5. Standard for Traction Electrification Stray Current/Corrosion Control Equipment Inspection and Maintenance

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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, RTS, stray current control, substation, traction electrification, training, qualifications

Introduction

(This introduction is not a part of APTA RT-FS-S-005-03, *Standard for 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:

- 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 an RTS operates. In such cases, the government regulations override any conflicting practices this document requires or recommends.

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Contents

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1. Overview

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 (RTS) employees or contractors that perform periodic inspection, maintenance, and testing tasks.

1.1 Purpose

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.

1.2 Scope

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
- Galvanic protection equipment

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. An individual 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 contractor: Any individual(s) or entity under contract with the rail transit system (including RTS and subcontractor personnel) to install, inspect, maintain, and/or test RTS vehicles, systems, and components. *Syn:* **consultant.**

2.1.2 heavy rail system: An electric railway capable of a "heavy volume" of traffic characterized by exclusive rights-of-way, multi-car trains, high speed and rapid acceleration, sophisticated signaling, and high platform passenger loading. *Syn:* **elevated railway, rapid rail, rapid transit, subway.**

2.1.3 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. *Syn:* **street car, tram, trolley car.**

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

2.1.5 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.

2.1.6 post-fault condition: Any condition caused by a system failure that causes either repetitive faults or lockout trip of any subsystem.

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

2.1.8 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.**

2.2 Acronyms

AAS	Associate in Applied Science
AC	alternating current
APTA	American Public Transportation Association
DC	direct current
FRA	Federal Railroad Administration
NFPA	National Fire Protection Agency
OEM	original equipment OEM
PPE	personal protective equipment
PM	preventive maintenance
RTS	rail transit system

3. Frequency of tasks

The inspection, maintenance, and testing procedures in this standard (see Section 8.9) shall be performed as deemed necessary by the RTS. Since age, type, operating conditions, and environment vary from system to system and OEM maintenance intervals may vary based on operating conditions, the RTS 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 RTS 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
- RTS testing and experience
- Regulatory requirements

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

4. 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 RTS shall determine what their 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.

4.1 Skills and knowledge

Each RTS 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.

4.1.1 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.

4.1.2 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 recognized trade school or apprenticeship training program.

4.1.3 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 equivalent.

4.2 Continuing Education

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

5. Tools

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

- Torque wrench
- Multi-meter*
- Megohm-meter*

– Standard tools carried by electrical maintenance workers

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

6. Safety

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

7. Personal protective equipment

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

8. Inspection, maintenance and testing

Rail transit systems shall evaluate their local operating environment and conditions to develop suitable inspection, maintenance, and testing programs.

8.1 Inspection, maintenance and testing categories

a) *Periodic inspection and maintenance* shall be performed to verify proper system operation and general system upkeep.

b) *Preventative 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.

c) *Condition-based maintenance* shall be performed following a fault condition, excessive number of operations of equipment or any abnormalities found.

8.2 Periodic inspection and maintenance

Monthly inspections and maintenance shall consist of the following:

a) Verify cleanliness of the stray current/corrosion control equipment and the area around it.

b) Check for the presence of oil, dust or other material on the equipment.

c) Check for presence of water or other material leaking onto the equipment.

d) If equipment is supplied with a power source, check for the presence of any “burning” smell, fumes, scorch marks or other material that could be signs of a future breakdown.

e) Verify operation of all lamps. Replace as necessary.

f) Verify operation of all alarms, if any.

g) Verify proper operation of any anti-condensation heaters and ensure that equipment vents are not blocked.

h) Measure and record voltage/current readings. Verify that voltage/current meters give expected readings. Investigate any unexpected readings.

8.3 Condition-based maintenance

8.3.1 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.

8.3.2 Other conditions

a) Changes in Anode Voltage or Current by more than 20 % since last quarter's readings.

b) Any other abnormal conditions found.

8.4 Procedures

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

8.4.1 Written policies and procedures

Each RTS 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.

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

8.4.2.1 Impressed current systems and rectifier negative grounding devices

8.4.2.1.1 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) Check 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 amperes for high resistance using any one of the of following methods:

- Use a low–resistance ohmmeter capable of reading 2 micro-ohms. Ensure maximum reading is less than 10 micro-ohms.

- 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.

8.4.2.1.2 Operational checks

a) Check operation of any remote alarms/indications.

b) Wherever possible, visually check that protected structure is not showing any signs of corrosion. Note corrosion is commonly worst at ground or water surface.

c) On impressed current systems check as-found readings against last readings taken. If the difference is more than 20 %, investigate to determine 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.

8.4.2.1.3 Test values

a) Compare bolted connection resistance to values of similar connections.

b) Ensure bolt-torque levels are in accordance with OEM recommendations.

c) Ensure micro-ohm 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, investigate any values that deviate from similar equipment by more than 25 percent of the lowest value.

8.4.2.2 Stray current drain equipment

8.4.2.2.1 Inspection and test

a) Record readings as found.

b) Inspect condition.

c) Inspect anchorage, alignment, and grounding.

d) Thoroughly clean unit.

e) Check that diodes and/or contactors are operating properly.

f) Check each bolted electrical connection of conductors carrying more than 30 amperes for high resistance using any one of the of following methods:

- Use a low–resistance ohmmeter capable of reading 2 micro-ohms. Ensure maximum reading is in accordance with RTS 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.

8.4.2.2.2 Operational checks

a) Check operation of any remote alarms/indications.

b) Wherever possible, visually check that protected structure is not showing any signs of corrosion.

NOTE– Corrosion is commonly worst at ground or water surface.

8.4.2.2.3 Test values

a) Compare bolted connection resistance to values of similar connections.

b) Ensure bolt-torque levels are in accordance with OEM recommendations.

c) Ensure micro-ohm 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, investigate any values that deviate from similar equipment by more than 25 percent of the lowest value.

8.4.2.3 Galvanic protection equipment

8.4.2.3.1 Inspection and test

a) Record readings as found.

b) Inspect physical and mechanical condition.

c) Thoroughly clean unit.

d) Record as-left in operation.

8.4.2.3.2 Operation checks

a) Check operation of any remote alarms/indications.

b) If possible, visually check that protected structure is not showing any signs of corrosion.

NOTE– Corrosion is commonly worst at ground or water surface.

9. Correction of deficiencies

Deficiencies identified during inspection, maintenance, and testing shall be corrected and documented in accordance with OEM and/or RTS 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 manpower are available.

The RTS 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 RTS shall take the equipment out of service.

The RTS shall review and develop a corrective action plans for documented system defects monthly.

10. Priority ratings

The RTS 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:

– 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 RTS.

– Priority 3: The defect will not affect revenue service. The repair shall be made in a predetermined timeframe set by each RTS.

11. Documentation

The RTS 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 RTS procedures and OEM recommendations. Documentation should be kept for the life of all in-service equipment and be readily available for review.