



**APTA RT-SC-S-046-03, Rev. 1**

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**APTA Signals and Communications  
Working Group**

# Radio Communication System Inspection and Testing

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

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

**Summary:** This standard provides testing and inspection procedures for transit radio communication systems in order to ensure that special life/safety equipment is operational and reliable; to help rail transit systems incorporate safety considerations during the inspection and maintenance process; and to identify inspection criteria and maintenance standards that provide a high level of passenger and personnel safety.



## 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 Communications Working Group as directed by the APTA Rail Transit Standards Policy 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 system'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-046-03, which has been revised. Below is a summary of changes from the previous document version:

- This document has been updated using the latest document template for the APTA Standards Program (e.g. new sections include a summary, foreword, summary of changes, etc.). This document was revised with new language describing inspection and testing of a transit radio communication system
- The acronym RTS has been replaced with rail transit system and/or rail transit agency throughout the document in addition to minor grammatical corrections.
- Keywords - The term "radio" was added
- Summary - The language was updated to reflect inspection and testing procedures
- Section 1.4 Tools - Ground resistance meter\* was added
  - It was also noted that any tools marked with an asterisk (\*) should be calibrated in accordance with OEM and/or rail transit agency requirements
- Section 1.7.4 Power sources/inspection and testing
  - Test under load was added to the procedure
  - If necessary, repair or replace unit was added to the procedure
  - Battery backup and uninterruptible power supplies were added to the procedure
  - Check all power supply and power converter output voltages was added to the procedure
  - Adjust voltage regulator, as identified in the equipment maintenance manual, if necessary was added to the procedure



- References - The citation for Land Mobile FM and PM Communications Equipment was updated.
- The definitions for the terms Antenna, frequency, gain, rail transit system, and receiver were updated



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## Introduction

*This introduction is not part of APTA RT-SC-S-046-03, “Radio Communication System Inspection and Testing.”*

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 testing rail transit radio communication systems. 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.

## 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).

# Radio Communication System Inspection and Testing

## 1. Inspection and testing requirements

### 1.1 Inspection and testing frequency

The inspection and testing procedures in this standard shall be performed

- annually
- when radio communications systems are placed in service
- when radio communications systems are modified, repaired, or disarranged
- as otherwise deemed necessary by the rail transit system

The rail transit system 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
- rail transit system testing and experience
- FCC regulatory requirements

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

### 1.2 Training

The rail transit system 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.

### 1.3 Materials

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

## **1.4 Tools**

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

- time domain reflectometer
- multimeter\*
- power supply
- RF signal generator\*
- frequency counter\*
- watt meter\*
- deviation meter\*
- distortion analyzer\*
- ground resistance meter\*
- oscilloscope\*
- communications analyzer
- battery analyzer/conditioner
- computer with applicable software, as required
- 50 ohm load\*
- rail transit system–approved portable radio
- standard tools carried by maintenance personnel
- additional tools as required by the OEM and/or rail transit system

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

## **1.5 Personal protective equipment**

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

## **1.6 Safety**

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

## **1.7 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 1.7.1 through 1.7.4 as a minimum.

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

- portable radios
- mobile radios
- base stations
- repeaters: fixed and mobile
- amplifiers: rf and audio
- base station antennas
- mobile antennas
- radiating cable
- power sources, ac and dc



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

### **1.7.1 Radio transmitter RF and audio test**

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

1. Notify the Operations Control Center (OCC) and/or other authorities of the testing activities to be performed.
2. Measure the base station or mobile transmitter output power to ensure the transmitter is operating at the licensed power.
3. Check the transmitter frequency and compare the amount of deviation from its assigned frequency. Adjust as necessary
4. Check the transmitter modulation deviation. Adjust as necessary
5. Check the transmitter symmetry.
6. Check the transmitter audio sensitivity to verify the audio gain in the transmitter.
7. Check the percentage of audio distortion of the transmitter.
8. Notify the OCC and/or other authorities when testing is complete.

### **1.7.2 Radio receiver RF and audio test**

1. Notify the OCC and/or other authorities of the testing activities to be performed.
2. Measure the receiver audio power to verify the detector circuit is functioning and normal audio gain exists.
3. Check the receiver audio distortion to verify the audio circuit is not producing any distortion that will affect the sensitivity measurements.
4. Check the receiver sensitivity to verify the gain of the RF circuits of the receiver.
5. Check the receiver signal noise and distortion.
6. Check the signal displacement bandwidth to show the useable bandwidth of the receiver and confirm its bandwidth is not too narrow or wide.
7. Check the receiver frequency to make sure it falls within the OEM specifications and FCC tolerance.
8. Confirm the proper operation of squelch circuits.
9. Check the battery or power source capacity, repair or replace as necessary.
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.

### **1.7.3 Antenna/radiating cable inspection and test**

1. FCC criteria for antenna structures must be adhered to identified in CFR 47 Part 17- Construction, Marking, and Lighting of Antenna Structures.
2. Notify the OCC and/or other authorities of the inspection and testing activities to be performed.
3. Notify the OCC and/or other authorities of the inspection and test to be performed.
4. 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.
5. 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.

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6. 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.
7. 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.

#### **1.7.4 Power sources/inspection and test**

1. Notify the OCC and/or other authorities of the inspection and testing activities to be performed.
2. Portable radio/battery packs:
  - Using a battery analyzer, exercise all battery packs as identified in the equipment manual.
  - Charge to capacity.
  - Replace any battery packs that do not meet requirements set by the manufacturer or rail transit system.

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

3. Power supplies, and converters:
  - Check all power supply and power converter output voltages.
  - Test under load.
  - Adjust voltage regulator, as identified in the equipment maintenance manual.
  - If necessary, repair or replace unit.
4. Battery backup and uninterruptible power supplies:
  - Check all power supply and power converter output voltages.
  - Test under load.
  - Adjust voltage regulator, as identified in the equipment maintenance manual.
  - If necessary, repair or replace unit.
5. Generating stations:
  - Change all oil, coolants, and anti-freeze, air and fuel filters.
  - Check all air inlets and outlets, all drive belts, hoses and clamps.
  - Check the exhaust system for any leaks.
  - Replace any worn or leaking components.
  - Ensure the automatic transfer function is operable and performs as intended
  - Ensure the utility power and the generator power transfer.
6. Notify the OCC and/or other authorities that inspection and testing activities are complete.

#### **1.8 Correction of deficiencies**

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

#### **1.9 Documentation**

Inspection and testing shall be documented, reviewed, and filed in accordance with rail transit system procedures.

## References

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

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

## Definitions

**antenna:** A device that sends and/or receives radio frequency energy.

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

**frequency:** The number of cycles of an alternating current that occur per second.

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

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

**Operations Control Center (OCC):** A location or locations designed, equipped, and staffed for the purposes of monitoring and controlling rail transit system activities from a central location or locations. Also called *rail control center, rail operations center, rail service control center*.

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

**receiver:** A device that converts radio waves into signals we can hear or see.

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

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

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

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

**transmitter:** A device that produces radio frequency signals.

## Abbreviations and acronyms

<b>dB</b>	decibels
<b>FM</b>	frequency modulation
<b>kHz</b>	kilohertz
<b>MHz</b>	megahertz
<b>OCC</b>	operations control center
<b>OEM</b>	original equipment manufacturer
<b>PPE</b>	personal protective equipment
<b>RF</b>	radio frequency

## Document history

<b>Document Version</b>	<b>Working Group Vote</b>	<b>Public Comment/ Technical Oversight</b>	<b>Rail CEO Approval</b>	<b>Policy &amp; Planning Approval</b>	<b>Publish Date</b>
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## **Appendix 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
- [B4] FCC regulatory requirements
- [B5] Original equipment manufacturer (OEM) recommendations for radio communications system inspection and testing.
- [B6] Rail transit system procedures for radio system inspection and testing.
- [B7] Standard Radio Communications Manual/R. Harold Kinley, CET Prentice-Hall Inc.