APTA STANDARDS PROGRAM

RECOMMENDED PRACTICE

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Signals and Communication Working Group

Switch Machine Inspection and Maintenance

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

Keywords: electric switch machine, electro-pneumatic switch machine, hand-operated switch machine, inspection, mainline switch machine, maintenance, signal, switch machine, track switch, yard switch machine

Summary: This recommended practice provides procedures for inspecting and maintaining rail transit switch machines. Individual rail transit agencies may modify these procedures to accommodate their specific equipment and mode of operation.

Foreword

The American Public Transportation Association is a standards development organization in North America. The process of developing standards is managed by the APTA Standards Program's Standards Development Oversight Council (SDOC). These activities are carried out through several standards policy and planning committees that have been established to address specific transportation modes, safety and security requirements, interoperability, and other topics.

APTA used a consensus-based process to develop this document and its continued maintenance, which is detailed in the manual for the APTA Standards Program. This document was drafted in accordance with the approval criteria and editorial policy as described. Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

This document was prepared by the Signals and Communication Working Group as directed by the Rail Standards Policy and Planning Committee.

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 recommended practices or guidelines contained herein is voluntary. APTA standards are mandatory to the extent incorporated by an applicable statute or regulation. In some cases, federal and/or state regulations govern portions of a transit agency's operations. In cases where there is a conflict or contradiction between an applicable law or regulation and this document, consult with a legal adviser to determine which document takes precedence.

This document supersedes APTA RT-SC-S-024-03, which has been revised. Below is a summary of changes from the previous document version:

- This document has been updated using the latest document template for the APTA Standards Program (e.g. new sections include a summary, foreword, summary of changes, etc.). This document was revised with new language describing the inspection and testing of switch machines
- The acronym RTS has been replaced with rail transit system and/or rail transit agency throughout the document in addition to minor grammatical corrections.
- Scope and purpose - Updated language reads as follows: This document is intended to satisfy the following objectives: to ensure that special life/safety equipment is operational and reliable; to incorporate safety considerations during the inspection and maintenance process; and to identify those inspection criteria and maintenance standards that provide a high level of passenger and personnel safety.
- Section 1.2 Materials and Data - Sandpaper and Lint-free clothes were removed from list of approved materials. Data was added as additional materials as required by the OEM and/or rail transit agency
- Section 1.3 Tools - Air pressure gauge (electro-pneumatic machines only)* was added to the list of approved tools
    - Rail transit agency approved personal communications device was added to the list of approved tools

    - It was also noted that any tools marked with an asterisk (*) should be calibrated in accordance with OEM and/or rail transit agency requirements
- Section 1.5 Safety - Entire section was updated with new language
- Section 1.6 Inspection prerequisites - Entire section was updated with new language
- Section 2 Inspection procedure - Entire section was updated with new language
- Section 2.1.1 Inspection - Procedure for inspection of switch points was updated to include heel block shoulder bolts, and saddle plates
    - Other associated switch layout parts for loose bolts/connections or deteriorated insulation. Use caution around switch heaters was added to procedure
    - Inspect the switch machine rod connecting pins, and ensure that cotter pins are in place and spread properly was added to the procedure
- Section 2.1.2 Maintenance - Procedures 3.7.2.6 through 3.7.2.22 have been harmonized in the new document as 2.1.2 11 through 26. These procedures have been completely revised
- Section 2.2 Electro-pneumatic and hydraulic switch machines
    - Inspection procedure added to Section 2.2.1 Inspection
    - Maintenance procedure added to Section 2.2.2 Maintenance
- Section 2.3 Hand-operated switch machines
    - Inspection procedure added to Section 2.3.1 Inspection
    - Maintenance procedure added to Section 2.3.2 Maintenance
- Section 3 Correction of deficiencies - Entire section was updated with new language
- Section 4 Documentation - Entire section was updated with new language
- Related APTA standards - The document APTA RT-SC-S-027-03, Switch Inspection and Obstruction Testing was added
- References - Entire section was added and includes new language
- Abbreviations and acronyms - PPE personal protective equipment and RTS rail transit system was removed.
- This document has been downgraded from a Standard to a Recommended Practice as part of the changes.

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Introduction

This introduction is not part of APTA RT-SC-RP-024-03, "Switch Machine Inspection and Maintenance."

APTA recommends the use of this document by:

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

Scope and purpose

This document is intended to satisfy the following objectives: to ensure that special life/safety equipment is operational and reliable; to incorporate safety considerations during the inspection and maintenance process; and to identify those inspection criteria and maintenance standards that provide a high level of passenger and personnel safety.

Switch Machine Inspection and Maintenance

1. Inspection requirements

1.1 Inspection frequency

The rail transit agency shall determine inspection frequency for 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
- rail transit agency testing and experience
- regulatory requirements

Inspections also may be undertaken after track maintenance/renewal/construction and before restoration of service following unplanned service interruptions.

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

1.2 Materials and data

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

- grease gun
- rags
- oil
- switch plate lubricant
- trash bags and ties
- rail transit agency–approved degreaser
- scrapers
- wire brush
- paint
- cleaning and dusting brushes
- rail transit agency–approved contact cleaner
- additional materials as required by the OEM and/or rail transit agency

1.3 Tools

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

- hand crank
- ruler
- multimeter*
- switch adjusting open end wrenches
- terminal nut wrench
- air pressure gauge (electro-pneumatic machines only)*
- switch blocks and/or switch point clamps
- rail transit agency–approved personal communications device
- standard tools carried by maintenance personnel
- additional tools as required by the OEM and/or rail transit agency

NOTE: Tools marked with an asterisk (*) must be calibrated in accordance with OEM and/or rail transit agency requirements.

1.4 Personal protective equipment

Personal protective equipment, as required by the rail transit agency, shall be worn at all times during inspection and maintenance procedures.

1.5 Safety

Rail transit agency safety rules, procedures and practices shall be followed at all times during testing. No work of any type shall be performed until train movements have been protected. The normal functioning of any device shall not be interfered with, in testing or otherwise, without first taking measures to provide for the safety of train operation, which depends on the normal functioning of such device.

1.6 Inspection prerequisites

This inspection has no prerequisites.

2. Inspection procedure

The inspection and maintenance procedure for switch machines shall be modified for each rail transit agency's requirements but shall contain the specific steps listed in this section as a minimum. Test requirements represented here may be combined with other tests for efficiency or ease of execution. When performing this test procedure, ensure that non-vital logic does not mask the proper operation of the vital logic (if the configuration of the system prevents this, then the method of testing shall be addressed through a documented alternate practice). Where actual relays are not available to verify logic states, the test person shall use the OEM-recommended microprocessor diagnostic tool to verify the internal states of vital logic equations.

2.1 Electric switch machines

2.1.1 Inspection

1. Notify the operations control center (OCC) and/or other authorities of the inspection activities to be performed.
2. Inspect switch points, stock rails, ties, tie plates, rail braces, heel block shoulder bolts, saddle plates, switch rods, tie straps and other associated switch layout parts for loose bolts/connections or deteriorated insulation. Use caution around switch heaters (if applicable).

3. Inspect the switch machine rod connecting pins, and ensure that cotter pins are in place and spread properly.
4. Inspect ties to ensure that they are well-tamped to withstand vibration and strain caused by passing trains.
5. Notify the OCC and/or other authorities when inspection and maintenance activities are complete.

2.1.2 Maintenance

1. Notify the OCC and/or other authorities of the maintenance activities to be performed.
2. Disable switch machine operation in accordance with rail transit agency procedures.
3. Clean accumulations of metallic particles, dirt, grease and oil from the exterior of the switch machine.
4. Clean areas of the switch machine where hardened deposits and/or rust are present, and paint or coat with rail transit agency–approved materials.
5. Remove excess ballast or hardened deposits of metallic particles and mud.
6. Clean rods in switch layout.
7. Clean and inspect switch rod insulation.
8. Clean off excessive accumulations of switch lubricant from slide plates, gauge plates and stock rails.
9. 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.
10. 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 entrances not used for ventilation should be sealed.
11. Remove covers from switch machine circuit controller, gearbox, cutout and motor compartments. Place covers in a safe area.
12. Check all switch cutouts/latches for operation; verify that energy supply is interrupted when switch cutout mechanism contacts are open. If so equipped, check that switch position contacts are open.
13. Check for and dry any signs of moisture accumulation within switch machine compartments.
14. Inspect and maintain drainage plugs per rail transit agency requirements.
15. Verify that internal switch compartment heaters (if so equipped) are functioning as intended.
16. Verify that snow melting equipment (if so equipped) is functioning as intended.
17. Clean accumulations of metallic particles, dirt, grease, oil, and foreign or conductive material from interior of switch machine.
18. 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.
19. Inspect junction boxes and enclosures for the presence and condition of stored circuit drawings, terminal list and instructions.
20. Lubricate switch components, and check lubricant levels per OEM recommendations or rail transit agency instructions.
21. Manually operate and lock (normal and reverse) the switch as often as necessary to perform the following checks:
    a) Check the throw of the switch points for proper distances as specified by the rail transit agency and/or OEM.
    b) Adjust switch points per OEM recommendations to meet the rail firmly, but not under a heavy strain.
    c) Inspect and adjust locking per OEM recommendations.

d) Check point detector rod to ensure that the rod is securely fastened to the switch point and has no obvious damage. Ensure that all fasteners are in place and effective. Ensure that the point detector rod moves freely when operated.
e) 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 or signs of pitting, corrosion or general deterioration.
f) Check that the commutator is smooth and clean (if applicable).
g) Check that the commutator brushes are free in their holders and are not excessively worn or out of alignment (if applicable).
h) Check rollers on points for free rotation (if applicable).
i) If any adjustments have been made, then complete obstruction testing per rail transit agency requirements.

22. Restore the switch cutout/latch to the operating position, and electrically operate the switch machine to verify 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 should 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 (if applicable). The friction clutch must be adjusted to slip at a motor current specified by the OEM or rail transit agency.
23. Perform any additional required OEM or local rail transit agency standard tests.
24. Replace covers, locks and other equipment removed for maintenance.
25. Verify that the system is restored to normal operating condition per rail transit agency procedures.
26. Notify the OCC and/or other authorities that the maintenance activities are complete.

2.2 Electro-pneumatic and hydraulic switch machines

2.2.1 Inspection

1. Notify the OCC and/or other authorities of the inspection activities to be performed.
2. Inspect switch points, stock rails, ties, tie plates, rail braces, heel block shoulder bolts, saddle plates, switch rods, tie straps and other associated switch layout parts for loose bolts/connections or deteriorated insulation. Use caution around switch heaters (if applicable).
3. Inspect rod connecting pins, and ensure that cotter pins are in place and spread properly.
4. Inspect ties to ensure that they are well-tamped to withstand vibration and strain caused by passing trains.
5. Inspect the switch machine, control pneumatic valve and layout for damage, rust, corrosion, and missing or loose components and hardware.
6. Inspect hoses and hose fittings for damage, cracks, leaks, breaks, loose connections, and missing or loose components and hardware. For hydraulic switch machines, verify that the hydraulic fluid reservoir is filled in accordance with OEM or local rail transit agency requirements.
7. Notify the OCC and/or other authorities when inspection is complete.

2.2.2 Maintenance

1. Notify the OCC and/or other authorities of the maintenance activities to be performed.
2. Disable switch operation in accordance with rail transit agency instructions.
3. Clean accumulations of metallic particles, dirt, grease and oil from exterior of switch machine.
4. Clean areas of the switch machine where hardened deposits and/or rust are present, and paint or coat with rail transit agency–approved materials.

5. Remove excess ballast or hardened deposits of metallic particles and mud.
6. Clean rods in switch layout.
7. Clean and inspect switch rod insulation.
8. Clean off excessive accumulations of switch lubricant from slide plates, gauge plates and stock rails.
9. 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.
10. 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 should be sealed.
11. Check switch machine and control-pneumatic valve airline connections, valves, cylinders, hose connections, etc., for loose, missing, broken, rusted, leaking or deteriorated components.
12. Remove covers from switch machine, circuit controller and control-pneumatic valve. Place covers in a safe area.
13. Check switch cutouts for proper operation. Verify that energy (air supply) is interrupted when switch cutout mechanisms are open.
14. Check that control contacts; indication contacts; cutout contacts; and associated cams, segments and linkages are properly adjusted and clean. Check for excessive wear and signs of pitting, corrosion or general deterioration.
15. Check for and dry any signs of moisture accumulation within switch machine and control-pneumatic valve compartments.
16. Inspect and maintain drainage plugs per rail transit agency requirements.
17. Inspect hydraulic unit or pump for damage, cracks or leaks.
18. Clean accumulations of metallic particles, dirt, grease, oil, and foreign or conductive material from interior of switch machine and control-pneumatic valve.
19. 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.
20. Inspect junction boxes and enclosures for the presence and condition of stored circuit drawings, terminal list and instructions.
21. Lubricate switch components, and check lubricant and fluid levels per OEM recommendations or rail transit agency instructions.
22. Enable switch operation in accordance with rail transit agency instructions.
23. Fully operate and lock switch (normal and reverse) as often as necessary to perform the following checks:
    a) Check the throw of the switch points for proper distances as specified by the rail transit agency/OEM.
    b) Adjust switch points per OEM recommendations to meet the rail firmly, but not under a heavy strain.
    c) If inspected switch machine is equipped with locking, then inspect and adjust in accordance with OEM recommendations. Where hydraulic or spring force is used, inspect and adjust in accordance with OEM recommendations.
    d) Check point detector rod to ensure that the rod is securely fastened to the switch point and has no obvious damage. Ensure that all fasteners are in place and effective. Ensure that the point detector rod moves freely when operated.
    e) Check for proper and smooth operation of switch machine parts and switch layout parts. Switch points should move without undue drag or spring, and should ride on slide plates.
    f) Verify normal and reverse indications.

g) Check for excessive or unusual vibration and noise.
h) Check for physical damage, excessive wear and lost motion of switch machine and layout parts.
i) Check cross-protection feature of control-pneumatic valve to ensure that the shifting pistons will not open the poppet valves and that the switch indication relay de-energizes when depressing all three control magnets simultaneously.
j) If any adjustments have been made, then complete obstruction testing per rail transit agency requirements.

24. Perform any additional required OEM or local rail transit agency standard tests.
25. Replace covers, locks and other equipment removed for maintenance.
26. Verify that the system is restored to normal operating condition per rail transit agency procedures.
27. Notify the OCC and/or other authorities when maintenance activities are complete.

2.3 Hand-operated switch machines

2.3.1 Inspection

1. Notify the OCC and/or other authorities of the inspection activities to be performed.
2. Inspect switch points, stock rails, ties, tie plates, rail braces, heel block shoulder bolts, saddle plates, switch rods, tie straps and other associated switch layout parts for loose bolts/connections or deteriorated insulation (if applicable).
3. Inspect the switch machine rod connecting pins, and ensure that cotter pins are in place and spread properly.
4. Inspect ties to ensure that they are well-tamped to withstand vibration and strain caused by passing trains.
5. Notify the OCC and/or other authorities when inspection is complete.

2.3.2 Maintenance

1. Notify the OCC and/or other authorities of the maintenance activities to be performed.
2. Clean accumulations of metallic particles, dirt, grease and oil from exterior of switch machine.
3. Clean areas of the switch machine where hardened deposits and/or rust are present, and paint or coat with rail transit agency–approved materials.
4. Remove excess ballast or hardened deposits of metallic particles and mud.
5. Clean rods in switch layout.
6. Clean and inspect switch rod insulation.
7. Clean off excessive accumulations of switch lubricant from slide plates, gauge plates and stock rails.
8. 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. Use caution around switch heaters (if applicable).
9. 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 entrances not used for ventilation should be sealed.
10. Remove covers from switch machine circuit controller, gearbox and lock mechanism. Place covers in a safe area.
11. Check for and dry any signs of moisture accumulation within switch machine compartments, including locking and circuit controller compartments as applicable.
12. Inspect and maintain drainage plugs per rail transit agency requirements.
13. Clean accumulations of metallic particles; dirt, grease and oil; and foreign or conductive material from interior of switch machine.

14. 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.
15. Inspect junction boxes and enclosures for the presence and condition of stored circuit drawings, terminal list and instructions.
16. Lubricate switch components, and check lubricant levels per OEM recommendations or rail transit agency instructions.
17. Fully operate switch (normal and reverse) as often as necessary to perform the following checks:
    a) Check the throw of the switch points for proper distances as specified by the rail transit agency/OEM.
    b) Adjust switch points per OEM recommendations to meet the rail firmly, but not under a heavy strain.
    c) Where applicable, check the electric lock mechanism for proper operation per rail transit agency procedure. Ensure that all fasteners are in place and effective. Ensure that electric lock rod components move freely and are not damaged.
    d) Check point detector rod to ensure that the rod is securely fastened to the switch point and that there is no obvious sign of damage. Ensure that all fasteners are in place and effective. Ensure that the point detector rod moves freely when operated.
    e) Check that indication contacts and associated cams, segments and linkages are properly adjusted and clean. Check for excessive wear and signs of pitting, corrosion or general deterioration.
    f) Check for proper and smooth operation of switch machine and layout parts. Switch points should move without undue drag or spring, and should ride on slide plates.
    g) Verify normal and reverse indications (if applicable).
    h) Check for physical damage, excessive wear and lost motion of switch machine and layout parts.
    i) If any adjustments have been made, then complete obstruction testing per rail transit agency requirements.
18. Perform any additional required OEM or rail transit agency standard tests.
19. Replace covers, locks and other equipment removed for maintenance.
20. Verify that the system is restored to normal operating condition per rail transit agency procedures.
21. Notify the OCC and/or other authorities when maintenance activities are complete.

3. Correction of deficiencies

Deficiencies identified during switch machine inspection and maintenance shall be corrected and documented in accordance with rail transit agency procedures and/or OEM recommendations.

4. Documentation

Testing shall be documented on a standard form (electronic or paper) and be reviewed and filed in accordance with rail transit agency procedures.

Related APTA standards

APTA RT-SC-S-027-03, "Switch Inspection and Obstruction Testing"

References

In addition to the most recent edition of OEM specifications documentation, specifications and manuals specific to the subject switch machine product, and rail transit agency procedures for switch machine inspection and maintenance, this document shall be used in conjunction with the following:

American Railway Engineering and Maintenance-of-Way Association (AREMA), "Communications and Signals Manual of Recommended Practices," Part 2.4.1, Section P: Switches, Derails and Switch Operating Mechanisms, and Section R: Switch Circuit Controllers, and Part 2.4.10, Recommended Instructions for Interlockings.

Abbreviations and acronyms

OCC operations control center
OEM original equipment manufacturer

Document history

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