 1, Section 3, and any other applicable sections of Volumes 1, 2, 3 and 4. Additionally, the authority should seek guidance from 49 CFR 234.

2.2.8 Flashing light units

Flashing light units must conform to AREMA Communications and Signal Manual, 3.2.35.

2.2.9 Fouling wires

A failure of shunt fouling circuits can cause the signal system to fail in an unsafe manner. When an authority installs a new or redesigned system, the authority shall explore alternatives to shunt fouling and use such alternatives whenever practical. Fouling wires shall conform to AREMA Communications and Signal Manual, 2.1.15.

2.2.10 Reverse switch cutout circuits

Reverse switch cutout circuits shall conform to AREMA Communications and Signal Manual, 16.30.5.

2.2.11 Wire identification

Wire identification shall conform to AREMA Communications and Signal Manual, 16.1.1.

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, 2009.

Federal Highway Administration, "Manual of Uniform Traffic Control Devices (MUTCD_," Section 1.A.10, General Provisions, Interpretations, Experiments and Changes. http://mutcd.fhwa.dot.gov/kno-millennium.htm

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

AREMA Communications & Signals Manual. http://www.arema.org/pubs/pubs/.htm.

Institute of Transportation Engineers, Recommended Practice, "Preemption of Traffic Signals Near Railroad Grade Crossings."

49 VFR 234, Subpart D, Grade Crossing Signal Safety
http://www.fra.gov/counsel/regs/cfr_491998/index.htm

Definitions

For the purposes of this standard, the following definitions apply. IEEE Std. 100-19961 and the AREMA Signal Manual should be referenced for terms not defined in this clause.

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.

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

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

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 tracks 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.

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

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

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.

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

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.

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.

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

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

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

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

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.

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.

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.

Abbreviations and acronyms

APTA	American Public Transportation Association
AREMA	American Railway Engineering and Maintenance-of-Way Association
CFR	Code of Federal Regulations
deg	degrees
IEEE	Institute of Electrical and Electronics Engineers
MUTCD	Manual on Uniform Traffic Control Devices
NATSA	North American Transit Services Association
RTS	rail transit system
RTV	rail transit vehicles
s	seconds

Summary of document changes

- Document formatted to the new APTA standard format.
- Sections to reflect APTA *Rail Standard* format added to Content Index.
- Omitted publish dates for IEEE and AREMA standards.
- Added sections 2.2.6, 2.2.7, 2.2.8, 2.2.9, 2.2.10 and 2.2.11, setting standards for these items.
- Added definitions for "gate up" and "island."
- References, definitions and acronyms moved to the rear of the document.

Document history

Document Version	Working Group Vote	Public Comment/ Technical Oversight	Rail CEO Approval	Rail Policy & Planning Approval	Publish Date
First published	Oct. 8, 2002	—	—	Jan. 10, 2003	June 8, 2003
First revision	—	—	—	Dec. 8, 2005	Dec. 8, 2005
Second revision	July 19, 2017	August 1, 2017	September 18, 2017	November 2, 2017	December 6, 2017