



APTA STANDARDS DEVELOPMENT PROGRAM

## RAIL STANDARD

American Public Transportation Association

1300 I Street, NW, Suite 1200 East, Washington, DC, 20005

APTA RT-OP-SP-006-03 Rev 3

Originally Published: June 8, 2003

First Revision: July 26, 2004

Second Revision: December 2012

Third Revision: October 8, 2018

APTA Rail Transit Operating Practices  
Working Group

# Rail Transit Signals Operating Rules and Procedures

**Abstract:** This Rail Standard provides guidance for the development of rail transit system (RTS) operating rules and procedures pertaining to signals. It outlines the wide variety of signal systems and the requirements for rules pertaining to their operation.

**Keywords:** automatic block system, automatic train control, automatic train operation, automatic train protection, block, block signal, cab signal, call-on, fail safe, fail soft, signal indication, interlocking, permissive block, positive stop, restricted speed, signal, timing signal, non-shunting equipment, vital function.

**Summary:** This standard establishes requirements for operating rules and procedures governing rail transit signal systems. It was developed to help rail transit systems apply and utilize train control signal technology to enhance safe, efficient train operation through the application of operating rules and procedures. Development of clear, system-specific rules and procedures will enhance the safety of employees and the riding public while promoting the most effective use of RTS resources.

**Scope and purpose:** This standard addresses train control signals as they relate to rules and procedures for train operations and their applications in RTSs. This standard addresses operating rules related to fixed signals and signs that can be considered as part of the train control system. It also addresses operating rules related to traffic “bar” signals and other “informational” signals. This standard addresses practice for operating rules and procedures which relate to railway signals and signs associated with an operating rail transit system. As used in this standard, “signal” includes but is not limited to any device along the wayside that conveys operational information to the train operator, including those that originate in the system of train control utilized in the signal system, including on-board cab signal displays; fixed and temporary wayside signage; and manually-given signals from roadway workers. Each RTS differs in operating characteristics, equipment design and environment; therefore, the RTS shall adapt this standard to its unique operating environment.

This document represents a common viewpoint of those parties concerned with its provisions, namely, transit operating/planning agencies, manufacturers, consultants, engineers and general interest groups. The application of any standards, practices or guidelines contained herein is voluntary. In some cases, federal and/or state regulations govern portions of a transit system's operations. In those cases, the government regulations take precedence over this standard. The North American Transit Services Association (NATSA) and its parent organization APTA recognizes that for certain applications, the standards or practices, as implemented by individual transit agencies, may be either more or less restrictive than those given in this document.

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## Introduction

This Introduction is not part of APTA RT-OP-S-006 Rev 3 “*Rail Transit Signal Operating Rules and Procedures.*”

This standard represents a common viewpoint of those parties concerned with its provisions, namely transit operating/planning agencies, rail transit systems, manufacturers, consultants, engineers and general interest groups. The application of any standards or recommended practices contained herein is voluntary. In some cases, federal and/or state regulations govern portions of a rail transit system’s . In those cases, the government regulations take precedence over this standard. APTA recognizes that for certain applications, the standards or recommended practices, as implemented by individual rail transit systems, may be either more or less restrictive than those given in this document.

## 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 impractical. As a result, certain rail transit systems may need to implement alternatives to these standards and practices. 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.
- 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 (e.g. 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 enacted to accomplish this complex task.

# Rail Transit Signals Operating Rules and Procedures

## 1. Objective

The objective of this standard is to attain a level of consistency between rail transit systems (RTS) and to achieve consistency in the concepts that support the signals operating rules and procedures.

This standard is not an attempt to establish uniformity among all RTSs in signal aspects, signal indications or related operating rules, nor is it intended to establish standards for the design of train control systems, or of elements of such systems, except where operating rules may be affected. Such a degree of standardization is neither desirable nor possible given the variations among rail transit systems in both train control technology and in operating philosophy.

## 2. Signal system

The primary purposes of a signal system on a rail system are:

- Train detection, to provide positive location of trains;
- Train separation, to protect a train from a collision with a train ahead operating on the same track;
- Train routing, to provide protection against conflicting train movements and to verify safety of train movements at crossover locations and at interlockings; and
- Movement authority, to provide authority for the movement of trains on the right of way.

The secondary purposes of a signal system on a rail system may include:

- Positive stop enforcement;
- Speed enforcement and control of train speeds;
- Broken rail detection;
- Control of crossing warning systems;
- Signal violation detection; and
- Interfacing with vehicular traffic systems. These are important concepts that have a strong impact on signal indications and on the implementation of associated rules and procedures.

### 2.1 Types of signals

The RTS shall classify signals according to the source and nature of the information displayed. The RTS shall arrange portions of the operating rulebooks pertaining to signals according to the type and surety of information conveyed by the signal. This is particularly important when certain classes of signals are displayed by equipment designed according to fail-safe principles of design for train detection and location (e.g., train control system), and others are not (e.g., traffic bar signals). Thus, if a train or other rail vehicle cannot positively be detected and located by the train control system, it will require a separate category of rules and procedures to govern its movement. Such differentiation may be accomplished by numbering rules by series.

Types of signals may include, but are not limited to:

- Wayside signals;
- Interlocking signals;

- Cab signals;
- Traffic bar signals;
- Indicators, including, but not limited to:
  - a) Grade crossings
  - b) Switch points
  - c) Derail positions
- Fixed signals and signs governing speed and/or operating conditions, including but not limited to interlocking signals, that modify other signals
- Flagging or hand signals

## **2.2 Safe spacing of trains**

The RTS shall develop and implement operating rules to work in conjunction with the signaling system to convey to the train operator the permission for movement and allowable maximum speed to provide for safe spacing of trains.

When safe spacing of trains is not accomplished by the train control system, safe spacing of trains along a route may be accomplished by one or more of the following methods and shall be reflected in the operating rules.

- Absolute block
- Manual block (Some RTS may refer to this as Permissive Block/Special Operations)
- Line of sight
- Timing devices or
- Operations Control Center (OCC) authorization

## **3. Train control**

### **3.1 Types of train control systems**

The RTS shall develop and implement rules and procedures that take into consideration the relevant types of train control systems and their system application, including but not limited to the following:

- Automatic block system (ABS)
- Automatic train control (ATC)
- Automatic train operation (ATO),
- Automatic train protection (ATP)
- Cab signaling
- Communications based train control (CBTC)

### **3.2 Interlocking and related systems**

The RTS shall develop and implement rules and procedures that take into consideration interlocking and related systems.

Train control systems are also designed to manage train routing at junctions, crossings, movable bridges or other special locations. This may be accomplished through use of interlockings, dedicated approach signals, or by routing or switch position signals. The primary indication conveyed by interlocking signals is the safety of train movement. The signal system may also convey the following information:

- Route and condition of block ahead (for purposes of conveying safe train spacing information);
- Speed restriction;
- Yard route, or other route into unsignaled territory;

- Indicators;
- Operations over unique track configuration or equipment; and
- Special Operations

The route and aspect chart developed as part of the design of the train control system shall be the basis for development of operating rules and associated signals at interlockings.

### **3.3 “Fail-soft”**

Within the fail-safe requirements associated with vital design principles, train control systems are generally configured to provide for limited movement of trains through fail-soft design. The RTS shall develop and implement operating rules and procedures that clearly delineate where such movement is at a level of safety that differs from that normally provided by the signal system. For example, if a wayside or cab signal system fails, the rules and procedures shall clearly define the remaining train movement capability and the level of protection that is provided by the train control under this alternate option. This shall also identify supplemental or alternate methods of protection, e.g., written train orders or verbal OCC authorizations.

## **4. Operating rulebook**

RTS operating rulebooks shall contain an illustration representative of each aspect. See Annex A.1 for an example of how to develop such illustrative charts. The RTS shall develop and implement operating rules and procedures associated with each aspect.

Examples of the following types of signals shall be identified and included in an operating rulebook, as appropriate to the individual RTS. They shall be identified and explained by category.

- End-of-track signals.
- Grade crossing signals. Special aspects may be displayed to the train operator to indicate status of crossing protection.
- Hand signals.
- Fixed signs such as block limit signs and cab-signal cut-in signs.
- Wayside signals
- Speed limit signals
- Traffic Bar Signals.
- Train Control, cab signals.
- Train Control, wayside signals.
- Work zone or slow zone signals.

### **4.1 Additional rules and procedures**

The RTS shall establish rules and procedures for the following situations. The RTS may also develop a corresponding procedure related to the following rules.

#### **4.1.1 Non-shunting equipment**

The RTS shall designate a class of equipment in the appropriate rulebook(s) for any equipment that operates on rail and is not positively detected by the train control system. Rules and procedures that reflect the inability of the train control system to recognize the presence of and to regulate the movement of such equipment shall be included in the rulebook.

#### **4.1.2 Movement to pass a stop signal**

The RTS shall establish rules and procedures for movement to pass a stop signal. The rule(s) shall specify who is authorized to approve such movement and the method (written or verbal) by which such movement is accomplished. The RTS shall establish a protocol for documenting such approvals.

#### **4.1.3 Timing signals**

Certain types of signaling systems may be designed with timing circuits for speed control. The RTS may elect to develop a special aspect for the display of timing signals. When timing signals are used, the RTS shall develop and implement a rule regarding appropriate train operations for such signals.

#### **4.1.4 Call-on signals**

Signals may be employed that require positive action by the train operator, train controller or both in order to display an aspect more favorable than stop under certain conditions. The RTS shall develop and implement a rule governing the usage of call-on signals.

#### **4.1.5 Multiple aspects**

At some rail properties, cases may exist in which multiple aspects are utilized to convey an indication. While this is permissible, the RTS shall clearly delineate in the rulebook the aspects utilized for a particular indication. Under no circumstances shall a single aspect be used to convey more than one indication or rule.

#### **4.1.6 Improperly displayed or dark signals**

Operating rules and procedures shall reflect the design philosophy associated with improperly displayed or dark signals, specifically whether or not “light out” or “dark signal” protection is provided. Under no circumstances shall a rule be implemented or signals utilized that permit an improperly displayed or dark signal to provide an indication that is more favorable than the actual condition.

#### **4.1.7 Movement through obstructed, malfunctioning or out of service crossings/traffic intersections**

The RTS shall develop rules and procedures for movements through crossings that are not fully functional due to equipment issues, broken gates, vehicular traffic encroachment onto the right-of-way, etc. In street-running systems the RTS shall do the same for shared traffic intersections where there are rail/bar or traffic signal malfunctions impacting safe train, vehicular and/or pedestrian movement.

### **4.2 Requirements for other operating conditions**

As appropriate, the RTS shall develop operating rules and procedures for conditions, such as the following:

- Entry into street or other unsignaled territory and entry from unsignaled territory into signal controlled territory.
- Conflicting aspects between the cab signal and wayside signal, wayside signals and auto traffic signals, or the cab signal and the auto traffic signals.
- Movement of trains between ABS and cab signal territory.
- Freight operations, and other Federal Railroad Administration (FRA) interfaces (for non-FRA properties).
- Highway grade crossings.
- Movement of ATO equipment onto tracks where on-track protection is active.
- Movement into and through established work zones or areas where equipment or personnel are fouling or have the potential to foul the right-of-way (as described in APTA RT-OP-S-004-03 Rev 2 and APTA RT-OP-S-016-11 Rev 1).

## 5. Configuration changes

The RTS shall establish a process for reviewing and modifying, as applicable, any signals operating rules and procedures as a result of any changes to the configuration of the operating signals or train control system.

The RTS shall establish a process for reviewing and modifying, as applicable, any employee training programs, as they relate to signals operating rules and procedures.

Prior to any rules being put into effect, the RTS shall train employees on signals operating rules and procedures that have changed.

APTA-RT-OP-S-001-02 Rev 2 “*Standard for Rule Book Development & Review*” establishes requirements for rulebook development and authority.

## Definitions

For the purposes of this standard, the following terms and definitions apply. The job titles listed below are used in this standard for informational purposes only. It is up to the individual RTS to determine and utilize titles as it finds appropriate.

**absolute block:** A block that no train is permitted to enter while it is occupied by another train.

**automatic block system (ABS):** A system of controlling train separation in which the signal aspects are activated by movement of trains into and out of blocks. The presence or absence of a train in a block is determined by a track circuit. If the circuitry fails, the signal shall display its most restrictive aspect.

**automatic train control (ATC):** A system that enforces speed restrictions and prevents exceeding speed restrictions by automatic brake applications; may additionally encompass automatic train operation, automatic train protection and automatic train supervision.

**automatic train operation (ATO):** A subsystem within the automatic train control system that performs any or all of the functions of speed regulation, programmed stopping, door control, performance level regulation or other functions otherwise assigned to the train operator.

**automatic train protection (ATP):** A subsystem within the automatic train control system that maintains fail-safe protection against collisions, excessive speed and other hazardous conditions through combination of train detection and train separation.

**bar signal:** An illuminated signal configured in the shape of a bar, normally positioned to appear in a vertical, angled or horizontal orientation. These are used as aspects to convey a signal indication. Bar signals are typically used on light rail transit systems.

**block:** A section of track of defined limits, the trains' entrance to which is governed by block signals and/or cab signals, or by verbal or written authority as prescribed by rule.

**block signal:** A fixed signal installed at the entrance to a block to govern trains entering and using that block.

**cab signal:** A signal in the train operator's cab that conveys either automatic block aspects or indicates the prevailing speed command, or both.

**call-on:** A signal aspect that requires the train operator to bring a train to a complete stop before proceeding into an occupied block at restricted speed.

**fail-safe:** A design philosophy applied to safety-critical systems such that the result of a hardware failure or the effect of a software error shall either prohibit the system from assuming or maintaining an unsafe state, or shall cause the system to assume a state known to be safe.

**fail-soft:** To fail in a manner that is consistent with fail-safe principles but that continues to provide some level of functionality. Under fail-soft conditions, vital functions are maintained, but at a lower or degraded level of functionality or operability. This includes a design using the concept of graceful degradation as part of the fail-safe, in which the system is shut down through intermediate steps, all of which are fail safe.

**interlocking:** An arrangement of switches, locks and signal devices that is located where tracks cross, join or separate. The devices are interconnected in such a way that their movements must succeed each other in a predefined order, thereby preventing opposing or conflicting train movements.

**maximum authorized speed:** The maximum speed limit authorized over a defined track segment. Typically this is referred to as maximum permitted speed.

**non-shunting equipment:** Any vehicle that operates on rail and that does not positively shunt track circuits.

**permissive block:** A block that permits a train to enter while it is occupied by another train.

**positive stop:** The requirement that a train be brought to a full and complete stop, either by the actions of a train operator or the train control system.

**rail transit system (RTS):** An organization that operates passenger train service and its supporting activities.

**restricted speed:** The allowable speed authorized, in conjunction with the line of sight rule in prescribed operating environments. This speed shall be defined in an RTS rulebook or standard operating procedure.

**right-of-way:** The area at track level or above track level within a distance designated by the RTS of the centerline of the closest tracks.

**sign:** A notice for giving directions or warning.

**signal:** A signal at a fixed location that indicates a condition that affects the movement of a train.

**signal aspect:** The appearance of a fixed signal conveying an indication as viewed from the direction of an approaching train. The appearance of a cab signal conveying an indication as viewed by the operator in the cab.

**signal indication:** The information conveyed by the aspect of a signal

**timing device:** A advance warning device designed to permit safe and efficient operation of rail and/or highway traffic over crossings.

**timing signal:** A signal that controls train speed by requiring that a certain time elapse in an approach block.

**train:** A rail service vehicle such as any motorcar, locomotive, or other self-propelled on-track equipment, with or without cars coupled.

**vital function:** A function in a safety-critical system that is required to be implemented in a fail-safe manner.

## **Abbreviations and acronyms**

<b>ABS</b>	automatic block system
<b>APTA</b>	American Public Transportation Association
<b>ATC</b>	automatic train control
<b>ATO</b>	automatic train operation
<b>ATP</b>	automatic train protection
<b>CBTC</b>	communication-based train control

<b>FRA</b>	Federal Railroad Administration
<b>NATSA</b>	North American Transit Services Association
<b>OCC</b>	operations control center
<b>PTC</b>	positive train control
<b>RTS</b>	rail transit system
<b>SBD</b>	safe braking distance

## Related APTA standards

Rail Transit Signals Operating Rules and Procedures contains information that is directly related to other APTA Standards and Recommended Practices. The following Standards and Recommended Practices contain information directly related to subjects within this Policy.

- **APTA-RT-OP-S-001-02 Rev 3** “*Rulebook Development and Review*”
- **APTA RT-OP-S-004-03 Rev 2** “*Work Zone Safety Practices*”
- **APTA RT-OP-S-011-10 Rev 2** “*Rule Compliance Program Requirements*”
- **APTA RT-OP-S-016-11 Rev 1** “*Roadway Worker Protection Program Requirements*”

## Summary of changes

- a) Changed title to “Rail Transit Signals Operating Rules and Procedures” (Added and Procedures)
- b) Expanded the primary and secondary purposes of signal systems in section 2 “Signal system”
- c) Added additional examples to section 2.1 “Types of signals”
- d) Modified language in section 2.2 “Safe spacing of trains”
- e) Changed section 3 to “Train control systems”
- f) Changed section 4 to “Operating rulebook content”
- g) Changed section 4.1 to “Additional rules and procedures”
- h) Added section 4.1.7
- i) Expanded section 5 “Configuration changes” to include additional RTS responsibilities
- j) Referenced related APTA standards
- k) Reviewed by small working group on 9/18/17
- l) Added signal aspect chart to Annex A.1
- m) Document formatted to a new APTA standard
- n) Sections have been renumbered and moved around
- o) Scope and summary moved to the front page
- p) Updated Working Group membership list
- q) Minor changes to spelling, capitalization and grammar
- r) A note on alternate practices added
- s) A new section “*Summary of Changes*” added
- t) A new section “*Document History*” added
- u) Definition section enlarged to incorporate new items and clarify some existing ones
- v) Old Section 4 “*Types of Signals*” deleted and replaced with a new Section 2 “*Signal System*” which now explains the primary and secondary purposes of this system

- w) Old Section 5 “*Train Control Systems and Related Signals*” deleted and replaced with a new Section 3 “*Train Control*” which includes among other items a new and more comprehensive sub-section on “*Interlocking and Related Systems*”
- x) Annex A “*Information on Signal Systems for use in the Development of Signal Rules*”, major revisions made and in particular an expansion on Table 1 which separately discussed the three types of signals – wayside color light signals, wayside bar signals, and wayside interlocking signals

**Document history**

Document Version	Working Group Vote	Public Comment/ Technical Oversight	Rail CEO Approval	Rail Policy & Planning Approval	Published Date
First published	Dec 15, 2002	-	-	Jun 8, 2003	Jun 8, 2003
First revision	-	-	-	Jul 26, 2004	July 26, 2004
Second revision	Sept 11 & 12, 2012	4Q 2012	4Q 2012	4Q 2012	Dec 2012
Third revision	Feb 14, 2018	April 17, 2018	July 6, 2018	Sept. 1, 2018	Oct. 8, 2018

## Annex A (informative): Information on signal systems for use in the development of signal rules

### A.1 Protocol for wayside signal aspects

Signal aspects used by RTS are varied and depend on the type of signaling system and their respective operating philosophies. While it is not possible to provide an exhaustive compendium of all types in current use, Tables 1, 2 and 3 attempts to describe some of the more typical aspects types, colors, and shapes of signals used in the transit industry. Therefore, this information is provided as a reference guide and is not intended to require agencies to change their aspects to match those of the chart.

The RTS shall determine in its rulebook and other operating procedures the indication of each aspect and what specific actions should be taken by the train operator when encountering them.

**Table 1**  
**Wayside Color Signals for Train Separation**

Signal Aspects	Indication	Aspect	Actions by Train Operator
Red	Stop		Stop
Dark Signal (No illumination)	Stop		Stop
Red with "Modifier" (Modifier may be an additional steady light or a flashing indication)	Stop & Proceed		Stop and proceed or proceed per rule when the condition of the block ahead is not certain. This could be an indication of a train ahead or a broken rail.
Green	Proceed		Proceed at permitted speed
Lunar	Proceed		Proceed at permitted speed
Yellow	Approach		Proceed at permitted speed and be prepared to stop at next signal

Note: Reference to color signals refers to circular or square wayside signal aspects for the purpose of distinguishing between these and bar signals.

**Table 2**  
**Wayside Bar Signals for Train Separation**

Signal Aspect	Indication		Actions by Train Operator
Red Horizontal	Stop		Stop
Yellow Horizontal	Stop		Stop
Amber Horizontal	Stop		Stop
White Horizontal	Stop		Stop
Lunar Horizontal	Stop		Stop
White Vertical	Proceed		Proceed at permitted speed
Lunar Vertical	Proceed		Proceed at permitted speed
Green Vertical	Proceed		Proceed at permitted speed

## A.2 Signal Location Configuration

Train control signals convey information regarding conditions of one or more blocks ahead of a train. Such signals should be configured (such as with respect to signal location or indications) to keep trains at an interval no less than safe braking distance (SBD) at the following train's speed *unless* a special indication is provided. As an alternate, or as a supplement, this distance may also be enforced through engineered equipment, a combination of equipment and operator action, or solely through operator action as prescribed by the rules.

## A.3 Advanced technology

As with all technology, train control systems have advanced and therefore require new operating rules to be implemented to incorporate these advances such as: CBTC systems or Positive Train Control (PTC).

The RTS should therefore consider developing operating rules for advanced technology train control such as:

- Train detection: The surety of train detection shall be reflected and rules shall be implemented for on-track equipment, "non-equipped" trains and other special vehicles.
- Commonality of indication and rules: Commonality and consistency of indications and rules with those based on conventional train control systems is desirable. This is particularly the case on rail transit systems that employ a mix of technologies.
- Fail soft design: Rules shall clearly delineate the modes of operation that are permissible under a partial or total failure of the train control system.