

24. Standard for Electric Switch Machine Inspection and Maintenance

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Abstract: This standard provides procedures for inspecting and maintaining rail transit mainline and yard electric switch machines.

Keywords: electric switch machine, inspection, mainline switch machine, maintenance, signal, switch machine, track switch, yard switch machine

Introduction

(This introduction is not a part of APTA RT-SC-S-024-03, *Standard for Electric Switch Machine Inspection 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 and maintaining rail transit electric switch machines.

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.

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Standard for Electric Switch Machine Inspection and Maintenance

1. Overview

1.1 Scope

This document establishes standard requirements for inspecting and maintaining rail transit mainline and yard electric switch machines.

1.2 Purpose

The purpose of this standard is to verify that electric switch machines are operating safely and as designed through periodic inspection and maintenance, thereby increasing reliability and reducing the risk of hazards and failures.

1.3 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 (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. Definitions and acronyms

For the purposes of this standard, the following definitions and acronyms apply:

2.1 Definitions

2.1.1 ballast: Granular material placed in the track bed to support and restrain the track in line and surface.

2.1.2 cam: A machine part with an irregular form such that its motion, usually rotary, imparts by contact to another part, specific reciprocating motion.

2.1.3 circuit controller: A device for opening and closing electric circuits operated by a rod connected to a switch, derail, or moveable point frog.

2.1.4 commutator brush: A piece of conductive material, usually carbon or graphite, that rides on the commutator of a motor and forms the electrical connections between the commutator and the power source.

2.1.5 connecting rod: A rod that transmits linear mechanical motion within the switch machine, or that transmits such motion outside the machine to some part of the track switch assembly. *See also: lock rod, switch rod, switch throw rod.*

2.1.6 cotter pin: A short strip of soft, folded metal that is inserted through a bolt head or nut to prevent rotation and/or disengagement of that bolt or nut from its connection

2.1.7 electric switch machine: An electrically controlled device for positioning of switch point, the complete operation of the switch machine performs the three functions of unlocking, operating and locking. Also referred to as power operated switch machine.

2.1.8 eyelet: A closed loop electrical fastener that provides a terminating point for wiring. Also referred to as ring terminal.

2.1.9 friction clutch: A device that absorbs the shock encountered in switch operation. The clutch is adjusted to slip at a specific motor current.

2.1.10 gauge plate: Metal plates that are typically insulated, extending from rail to rail, used to maintain gauge of track.

2.1.11 hand crank: A tool designed for the manual operation of a switch machine. Also the action of using such a tool.

2.1.12 hand throw lever: A lever used to position switch points. This device can be used on a dual control switch that provides for either power or hand operation and on non-interlocked hand operated switches.

2.1.13 hazard: Any real or potential condition that can cause injury, death, or damage or loss of equipment or property.

2.1.14 indication contact: A conducting part which co-acts with another conducting part to open or close an electric circuit for the purpose of providing and removing voltage to an indication device.

2.1.15 linkage: A mechanical arrangement for transferring motion in a desired manner.

2.1.16 local control panel: A panel displaying a line diagram of the trackage in and near a particular interlocking or group of interlockings, and equipped with various pushbuttons, electric switches, indicator lights, and audible alarms to allow control and monitoring of that section of trackage. *Syn:* **interlocking control panel.**

2.1.17 lock rod: A rod attached to the front rod or lug, through which a locking plunger (dog) may extend when the switch points or derail are in the normal or reverse position. *See also:* **connecting rod, switch rod, switch throw rod.**

2.1.18 lock rod notch: The cut out portion of a switch machine lock rod designated for insertion of the locking dog to mechanically lock a switch machine.

2.1.19 locking dog: A steel block that is automatically positioned, in the switch and lock movement, at the completion of a machine's throw to effect mechanical switch locking of the points.

2.1.20 motor: The basic assembly that converts external electrical energy into rotational torque.

2.1.21 motor control contact: A contact of a relay, switch, or other devices used to provide electrical energy to a motor or a device to be power operated.

2.1.22 motor cutout contact: The contacts on a switch machine that open the motor circuit when a switch machine is operated in the manual mode.

2.1.23 motor cutout contact spring: Tension applying device designed to ensure that motor electrical contacts, designed to remove power from the motor in the event of a jam or overload, make sufficient contact to pass electrical energy.

2.1.24 operations control center (OCC): That facility from which train control, train dispatching, and/or train supervision takes place for the entire RTS 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.**

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

2.1.26 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.

2.1.27 point detector rod: A device used to translate mechanical position of the switch points to the switch machine.

2.1.28 post maul: A large sledgehammer.

2.1.29 rail brace: A device that provides lateral support on the field side of stock rails to maintain the track gauge.

2.1.30 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.**

2.1.31 ring terminal: A closed loop fastener that is used to secure wire to a terminal post. *Syn:* eyelet.

2.1.32 slide plate: A flat plate contained in the switch layout that provides a surface for the movement of the switch points from one position to the opposite position. *Syn:* **wear plate.**

2.1.33 stock rail: The rail against which the point of a switch, derail or moveable point frog rests.

2.1.34 switch: A pair of switch points with their fastenings and operating rods providing the means for establishing a route from one track to another.

2.1.35 switch block: A wedge-shaped wooden block, designed to be forced between an open switch point and a stock rail of a track switch, to hold the other switch point firmly against its stock rail to ensure safe train passage.

2.1.36 switch cutout: A device that opens contacts and interrupts power to the switch motor.

2.1.37 switch latch: An assembly or device that latches the crank cutout contacts in the open position when engaged by a hand crank. When the switch latch is closed, the cutout contacts are restored.

2.1.38 switch layout: A complete track assembly that includes the switch machine, the switch points, rails, frogs, and other related components.

2.1.39 switch machine: A device that performs the mechanical function of controlling the movement of switch points or a derail from one position to the other.

2.1.40 switch point clamp: A lockable device for clamping the base of a closed switch point to the base of the adjacent stock rail.

2.1.41 switch point: A movable tapered track rail, the point of which is designed to fit against the stock rail.

2.1.42 switch rod: A rod connecting the two points of a switch or moveable point frog, by means of which the relative distance between the points is maintained. *See also:* **connecting rod, lock rod, switch throw rod.**

2.1.43 switch rod insulation: Non-conductive material used to electrically isolate the two sections of a switch rod.

2.1.44 switch throw rod: The connecting rod that transfers motive force from the switch machine throw bar to the switch points. *See also:* **switch throw bar**; *Syn:* **throw rod, switch operating rod.**

2.1.45 tamp: The process of compacting ballast under ties.

2.1.46 terminal block: A molded non-conductive material containing one or more electrical wiring terminals. *See also:* **terminal board.**

2.1.47 tie: The transverse member of the track structure to which the running rails are fastened, which is centered on the track and designed to cushion, distribute, and transmit the stresses of traffic from the rail to the ballast. *Syn:* **crosstie.**

2.1.48 tie plate: A plate that is used to provide a bearing area for the rail base that distributes the rail vehicle load to the tie and prevents lateral movement of the rail.

2.1.49 tie strap: A steel bar used to maintain tie spacing and prevent movement.

2.1.50 torque: A force that produces rotational twisting.

2.2 Acronyms

OCC	operations control center
OEM	original equipment manufacturer
PPE	personal protective equipment
RTS	rail transit system

3. Inspection and maintenance requirements

3.1 Inspection and maintenance frequency

The inspection and maintenance procedures in this standard shall be performed when electric switch machines are placed in service, when they are modified, repaired, or disarranged, or as otherwise deemed necessary by RTS.

The RTS shall determine the need for additional inspection and maintenance frequencies for electric switch machines. A review of the following factors may be useful in making this assessment:

- OEM-recommended intervals
- Industry experience
- Operating environment/conditions
- Historical data
- Reliability-centered maintenance program development

- Failure analysis
- RTS testing and experience
- Regulatory requirements.

The frequency of tasks shall comply with applicable federal, state, and local regulations.

3.2 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.

3.3 Materials

The following materials are required for inspecting and maintaining electric switch machines:

- Sandpaper
- Grease gun
- Rags
- Oil can with oil
- Switch plate lubricant
- Trash bags and ties
- RTS-approved degreaser
- Scrapers
- Wire brush
- Paint
- Cleaning and dusting brushes
- RTS-approved contact cleaner
- Lint-free cloths
- Additional materials as required by the OEM and/or RTS

3.4 Tools

The following tools are required for inspecting and maintaining electric switch machines:

- Hand crank
- Ruler
- Multi-meter*
- Switch adjusting open end wrenches
- Terminal nut wrench
- Post maul
- Switch blocks and/or switch point clamps
- RTS-approved portable radio
- Standard tools carried by maintenance personnel
- Additional tools as required by the OEM and/or RTS

* Calibrate in accordance with OEM and/or RTS requirements.

3.5 Personal protective equipment

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

3.6 Safety

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

3.7 Inspection and maintenance procedures

Electric switch machine inspection and maintenance procedures may be modified for each rail transit system's requirements (see Section 1.3) but shall contain the steps listed in Sections 3.7.1-3.7.2 as a minimum.

3.7.1 Inspection

3.7.1.1 Notify the operations control center (OCC) and/or other authorities of the inspection activities to be performed.

3.7.1.2 Disable the switch operation in accordance with RTS instructions.

- 3.7.1.3 Inspect the switch machine and layout for an accumulation of debris. Remove and bag debris.
- 3.7.1.4 Inspect wayside drains for blockage or ineffective drainage.
- 3.7.1.5 Inspect the switch machine and layout for damage caused by standing water, water leaks, or retention.
- 3.7.1.6 Inspect the switch machine and layout for any condition that may interfere with the operation of the equipment. Ensure switch points and rods are clear of ballast.
- 3.7.1.7 Inspect the switch machine, and layout for damage, rust, corrosion, and missing or loose components and hardware. Inspect rod connecting pins and ensure cotter pins are in place and spread properly.
- 3.7.1.8 Inspect switch machine junction boxes and other enclosures for damage, cracks, breaks, defective latches, locks, hinges, covers, and loose, deteriorated, or damaged conduit connections, and hardware. Holes and unused entrances not used for ventilation shall be sealed.
- 3.7.1.9 Inspect polyvinyl chloride (PVC), fiberglass, rubber and other cable conduit material for damage, cracks, breaks, loose conduit connections, missing or loose components, and hardware.
- 3.7.1.10 Inspect switch points, stock rails, ties, tie plates, rail braces, switch rods, tie straps, and other associated switch layout components.
- 3.7.1.11 Inspect ties to ensure they are well tamped to withstand vibration and strain caused by passing trains.
- 3.7.1.12 Enable switch operation in accordance with RTS procedures.
- 3.7.1.13 Operate switch in both directions to ensure proper locking and indication.
- 3.7.1.14 Observe that covers and locks are in place and secured.
- 3.7.1.15 If no further work is to be performed, notify the OCC and/or other authorities that the inspection activities are complete.

3.7.2 Maintenance

- 3.7.2.1 Notify OCC and/or other authorities of the maintenance activities to be performed.
- 3.7.2.2 Remove covers from switch machine circuit controller, gearbox, cutout, and motor compartments. Place covers in a safe area.
- 3.7.2.3 Check switch cutout/latch for operation, verify that energy supply is interrupted when switch cutout mechanism contacts are open, leave cutout in open position.

- 3.7.2.4** Clean accumulations of metallic particles, dirt, grease, and oil from exterior and interior of switch machine.
- 3.7.2.5** Clean areas of the switch machine where hardened deposits and/or rust are present and paint or coat with RTS-approved materials.
- 3.7.2.6** Remove excess ballast or hardened deposits of metallic particles and mud, as they could not only obstruct switch operation, but also could create dams, and in wet locations produce pools of water under and around the switch layout.
- 3.7.2.7** Clean rods in switch layout.
- 3.7.2.8** Clean and inspect switch rod insulation.
- 3.7.2.9** Clean off excessive accumulations of switch lubricant from slide plates, gauge plates, and stock rails.
- 3.7.2.10** Check for and dry any signs of moisture accumulation within switch machine compartments.
- 3.7.2.11** Inspect switch machine and layout for condition of identification plates and markers, damage, rust, corrosion, and missing or loose components and hardware including bolts, nuts, cotter pins, lock washers and screws.
- 3.7.2.12** Inspect cable, wiring, and terminal blocks for condition of wire tags, defective insulation, heat, and loose, corroded, rusted, damaged, or missing connectors and terminals. Special attention must be given to the condition of the wires connected at the eyelet/ring terminal, excessive movement will eventually cause breakage
- 3.7.2.13** Inspect polyvinyl chloride (PVC), fiberglass, rubber and other cable conduit material for damage, cracks, breaks, loose conduit connections, missing or loose components, and hardware.
- 3.7.2.14** Inspect switch machine junction boxes and other enclosures for condition of identification plates and markers, rust, corrosion, damage, cracks, breaks, defective latches, locks, hinges, covers, weather seals, and gaskets, loose, deteriorated, or damaged conduit connections, and missing or loose components and hardware. Holes and unused entrances not used for ventilation shall be sealed.
- 3.7.2.15** Inspect junction boxes and enclosures for the presence and condition of stored circuit drawings, terminal list, and instructions.
- 3.7.2.16** Inspect associated wayside signs and hardware for proper location, visibility, damage, rust, corrosion, and missing or loose components and hardware.
- 3.7.2.17** Lubricate switch components and check lubricant levels per OEM recommendations or RTS instructions.

3.7.2.18 Using a hand crank or hand throw lever, fully operate and lock (normal and reverse) switch as often as necessary to perform the following:

- a) Wipe off accumulated dirt or corrosion from motor control contacts and indication contacts.
- b) Check for and clean any accumulation of foreign or conductive material.
- c) Check that motor control contacts, indication contacts, motor cutout contacts, and associated cams, segments, and linkages are properly adjusted and clean. Check for excessive wear, signs of pitting, corrosion, or general deterioration.
- d) Check that the commutator is smooth and clean.
- e) Check that the commutator brushes are free in their holders and are not excessively worn or out of alignment.
- f) Check the throw of the switch points. The distance between the gauge side of the stock rail and the near side of the open switch point should be 3-3/4" over the #1 switch rod. The minimum opening is 3-1/2" and the maximum opening is 4" or other distances as determined by the RTS.
- g) Check switch throw rod to see that there is sufficient adjustment remaining.
- h) Check adjustments of switch throw rod to balance the excess throw when each point is against its respective stock rail without excessive pressure on the points. Switch points should be adjusted to meet the rail firmly, but not under a heavy strain. Too much tension creates excessive wear in the switch machine and does not increase the safety of the switch.
- i) Check lock rods to ensure locking dogs are centered in the lock rod notches with equal clearance on each side of the locking dogs and sufficient clearance for adjustments on the non-locking side of the rod. With above adjustments, lock rods should be free from strain in either full locked position. Corners of locking dogs and lock rod notches must be square and not damaged.
- j) Check point detector rod to ensure the rod is securely fastened to each switch point. Ensure that all fasteners are in place and effective. Ensure the point detector rod moves freely when operated.

3.7.2.19 Restore the switch cutout/latch to the operating position and electrically operate the switch machine for the following:

- a) Check for proper and smooth operation of switch machine parts and switch layout parts. Switch points should move without undue drag or spring, and ride on slide plates.
- b) Verify normal and reverse indications.

- c) Check for excessive or unusual vibration and noise.
- d) Check for physical damage, excessive wear, and lost motion of switch machine and layout parts.
- e) Check friction clutch adjustment. A switch machine's friction clutch must slip at just the right amount of torque. The torque must be sufficient to carry the switch machine's operational loading during the driving of the switch points under normal operating conditions. At the same time, to transmit this torque, the friction clutch should not be over-tightened, as this will prevent protection of the mechanism from shock and excessive current draw. To obtain both desired motor protection and optimum operating torque, the friction clutch must be adjusted to slip at a motor current specified by the OEM or RTS.
- f) Check restoring feature of the switch, if required.

3.7.2.20 Perform required OEM or local RTS standard tests.

3.7.2.21 Replace covers, locks, and other equipment removed for maintenance.

3.7.2.22 If no further work is to be performed, notify the OCC and/or other authorities that the inspection activities are complete.

3.8 Correction of deficiencies

Deficiencies identified during the inspection and maintenance of the electric switch machines shall be corrected and documented in accordance with RTS and/or OEM requirements.

3.9 Documentation

Inspection and maintenance activities shall be documented, reviewed, and filed in accordance with RTS procedures.

Annex A

(informative)

Bibliography

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