

46. Standard for Radio Communication System Inspection and Testing

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Abstract: This standard provides procedures for inspecting and testing rail transit radio communication systems.

Keywords: antenna, communication, deviation, distortion, frequency modulation, inspection, maintenance, receiver, selectivity, sensitivity, test, testing, transmitter-licensed power

Introduction

(This introduction is not a part of APTA RT-SC-S-046-03, *Standard for Radio Communication System Inspection and Testing*.)

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), manufacturers, consultants, engineers, and general interest groups. This standard provides procedures for inspecting and testing rail transit radio communication systems.

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 a rail transit system operates. In such cases, the government regulations override any conflicting practices this document requires or recommends.

Participants

APTA greatly appreciates the contributions of the following members of the Signals and Communications Subcommittee who provided the primary effort in drafting the *Standard for Radio Communication System Inspection and Testing*:

Carlton “Don” Allen, P.E.
Sal Arceo
Gabrielle Bayme
Paul Camera

Lenny De Meyer
Michael Esford
Patrick Lavin
Ruben Madrigal

Thomas Peacock
Stephen Roberts
Carey Vaughn

The following members of the Rail Transit Standards Fixed Structures Inspection and Maintenance Committee contributed to the review and approval process of the *Standard for Radio Communication System Inspection and Testing*:

James Dwyer, Chair
Frank Cihak, Vice Chair

Anthony Adams
Carlton “Don” Allen, P.E.
Sal Arceo
Roger Avery
Peter Bertozzi
Steven Bezner, P.E.
Raymond Borge
Michael Brown
John Bumanis
Clay Bunting
R. Sean Burgess
Paul Camera
David Cappa, P.E.
Gricelda Cespedes
Robert Chappell
Frank Cihak
Catherine Cronin
Lenny De Meyer
Tom Devenny

David Dunderdale
James Dunn
James Dwyer
William Early, P.E.
Percy Erves
Michael Esford
Richard Falcon
Ray Favetti
Peter Fedun, P.E.
Steve Feil
Robert Fiore
John Gaito
Ricky Green
Mohammad Irshad
Patrick Lavin
Harry Lupia
Frank Machara
Ruben Madrigal
Michael Monastero

Bill Petit
David Rankin
Pingali Rao, P.E.
Richard Raschke
James Redding
Stephen Roberts
Charles Slavis, P.E.
Frederick Smith, P.E.
Richard Spatz
Charles Stanford
F. Brian Steets
Paul Swanson, P.E.
Steven Thompson
Fred Tijan
Gary Touryan
Carey Vaughn
James Wang, P.E.

APTA Rail Transit Standards Fixed Structures Inspection and Maintenance Committee project consultants:

Peter Gentle, P.E., *STV Incorporated*
Carol Rose, *STV Incorporated*

APTA Rail Transit Standards project team:

Gabrielle Bayme, *Standards Development Program Specialist and Project Editor*
Saahir Brewington, *Administrative Assistant and Project Editor*
Antoinette Hankins, *Program Assistant*
Thomas Peacock, *Director-Operations & Technical Services*
David Phelps, *Senior Project Manager - Rail Programs*

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Standard for Radio Communication System Inspection and Testing

1. Overview

1.1 Scope

This document establishes standard requirements for inspecting and testing rail transit radio communication systems.

1.2 Purpose

The purpose of this standard is to verify that radio communication systems are operating safely and as designed through periodic inspection and testing, thereby increasing reliability and reducing the risk of failures and hazards.

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. A rail transit system (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. References

This standard shall be used in conjunction with the most recent versions of the following publications.

CFR 47 Part 17-Construction, Marking and Lighting of Antenna Structures.

IA/EIA-603 Land Mobile FM and PM Communications Equipment Measurement and performance Standard/Telecommunications Industry Association.

3. Definitions, abbreviations, and acronyms

For the purposes of this standard, the following definitions, abbreviations, and acronyms apply:

3.1 Definitions

3.1.1 antenna: A device that picks up or sends out radio frequency energy.

3.1.2 distortion: An undesired change in the waveform of a signal.

3.1.3 frequency: The number of alternating current cycles per second.

3.1.4 gain: (A) An increase in the effective power radiated by an antenna in a certain desired direction. (B) An increase in received signal strength from a certain direction.

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

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

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

3.1.8 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.

3.1.9 pull station: A manually activated device used to initiate a fire alarm condition.

3.1.10 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.**

3.1.11 receiver: A device that converts radio waves into audio or visual signals.

3.1.12 repeater: An automatic relay station, generally in a high elevation, that is used to increase the range of an FM transmitter or receiver.

3.1.13 selectivity: The ability of a receiver to separate two closely spaced signals.

3.1.14 sensitivity: The ability of a receiver to detect weak signals.

3.1.15 squelch: A circuit within a radio that keeps the speaker silenced until the signal level exceeds a certain point.

3.1.16 transmitter: A device that produces radio frequency signals.

3.2 Abbreviations and acronyms

dB	decibels
FM	frequency modulation
kHz	kilohertz
MHz	megahertz
OCC	operations control center
OEM	original equipment manufacturer
PPE	personal protective equipment
RF	radio frequency
RTS	rail transit system

4. Inspection and testing requirements

4.1 Inspection and testing frequency

The inspection and testing procedures in this standard shall be performed

- a) annually
- b) when radio communications systems are placed in service
- c) when radio communications systems are modified, repaired, or disarranged
- d) as otherwise deemed necessary by the RTS

The RTS shall determine the need for additional inspection and testing frequencies for radio communication systems. 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
- RTS testing and experience
- FCC Regulatory requirements

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

4.2 Training

The RTS and/or their maintenance contractors shall 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.

4.3 Materials

No consumable materials are required for inspecting and testing radio communications systems unless otherwise specified by the OEM and/or RTS.

4.4 Tools

The following tools and/or test equipment are required for inspecting and testing radio communications systems:

- Time domain reflectometer
- Multi-meter*
- Power supply
- RF signal generator*
- Frequency counter*
- Watt meter*
- Deviation meter*
- Distortion analyzer*
- Oscilloscope*
- Communications analyzer
- Battery analyzer/conditioner

- Computer with applicable software, as required
- 50 ohm load*
- RTS-approved portable radio
- Standard tools carried by maintenance personnel
- Additional tools as required by the OEM and/or RTS

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

4.5 Personal protective equipment

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

4.6 Safety

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

4.7 Inspection and testing procedures

Radio communications system inspection and testing procedures may be modified for each rail transit system's requirements (see Section 1.3) but shall contain the steps listed in Sections 4.7.1-4.7.4 as a minimum.

The following radio communications system devices, where applicable, shall be inspected and tested:

- a) Portable radios
- b) Mobile radios
- c) Base stations
- d) Repeaters: fixed and mobile
- e) Amplifiers: rf and audio
- f) Base station antennas
- g) Mobile antennas
- h) Radiating cable
- i) Power sources/ac & dc

The transmitter and receiver standard test may be utilized for all portable radios, mobile units, base stations, amplifiers, and repeaters.

4.7.1 Radio transmitter RF and audio test

NOTE – All transmitter audio tests are performed with a 1 kHz tone applied audio input circuit. This criteria and tuning procedures are identified in the TIA/EIA 603 standard.

- 4.7.1.1** Notify the operations control center (OCC) and/or other authorities of the testing activities to be performed.
- 4.7.1.2** Measure the base station or mobile transmitter output power to ensure the transmitter is operating at the licensed power.
- 4.7.1.3** Check the transmitter frequency and compare the amount of deviation from its assigned frequency. Adjust as necessary
- 4.7.1.4** Check the transmitter modulation deviation. Adjust as necessary
- 4.7.1.5** Check the transmitter symmetry.
- 4.7.1.6** Check the transmitter audio sensitivity to verify the audio gain in the transmitter.
- 4.7.1.7** Check the percentage of audio distortion of the transmitter.
- 4.7.1.8** Notify the OCC and/or other authorities when testing is complete.

4.7.2 Radio receiver RF and audio test

- 4.7.2.1** Notify the OCC and/or other authorities of the testing activities to be performed.
- 4.7.2.2** Measure the receiver audio power to verify the detector circuit is functioning and normal audio gain exists.
- 4.7.2.3** Check the receiver audio distortion to verify the audio circuit is not producing any distortion that will affect the sensitivity measurements.
- 4.7.2.4** Check the receiver sensitivity to verify the gain of the RF circuits of the receiver.
- 4.7.2.5** Check the receiver signal noise and distortion.
- 4.7.2.6** Check the signal displacement bandwidth to show the useable bandwidth of the receiver and confirm its bandwidth is not too narrow or wide.
- 4.7.2.7** Check the receiver frequency to make sure it falls within the OEM specifications and FCC tolerance.
- 4.7.2.8** Confirm the proper operation of squelch circuits.

4.7.2.9 Check the battery or power source capacity, repair or replace as necessary.

4.7.2.10 If testing/inspection activities have been completed and no further work is to be performed, notify OCC and/or other authorities that testing/inspection activities have been completed.

4.7.2.11 Notify the OCC and/or other authorities when testing is complete.

4.7.3 Antenna/radiating cable inspection and test

FCC criteria for antenna structures must be adhered to identified in *CFR 47 Part 17-Construction, Marking and Lighting of Antenna Structures*¹.

4.7.3.1 Notify the OCC and/or other authorities of the inspection and testing activities to be performed.

4.7.3.2 Notify the OCC and/or other authorities of the inspection and test to be performed.

4.7.3.3 Visually and mechanically check the antenna bases and/or mounts to make sure they are secure. All directional antennas shall be checked for proper alignment and adjusted if necessary.

4.7.3.4 Check all antenna grounds. A good ground with low impedance is desired. A poor ground will result in loss of radiation and weaken the signal. The site ground should be tested annually with an industry recognized ground resistance meter.

4.7.3.5 For tunnel locations, check all radiating cables, connectors, splitters, terminators, and modular plugs for defective insulation, rust, corrosion, damage, creaks, breaks, covers, seals, loose conduit connections, and missing or loose components and/or hardware.

4.7.3.6 If inspection and testing activities have been completed and no further work is to be performed, notify OCC and/or other authorities that inspection activities have been completed.

4.7.3.7 Notify the OCC and/or other authorities when inspection and testing activities are complete.

4.7.4 Power sources/inspection and test

4.7.4.1 Notify the OCC and/or other authorities of the inspection and testing activities to be performed.

4.7.4.2 Portable radio/battery packs

- a) Using a battery analyzer, exercise all battery packs as identified in the equipment manual.

¹ For references in italics, see Section 2.

- b) Charge to capacity.
- c) Replace any battery packs that do not meet requirements set by the manufacturer or RTS.

NOTE: Ensure that the proper battery and testing parameters are used for the application.

4.7.4.1 Power supplies and converters

- a) Check all power supply and power converter output voltages.
- b) Adjust voltage regulator, as identified in the equipment maintenance manual.
- c) Test under load.
- d) Repair or replace unit.

4.7.4.2 Generating stations

- a) Change all oil, coolants, and anti-freeze, air and fuel filters.
- b) Check all air inlets and outlets, all drive belts, hoses and clamps.
- c) Check the exhaust system for any leaks.
- d) Replace any worn or leaking components.
- e) Ensure the automatic transfer function is operable and performs as intended
- f) Ensure the utility power and the generator power transfer.

4.7.4.3 Notify the OCC and/or other authorities that inspection and testing activities are complete.

4.8 Correction of deficiencies

Deficiencies identified during radio communication system inspection and testing shall be corrected and documented in accordance with FCC, OEM, and/or RTS requirements.

4.9 Documentation

Inspection and testing shall be documented, reviewed, and filed in accordance with RTS procedures.

Annex A

(informative)

Bibliography

- [B1] Amateur Radio Handbook/American Radio Relay League.
- [B2] CFR 47 Part 90-Federal Communications Commission.
- [B3] EIA RS-374 Land Mobile Signaling Standard ECP-165D Test and Troubleshooting Handbook/Ericsson Inc. PRS Technical Training
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- [B6] Rail Transit System (RTS) procedures for radio system inspection and testing.
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