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Signals and Communication Working
Group

Impedance Bond Inspection and Maintenance

Abstract: This standard provides procedures for inspecting and maintaining rail transit impedance bonds.

Keywords: audio frequency, bond, impedance bond, inspection, maintenance, mini-bond, signal, traction power return cables, tuning unit

Summary: The rail transit impedance bond inspection and maintenance procedures in this document are to be performed when impedance bonds are placed in service; when they are modified, repaired or disarranged; or as otherwise deemed necessary by the rail transit agency.



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. 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-043-03, which has been revised. Below is a summary of changes from the previous document version:

- Migration to the new 2025 APTA document template which standardizes and reorganizes the document's content; a document summary and foreword were added; the scope and purpose have been combined and updated to be more specific.
- Updated list of participants.
- Updated definitions, abbreviations and acronyms to be consistent with standard definitions; specifically, RTS has been replaced with rail transit system throughout the document.



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Introduction

This introduction is not part of APTA RT-SC-S-043-03, "Impedance Bond Inspection and Maintenance."

APTA recommends the use of this document 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).

Scope and purpose

This document establishes standard requirements for inspecting and maintaining rail transit audio frequency and power frequency impedance bonds. The purpose of this standard is to verify that impedance bonds are operating safely and as designed through periodic inspection and maintenance, thereby increasing reliability and reducing the risk of hazards and failures.

Impedance Bond Inspection and Maintenance

1. Inspection and maintenance requirements

1.1 Inspection and maintenance frequency

The inspection and maintenance procedures in this standard should be performed when impedance bonds are placed in service; when they are modified, repaired or disarranged; or as otherwise deemed necessary by the rail transit agency.

The rail transit agency should determine the need for additional inspection and maintenance frequencies for impedance bonds. 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

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

1.2 Training

The rail transit agency and/or its maintenance contractors should 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.

1.3 Materials

The following materials are required for inspecting and maintaining impedance bonds:

- rail transit agency-approved lubricants
- rail transit agency-approved cleaning solutions
- additional materials as required by the OEM and/or rail transit agency

1.4 Tools

The following tools are required for inspecting and maintaining impedance bonds:

- rail transit agency-approved portable radio
- standard tools carried by maintenance personnel
- additional tools as required by the OEM and/or rail transit agency

1.5 Personal protective equipment

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

1.6 Safety

Rail transit agency safety rules, procedures and practices should be followed at all times during inspection and maintenance.

1.7 Inspection and testing procedures

Impedance bond inspection and maintenance procedures may be modified for each rail transit agency's requirements but should contain the steps listed in sections 1.7.1 and 1.7.2 as a minimum.

1.7.1 Inspection

- a. Notify the operations control center (OCC) and/or other authorities of the inspection activities to be performed.
- b. Inspect the impedance bond for any accumulation of debris. Remove and bag debris.
- c. Inspect wayside drains for blockage or ineffective drainage.
- d. Inspect the impedance bond for damage caused by standing water, water leaks or water retention.
- e. Inspect the impedance bond for any condition that may interfere with the operation of the equipment.
- f. Inspect the impedance bond and traction power return cables, rail cable clamps, pin bonds and welds, wiring, bonding, and hardware for defective insulation, rust, corrosion, missing components, damage, and loose or broken connections.
- g. Inspect bond tuning unit for rust; corrosion; damage; cracks; breaks; defective latches, hinges, locks, covers, seals and gaskets; loose conduit connections; and missing or loose components and hardware. Holes and unused entrances not used for ventilation should be sealed.
- h. Inspect junction boxes and enclosures for the presence and condition of stored circuit drawings, terminal list, wire tags and instructions.
- i. Inspect the encapsulated transformer portion of the bond for rust, corrosion, damage, cracks and breaks, and for damaged J-bars, connectors, and missing or loose components and hardware.
- j. Inspect impedance bond insulated joints for bridging, broken or deteriorated insulation, metal shavings, and loose or missing hardware.
- k. Inspect the impedance bond for damage; cracks; breaks; defective latches, locks, hinges and covers; and loose, deteriorated or damaged conduit connections, and hardware.
- l. Inspect PVC, fiberglass, rubber and other cable conduit material for damage, cracks, breaks, loose conduit connections, missing or loose components, and hardware.
- m. Ensure that covers, doors and locks are in place and secured.
- n. Notify the OCC and/or other authorities when inspection is complete.

1.7.2 Maintenance

- a. Notify the OCC and/or other authorities of the maintenance activities to be performed.
- b. Clean and lubricate bond layout hardware and/or components in accordance with rail transit agency procedures.
- c. Verify that bond and/or tuning unit are mounted securely.
- d. Verify that bond fluid and/or compound levels are in compliance with rail transit agency specifications.
- e. Verify that bond air gaps are in compliance with rail transit agency specifications.
- f. Verify that clearance between top of bond and/or tuning unit case and lowest rail is in accordance with rail transit agency specifications.

- g. Ensure that covers and locks are in place and secured.
- h. Notify the OCC and/or other authorities when maintenance activities are complete.

1.8 Correction of deficiencies

Deficiencies identified during impedance bond inspection and maintenance should be corrected and documented in accordance with OEM and/or rail transit agency requirements.

1.9 Documentation

Inspection and maintenance activities should be documented, reviewed and filed in accordance with rail transit agency procedures.

References

This standard should be used in conjunction with OEM specifications and rail transit agency procedures for bond inspection and maintenance.

Definitions

audio frequency impedance bond: A device of low resistance and low impedance to all frequencies to which it is not tuned, used with jointless audio frequency track circuits to couple inductively and confine the signaling energy to its own track circuit and equalize the return propulsion current between rails without impeding its flow. Also called *signal impedance bond*.

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

impedance bond: See *audio frequency impedance bond, power frequency impedance bond*.

operations control center (OCC): The facility from which train control, train dispatching and/or train supervision takes place for the entire rail transit agency or for specific segments of a system if there is more than one control center. Also called *rail control center, rail operations center, rail service control center, train command center*.

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

personal protective equipment: 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.

pin bond: A rail bond where the conductor is connected to a tapered pin that is driven into a predrilled hole in the rail.

power frequency impedance bond: An iron core coil of low resistance and relatively high reactance, used on electrified railroad to provide a continuous path for the return propulsion current around insulating joints and to confine the alternating current signaling energy to its own track circuit.

rail cable clamp: A mechanical device used to secure large current carrying cables to the running rail.

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

traction power return cable: Heavy-duty cables of various sizes that are connected to the running rails, impedance bonds, and other track locations and components that provide a path for the negative traction power current to flow and be returned.

tuning unit: The portion of a two-piece signal impedance bond system that houses the electronic components that are wired in parallel with the bond toroid coils and used to form the resonant circuits required to provide specific automatic train protection functions.

Abbreviations and acronyms

| | |
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| OCC | operations control center |
| OEM | original equipment manufacturer |
| PVC | polyvinyl chloride |

Document history

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