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APTA Rail Transit Standards Vehicle Inspection and Maintenance Working Group

Battery Systems Periodic Inspections and Maintenance

Abstract: This *Recommended Practice* provides guidance for the periodic inspection and maintenance of battery systems mounted on rail transit vehicles.

Keywords: battery, periodic inspection and maintenance, rail transit vehicles

Summary: This document provides a set of useful practices that can be selected and applied during the periodic inspection and maintenance of battery systems mounted on rail transit vehicles, as the particular design warrants.

Scope and purpose: This *Recommended Practice* applies to batteries used aboard rail transit vehicles. The recommendations presented provide guidance to aid in the establishment of a systematic and comprehensive inspection and maintenance set of procedures using manufacturers' recommendations and proven best practice maintenance and procedures developed by rail transit systems.

Participants

The American Public Transportation Association greatly appreciates the contributions of Kenneth Morford and Daniel Wilson, who provided the primary effort in revising this *Recommended Practice*.

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Introduction

This Introduction is not part of RT-VIM-RP-009-02 Second Revision June 28, 2013, *Recommended Practice for Battery Systems Periodic Inspection and Maintenance.*

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

This Recommend Practice is intended to assist RTS personnel in performing basic maintenance and inspection procedures on rail transit door systems. Since each rail transit rail cars may be different, the procedures and steps described in this document will not necessarily be applied to, nor required for, every RTS maintenance and inspection procedure.

APTA recommends the use of this recommended practice by:

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

Battery Systems Periodic Inspections and Maintenance

1. Frequency of conduct

Periodic inspection and maintenance tasks on the battery system should be performed on a regular schedule as determined by the rail transit system. The frequency of any task contained within this *Recommended Practice* should comply with all applicable federal, state and local regulations. Further, in the conduct of a rail transit system's periodic inspection and maintenance programs, the frequencies for individual tasks should be established based on a number of additional factors, including but not limited to the following:

- OEM- recommended intervals
- Industry experience
- Operating environment/conditions
- Historical data
- Performance requirements
- Failure analysis
- Reliability-centered maintenance programs

2. Requirements and specific tasks

WARNING: Read and understand all Material Safety Data Sheets (MSDS) before proceeding with work to maintain the battery.

WARNING: Do not wear metallic clothing or jewelry when handling battery or battery components. Use tools with insulated handles only. Care should be taken to avoid shorting individual cells or groups of cells.

WARNING: Alkaline/acid electrolyte in the battery is a strong caustic/corrosive agent. Wear rubber gloves, protective goggles, face shield, long-sleeved clothing and an approved apron when handling batteries or components. Make sure that an emergency water supply is readily available in case electrolyte accidentally comes in contact with clothing, skin or eyes. If electrolyte is splashed on clothing or skin, wash the affected area immediately with water for 10 to 15 minutes and follow approved safety procedures for chemical burns or spills. If electrolyte is splashed in eyes, immediately flood eyes with water and call a physician.

WARNING: The electrolyte level must be maintained as per the OEM recommendation. When electrolyte levels are allowed to remain below minimum (lower) level, excessive heat is generated within the cells, causing damage to the cells. If this condition is allowed to continue for an extended period of time, a battery fire could result.

WARNING: A separate storage maintenance area should be provided for nickel-cadmium batteries. The electrolyte is chemically opposite to the sulfuric acid used in lead-acid batteries. Fumes from a lead-acid battery can contaminate the electrolyte in a nickel-cadmium battery. This precaution should include equipment such as hand tools and syringes used with lead-acid batteries. Every precaution should be taken to keep anything containing acid away from the nickel-cadmium battery shop.

WARNING: Charging batteries give off a mixture of hydrogen and oxygen gas that are extremely flammable. Never allow sparks, flames or smoking materials near the battery area.

WARNING: Use only approved dispensers (cell toppers) to add water.

WARNING: Battery cells can generate very high currents, and multi-cell batteries can attain high voltages. Caution must be exercised during battery maintenance to prevent electrical burns or shocks.

2.1 Materials

The following materials are normally required for battery periodic inspection and maintenance:

- OEM and rail transit system recommended lubricants
- OEM and rail transit system recommended cleaning supplies

Reference OEM maintenance manuals for additional materials.

2.2 Tools

In addition to the standard tools carried by maintenance personnel (standard tools should be suitably insulated for working on batteries), the following specialized equipment will be required:

- digital voltmeter*
- cell topper (filler pistol)
- nylon brush
- cell tester
- torque wrench (0 –250 in.-lb.)*
- hydrometer

NOTE: Tools marked with * require periodic calibration as specified by the rail transit system's practices.

Refer to the OEM for specific requirements and other specialized tooling.

2.3 Safety/personal protective equipment

Appropriate personal protective equipment (PPE) meeting minimum ANSI standards, and as required by the rail transit system, should be worn at all times in the performance of these inspection and maintenance tasks. The following personal protective equipment should be worn while performing these inspection and maintenance tasks:

- approved apron
- protective face shield
- goggles
- rubber gloves

2.4 Training requirements

Rail transit systems and/or their maintenance contractors should develop and execute training programs that provide employees with the knowledge and the skills necessary to safely and effectively perform the tasks outlined in this *Recommended Practice*.

2.5 Inspection and maintenance

In all of the following procedures and recommended practices, the OEM's maintenance manuals should be referred to for such items as torque values, condemning limits, clearance measurements and specific procedure methodology. Devices should be cleaned for proper inspection. These procedures cover only the visual inspection, gauging, adjustment and functional testing of battery systems mounted on a rail transit vehicle. Some procedures may require the use of heavy lifting and support devices due to the size and weight of the equipment. Some procedures require more than one individual. Some procedures will not be applicable due to design variations.

Methodologies for the resolution of deficiencies noted while inspecting, gauging, adjusting or functionally testing the batteries and associated devices should be tailored by the rail transit system in conjunction with the OEM. Documentation of the inspection and maintenance process as to interval, deficiencies and resolution of those deficiencies found should be done in a comprehensive manner so as to create a useful database, which will enhance the reliability and accountability of the process.

The following suggested inspection and maintenance procedures are intended for use in conjunction with the OEM's recommended inspection and maintenance procedures. In the event of a conflict between this *Recommended Practice* and the manufacturer's recommendations, the manufacturer's recommendations should prevail.

2.5.1 Prepare battery for inspection

a. Place battery switch (breaker) to OFF position and place lockout tag per rail transit system procedures.
b. Remove battery box cover or open battery box and slide crate assemblies/battery tray (if equipped) out to their fully extended service position.
c. Disconnect the battery leads as per the OEM and rail transit systems procedures.

2.5.2 Crate assembly

a. Make sure cell assemblies are properly seated in each crate assembly. Make sure each crate assembly is clean and dry. Inspect each crate assembly for proper drainage. Check for soft or weakened crate structure.
b. Inspect each cell assembly for signs of leaking, excessive corrosion or physical damage. Batteries that are excessively corroded should be removed from the car for proper cleaning.

2.5.3 Clean battery and tray

a. Use a soft nylon brush to loosen any accumulation of corrosion from the battery or terminals. Use clean, lint-free wiping rags to wipe cells clean. Use water to clean tops of cells only if absolutely necessary. Vent caps should be closed during cleaning.
b. It is important to keep the battery dry and clean. This will contribute to top performance, maximum service life and non-contamination of cell during topping off.

2.5.4 Electrolyte

CAUTION: To avoid contamination of electrolyte, only use distilled or deionized water that has been properly labeled and stored in plastic containers. For maximum safety while working on the battery,

always keep the vents closed, except for the moment of topping off or measuring specific gravity of electrolyte.

a. Open vent plug assembly and insert glass or plastic hydrometer into cell assembly so that it contacts top of plates. Using hydrometer, remove electrolyte from cell and measure specific gravity of electrolyte. Return electrolyte to cell. Repeat on all cells.
b. Adjust electrolyte level in each cell assembly with distilled or de-ionized water, as required, so that electrolyte is level in all cells and above plates according to OEM recommendations. On cells with transparent cases, fill to top line. Close all vent plug assemblies.
c. Wipe clean exterior surface of all cell assemblies, crate assemblies and interior of battery box with clean, lint-free wiping rags.
d. Using less than 30 psi of compressed air in accordance with OSHA 29-CFR 1910.242b, blow-dry cell assemblies, crate assemblies, and interior of battery box.

CAUTION: Do not splash or spill water or electrolyte on the battery. Do not overfill the battery. When electrolyte levels are allowed to remain above maximum (upper) level, overflow of electrolyte could result. When the exterior of the battery is wet, ground leakage and erratic battery operation could result.

2.5.5 Battery connection inspection

a. Check cell-to-cell and post-to-post rigid connectors for loose connections, missing or defective hardware, corrosion and hot spots. Replace/repair/torque to OEM specifications.
b. Check inter-crate flexible jumper cables for loose connections, missing or defective hardware, chafing and loose lugs. Repair/replace as required.

2.5.6 Battery leads inspection

a. Check battery leads for chafed or cut insulation. Replace as required.
b. Check battery leads for broken strands. Replace as required.
c. Check for corrosion of terminals and cable lugs; clean or replace as required.
d. Check battery leads for worn or loose cable lugs. Replace as required.
e. Check battery connections for loose hardware, and torque nuts to OEM specifications.

2.5.7 Cell voltage

a. Ensure that the battery is disconnected from the charging system and all loads. With cell voltage tester or digital voltmeter, measure and record each cells voltage. If any cell’s voltage differs from the average by more than the manufacturer’s recommendation, record on inspection report and notify proper individual in accordance with rail transit system procedures.
b. Check output voltage of power supply and battery charger at the battery lead terminals.

2.5.8 Temperature sensor

a. Check temperature sensor for chafed or cut insulation, broken strands and cracked or broken casing. Repair or replace as required.
b. Check temperature sensor for proper resistance reading per OEM.
c. Check temperature sensor for secure mounting. Repair as required.

2.5.9 Battery box condition

a. Check condition of battery box for cracks and breaks. Repair or replace as required.

b. Inspect battery box and brackets for loose or missing mounting hardware. Tighten loose mounting hardware. Replace missing mounting hardware.
c. Check battery box for dirt on tray and rack assembly. Clean as required with sash brush.
d. Inspect vent holes for dirt. If vent holes are dirty or clogged, clean area around holes with bristle brush.

2.5.10 Prepare battery for operation

a. Place crate assembly into battery tray if it was removed.
b. Reconnect intercrate flexible jumper cables if removed, and torque nuts to OEM specification.
c. Connect the battery leads as per OEM and rail transit systems procedures.
d. Apply thin coat of non-oxidizing anti-seize compound or equivalent on all rigid connectors and nuts.
e. Push battery tray (if equipped) into battery box. Check for ease of movement and engagement of locking devices. Close door and secure with latches.

2.5.11 Battery Miscellaneous Equipment

a. Check battery trainline fuses if equipped. If found open, seek cause before replacement.
b. Check battery trainline resistors if equipped. Inspect for general condition, security of attachment and proper resistance as required.

3. Correction of deficiencies

Any deficiencies uncovered during the inspections in Sections 2.5.1 through 2.5.11 should be corrected and documented in accordance with established rail transit system procedures and OEM recommendations.

References

American Public Transportation Association, *Standard*:

APTA RT–IM–S-001–98 Rev 1, "Standard for Passenger Rail Equipment Battery System Periodic Inspection and Maintenance" (Document was previously numbered as APTA SS-I&M-001-98 Rev 1)

Code of Federal Regulations, 29 CFR 1910.242b, Compressed Air Used For Cleaning.

Definitions

cell: The smallest indivisible unit of the battery; the fundamental electrochemical unit.

electrolyte: A substance that when dissolved in a suitable solvent becomes an ionic conductor.

specific gravity: The ratio of the density of a solid or liquid to the density of an equal volume of distilled water.

Abbreviations and acronyms

ANSI	American National Standards Institute
CFR	Code of Federal Regulations
OEM	original equipment manufacturer
OSHA	Occupational Safety and Health Administration
MSDS	Material Safety Data Sheet

Summary of document changes

1. Document formatted to the new APTA standard format.
2. Sections have been renumbered and moved around.
3. Two new sections added, *Summary of changes* and *Document history*
4. Some global changes to section headings and numberings resulted when sections dealing with references and acronyms were moved to the end of the document and other cosmetic changes, such as capitalization, punctuation, spelling, grammar and general flow of text.
5. Changes in the following sections:
   a) 2.5.4 Electrolyte – expanded CAUTION paragraph and added di-ionized water
   b) 2.5.7 Cell voltage – modified text in subsection a)
   c) 2.5.7 Cell voltage – deleted subsection b)
   d) 2.5.8 Temperature sensor – added step c.

Document history

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