APTA STANDARDS DEVELOPMENT PROGRAM

STANDARD

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

APTA RT-FS-S-005-03, Rev. 2

Published: Sept. 28, 2003

First Revision: July 26, 2004

Second Revision: December 6, 2017

Fixed Structures Inspection and Maintenance Working Group

Traction Electrification Stray Current/Corrosion Control Equipment Inspection and Maintenance

Abstract: This standard provides minimum requirements for inspecting, maintaining and testing rail transit stray current/corrosion control systems on traction electrification systems and subsystems.

Keywords: corrosion control, inspection, maintenance, qualifications, stray current control, substation, traction electrification, training

Summary: This document establishes a standard for the periodic inspection, maintenance and testing of the major components of traction electrification stray current/corrosion control and monitoring equipment. This includes periodic visual, electrical and mechanical inspections of components that affect safe and reliable operation. This standard also identifies the necessary qualifications for rail transit system employees or contractors who perform periodic inspection, maintenance and testing tasks.

Scope and purpose: This standard applies to rail transit systems that operate electrified light rail and/or heavy rail systems and applies to normal operating conditions. This standard does not apply to commuter railroads that operate on the general railroad system regulated by the Federal Railroad Administration (FRA). The standard covers the following equipment: impressed current systems, rectifier negative grounding devices, stray current drain equipment and galvanic protection equipment. The purpose of this standard is to verify that traction electrification stray current/corrosion control and monitoring equipment is operating safely and as designed through periodic inspection, maintenance and testing, thereby increasing reliability and reducing the risk of hazards and failures.

Table of Contents

Participants iii
Introduction iv
Note on alternate practices iv

1. Frequency of tasks 1
2.1 Skills and knowledge 1
2.2 Continuing education 2

5. Personal protective equipment 2

6. Inspection, maintenance and testing 2
6.1 Inspection, maintenance and testing categories 3
6.2 Periodic inspection and maintenance 3
6.3 Condition-based maintenance 3
6.4 Procedures 3

7. Correction of deficiencies 5

8. Priority ratings 6

9. Documentation 6
Definitions 7
Abbreviations and acronyms 7
Summary of document changes 7
Document history 8

Participants

The American Public Transportation Association greatly appreciates the contributions of the **Rail Transit Standards Fixed Structures Inspection and Maintenance Working Group**, which provided the primary effort in the drafting of this document.

At the time this standard was completed, the working group included the following members:

Greg O'Hare, *Chair*
Clay Bunting, *Vice Chair*
Tou Bong Vang, *Secretary*

Charles Anderson Jr., *Metro Transit Light Rail*
Steve Bezner, *The Burns Group*
Jose Burgos, *Miami-Dade Transit*
Antonio Cabrera, *MTA*
Arthur Douwes, *Santa Clara VTA*
James Dwyer, *ARM Corporation*
Michael Esford, *NFTA*
Anthony Fazio, *SEPTA*
Richard Hovde, *David Evans and Associates*
Richard Kindig, *TriMet*
Michael Monastero, *SEPTA*
Wilbert Mullet Jr., *Regional Transit Authority*
Rotimi Ogunsuyi, *FTA*
John Rhone, *Dallas Area Rapid Transit*
Carol Rose, *STV Inc.*
Mark Rudnicki, *SFMTA*
Glenn Shankle, *Dallas Area Rapid Transit*
Paul Swanson, *consultant*

Project team
Charles Joseph, *American Public Transportation Association*

Introduction

This introduction is not part of APTA RT-FS-S-005-03, Rev. 1, "Traction Electrification Stray Current/Corrosion Control Equipment 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), OEMs, consultants, engineers and general interest groups. This standard provides procedures for inspecting, maintaining and testing, rail transit traction electrification stray current/corrosion control equipment.

APTA recommends this standard for the following:

- 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

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).

Traction Electrification Stray Current/Corrosion Control Equipment Inspection and Maintenance

1. Frequency of tasks

The inspection, maintenance and testing procedures in this standard (see Section 6) shall be performed as deemed necessary by the rail transit system. Since age, type, operating conditions and environment vary from system to system, and OEM maintenance intervals may vary based on operating conditions, the rail transit system makes the final determination of inspection, maintenance and testing frequencies based on experience.

Following OEM-specified maintenance intervals for equipment is recommended. Inspection frequency should be increased for severe operating conditions.

The rail transit system shall determine the need for additional inspection, maintenance and testing frequencies for traction electrification stray current/corrosion control equipment. A review of the following factors may be useful in making this assessment:

- OEM-recommended testing intervals
- industry experience
- operating environment/conditions
- historical data
- reliability-centered maintenance program development
- failure analysis
- rail transit system testing and experience
- regulatory requirements

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

2. Qualifications of maintenance personnel

Due to the nature and hazards associated with electrical work on high-voltage AC and DC components, maintenance personnel must meet minimum recommended qualifications to perform many inspection, maintenance and testing tasks. The rail transit system shall determine what its needs and resources are. For example, systems may wish to consider a combination of written and practical experience, together with continuing education programs geared toward traction and electrification systems maintenance.

2.1 Skills and knowledge

Each rail transit system shall ensure that employees and/or contractors responsible for the performance of periodic inspections and maintenance have the skills and knowledge required to effectively perform the inspections assigned to them.

2.1.1 Basic inspection level

Inspectors must have a minimum of two years' experience working on high-voltage power distribution or related traction and electrification systems. All inspectors must be familiar with the installation and repair of the components associated with traction and electrification systems.

2.1.2 Maintenance level

Maintainers must have three or more years' experience working on high-voltage power distribution or related traction and electrification systems, either by in-house experience or a recognized trade school or apprenticeship training program.

2.1.3 Technician level

Technicians must have three or more years' experience working on high-voltage power distribution or related traction and electrification systems or possess an associate in applied science (AAS) degree in electrical systems or the equivalent.

2.2 Continuing education

A rail transit system should establish a continuing education program for the above positions based upon its specific operation and requirements.

3. Tools

The following tools are required for inspection, maintenance and testing of traction electrification stray current/corrosion control equipment:

- torque wrench
- multimeter*
- megohmmeter*
- standard tools carried by electrical maintenance workers

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

4. Safety

Rail transit system safety rules, procedures and practices shall be followed at all times during inspection, maintenance and testing.

5. Personal protective equipment

Personal protective equipment (PPE), as required by the rail transit system, shall be worn at all times during inspection, maintenance and testing.

6. Inspection, maintenance and testing

Rail transit systems shall evaluate their local operating environment and conditions to develop or formally adopt existing suitable inspection, maintenance and testing programs that include the following, as a minimum (where applicable):

NOTE: Rail Transit Systems can supplement the minimum requirements below with applicable Institute of Electrical and Electronics Engineers (IEEE) Standards.

6.1 Inspection, maintenance and testing categories

- **Periodic inspection and maintenance** shall be performed to verify proper system operation and general system upkeep.
- **Preventive maintenance (PM) and testing** may require removing the equipment from service and performing tests on the equipment or the materials to ensure proper operation. This type of maintenance occurs on a regularly scheduled basis.
- **Condition-based maintenance** shall be performed following a fault condition, excessive number of operations of equipment, or any abnormalities found.

6.2 Periodic inspection and maintenance

Monthly inspections and maintenance shall consist of the following:

- Verify cleanliness of the stray current/corrosion control equipment and the area around it.
- Check for the presence of oil, dust or other material on the equipment.
- Check for the presence of water or other material leaking onto the equipment.
- If equipment is supplied with a power source, then check for the presence of any “burning” smell, fumes, scorch marks or other material that could be signs of a future breakdown.
- Verify operation of all lamps. Replace as necessary.
- Verify operation of all alarms, if any.
- Verify proper operation of any anti-condensation heaters, and ensure that equipment vents are not blocked.
- Measure and record voltage/current readings. Verify that voltage/current meters give expected readings. Investigate any unexpected readings.

6.3 Condition-based maintenance

6.3.1 Equipment failure

Examples:

- Voltage or current output of an impressed current rectifier goes to zero.
- Galvanic action anode voltage goes to zero.
- Current in stray current drain goes to zero, goes very high or reverses direction.

6.3.2 Other conditions

- Changes in anode voltage or current by more than 20 percent since last quarter’s readings.
- Any other abnormal conditions found.

6.4 Procedures

The rail transit system shall perform inspection, maintenance and testing in accordance with this standard and develop local policies and procedures to meet the requirements herein.

6.4.1 Written policies and procedures

Each rail transit system shall develop specific written policies and procedures that take into account specific equipment designs and local operating conditions to implement the inspection, maintenance and testing required by this standard. These policies and procedures shall give maintenance staff clear guidance and criteria for performing these activities.

6.4.2 Procedures for inspecting, maintaining and testing stray current/corrosion control and monitoring equipment

6.4.2.1 Impressed current systems and rectifier negative grounding devices

Inspection and test

a) Record readings as found.
b) Inspect condition.
c) Inspect anchorage, alignment and grounding.
d) Perform operational check of AC input circuit breaker/fuse switch and any indications.
e) Ensure that temperature of equipment is not excessive.
f) Verify operation of anti-condensation heaters, if applicable.
g) Thoroughly clean unit.
h) Check that diodes/thyristors are working properly.
i) Check each bolted electrical connection of conductors carrying more than 30 A for high resistance using any one of the following methods:
    - Use a low-resistance ohmmeter capable of reading 2 μΩ. Ensure the maximum reading is less than 10 μΩ.
    - Calibrate using torque-wrench method in accordance with OEM recommendations to verify the tightness of accessible bolted electrical connections.
j) Perform insulation resistance test of secondary wiring.
k) Record readings as-left in operation.

Operational checks

a) Check operation of any remote alarms/indications.
b) Wherever possible, visually check that the protected structure is not showing any signs of corrosion.

    NOTE: Corrosion is commonly worst at the ground or water surface.

c) On impressed current systems check as-found readings against last readings taken. If the difference is more than 20 percent, then investigate to determine the reason.
d) On rectifier negative grounding devices, check calibration of voltage needed to clamp rectifier negative to ground, current value and direction to release clamping.

Test values

a) Compare bolted connection resistance with values of similar connections.
b) Ensure bolt-torque levels are in accordance with OEM recommendations.
c) Ensure that microhm or millivolt drop values do not exceed the high levels of the normal range as indicated in the OEM-published data. If the OEM data is not available, then investigate any values that deviate from similar equipment by more than 25 percent of the lowest value.

6.4.2.2 Stray current drain equipment

Inspection and test

a) Record readings as found.
b) Inspect condition.
c) Inspect anchorage, alignment and grounding.
d) Thoroughly clean the unit.
e) Check that diodes and/or contactors are operating properly.

f) Check each bolted electrical connection of conductors carrying more than 30 A for high resistance using any one of the following methods:
   - Use a low-resistance ohmmeter capable of reading 2 μΩ. Ensure that the maximum reading is in accordance with rail transit system specifications.
   - Calibrate using torque-wrench method in accordance with OEM recommendations to verify the tightness of accessible bolted electrical connections. Clean or replace any connections that show signs of corrosion.

g) Perform insulation resistance test of secondary wiring when disconnected from the shunt.
h) Record readings as-left in operation.

Operational checks

a) Check operation of any remote alarms/indications.
b) Wherever possible, visually check that the protected structure is not showing any signs of corrosion.

NOTE: Corrosion is commonly worst at the ground or water surface.

Test values

a) Compare bolted connection resistance with values of similar connections.
b) Ensure that bolt-torque levels are in accordance with OEM recommendations.
c) Ensure that microhm or millivolt drop values do not exceed the high levels of the normal range as indicated in the OEM-published data. If the OEM data is not available, then investigate any values that deviate from similar equipment by more than 25 percent of the lowest value.

6.4.2.3 Galvanic protection equipment

Inspection and test

a) Record readings as found.
b) Inspect physical and mechanical condition.
c) Thoroughly clean unit.
d) Record as-left in operation.

Operation checks

a) Check operation of any remote alarms/indications.
b) If possible, visually check that the protected structure is not showing any signs of corrosion.

NOTE: Corrosion is commonly worst at the ground or water surface.

7. Correction of deficiencies

Deficiencies identified during inspection, maintenance and testing shall be corrected and documented in accordance with OEM and/or rail transit system requirements. Some operational equipment may need to be taken out of service immediately until the problem is corrected. Other equipment may be left in service and corrected when parts, tools and/or appropriately skilled personnel are available.

The rail transit system shall designate a person responsible for deciding whether or not to leave defective equipment in service in order to operate. In the absence of a designated person, the system shall take the equipment out of service.

The rail transit system shall review and develop a corrective action plan for documented system defects monthly.

8. Priority ratings

The rail transit system shall develop a priority rating system to evaluate and determine the effects that any single defect will have on the system. Recommended priority ratings are the following:

- **Priority 1:** The defect will endanger the safety of patrons and personnel and/or continuation of revenue service. A permanent or temporary repair shall be made immediately.
- **Priority 2:** The defect may cause disruption of revenue service. The repair shall be made in a predetermined timeframe set by each rail transit system.
- **Priority 3:** The defect will not affect revenue service. The repair shall be made in a predetermined timeframe set by each rail transit system.

9. Documentation

The rail transit system shall develop and implement a fully auditable process for recording and tracking inspection, maintenance and testing activities and outstanding system defects. Such documentation shall be documented, reviewed and filed in accordance with rail transit system procedures and OEM recommendations. Documentation should be kept for the life of all in-service equipment and be readily available for review.

Definitions

contractor: Any individual or entity under contract with the rail transit system (including rail transit system and subcontractor personnel) to install, inspect, maintain and/or test vehicles, systems and components. Also called a consultant.

heavy rail system: An electric railway capable of a heavy volume of traffic characterized by exclusive rights-of-way, multicar trains, high-speed and rapid acceleration, sophisticated signaling, and high-platform passenger loading. Also called elevated railway, rapid rail, rapid transit or subway.

light rail system: An electric railway with a lighter volume of train traffic than heavy rail that may use shared or exclusive rights-of-way and may run trains intermingled with street traffic. Light rail systems frequently operate with low-platform loading and single-car trains. Also called streetcars, trams or trolley cars.

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

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.

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

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

Abbreviations and acronyms

µΩ	microhms
A	amperes
AAS	Association in Applied Science
AC	alternating current
DC	direct current
FRA	Federal Railroad Administration
NATSA	North American Transit Services Association
OEM	original equipment manufacturer
PPE	personal protective equipment
PM	preventive maintenance

Summary of document changes

- Document formatted to the new APTA standard format.
- Sections have been moved and renumbered.
- Definitions, abbreviations and acronyms have been moved to the back of the document.
- Two new sections added: “Summary of document changes” and “Document history.”
- Some global changes to section headings and numberings resulted when sections dealing with references and acronyms were moved to the end of the document, as well as other cosmetic changes, such as capitalization, punctuation, spelling, grammar and general flow of text.

- Section 6; Language added to allow Agencies to also incorporate IEEE standards into their inspection, maintenance and testing procedures
- Minor editorial changes.

Document history

Document Version	Working Group Vote	Public Comment/ Technical Oversight	CEO Approval	Policy & Planning Approval	Publish Date
First published	Nov. 22, 2002	—	—	Sept. 28, 2003	September 2003
First revision	-	-	-	-	July 26, 2004
Second Revision	June 14, 2017	August 1, 2017	September 18, 2017	November 7, 2017	December 6, 2017