

NFPA[®]

1802

Standard on Two-Way, Portable
RF Voice Communications Devices
for Use by Emergency Services
Personnel in the Hazard Zone

2021



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NFPA® 1802

Standard on

Two-Way, Portable RF Voice Communications Devices for Use by Emergency Services Personnel in the Hazard Zone

2021 Edition

This edition of NFPA 1802, *Standard on Two-Way, Portable RF Voice Communications Devices for Use by Emergency Services Personnel in the Hazard Zone*, was prepared by the Technical Committee on Electronic Safety Equipment and released by the Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment. It was issued by the Standards Council on October 5, 2020, with an effective date of October 25, 2020.

This document has been amended by one or more Tentative Interim Amendments (TIAs) and/or Errata. See “Codes & Standards” at www.nfpa.org for more information.

This edition of NFPA 1802 was approved as an American National Standard on October 25, 2020.

Origin and Development of NFPA 1802

On June 2, 2011, Lieutenant Vincent Perez and Firefighter/Paramedic Anthony Valerio of the San Francisco Fire Department (SFFD) were killed in the line of duty as a result of injuries sustained while operating at Box 8155, 133 Berkeley Way. An internal SFFD Safety Investigation Report released in February 2012 found “a very troubling matter” with regard to the equipment used by Lieutenant Perez and Firefighter/Paramedic Valerio — their portable radios and, specifically, their remote speaker mics (RSM) failed from exposure to heat from the fire.

As a result of this investigation, in November 2011 the SFFD Fire Chief and the International Association of Firefighters (IAFF) requested that NFPA consider the development of a new standard on the design, performance, testing, and certification of two-way, portable (handheld) land mobile radios (LMR) for use by emergency services personnel.

The National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program report F2011-13, released March 1, 2012, of the same SFFD fire, revealed similar issues regarding the members’ portable radios. That report produced “Recommendation #9: First responder radio manufacturers, research/design facilities and standard setting bodies should continue research and efforts to improve radio system capabilities.” Further review of other NIOSH Firefighter Fatality Investigations found portable radio deficiencies nationwide, including in California, North Carolina, South Carolina, and Virginia.

On March 23, 2012, at the request of the SFFD and IAFF, the NFPA Standards Council published a notice to solicit public comments on the need for the LMR standard and to identify subject matter resources, those interested in participating, if established, and other organizations actively involved with the subject. Of 40 public comments received, only three were not in favor of the development of an LMR standard.

Scientific research conducted by the National Institute for Standards and Technology (NIST), and published August 2006 in NIST Technical Note 1477, tested portable radios in simulated firefighting environments and determined that radios are vulnerable when exposed to elevated temperatures. The report also stated that failure of the external speaker/microphone, the part most likely to be exposed to extreme conditions, could mean complete loss of radio operation. The report concluded that because firefighter personal protective clothing (FF PPE) is designed to Thermal Class III, LMRs and accessories such as RSM should also be designed to withstand the fire environment. Finally, the NIST report recommended working with NFPA “to develop a radio standard that would include requirements for the thermal testing of handheld radios.”

On September 10, 2012, the NFPA Standards Council approved the request and assigned the development of the LMR standard to the Electronic Safety Equipment Technical Committee (TC)

and directed the TC to review its membership to ensure that it had appropriate expertise in the design, performance, testing, and certification of LMRs.

NFPA Standards Council also provided direction regarding the document scope. The purpose of this standard would also include establishing minimum requirements for the proper function of the electronics embedded in or associated with emergency services electronic safety equipment when exposed to hostile thermal, immediately dangerous to life and health (IDLH) environments and nonhostile emergency scene environments. The standard was not intended to cover interoperability and was limited to the performance of the LMR in the firefighting environment.

The initial pre-first draft meeting convened on March 19, 2013, with the Electronic Safety Equipment Technical Committee led by newly appointed chairman, Robert Athanas. Due to recruitment and interest in the project, attendance exceeded expectations. Present were representatives from several public safety and military LMR and component manufacturers and agencies such as the Association of Public Safety Communications (APCO), Telecommunications Industry Association (TIA), the Federal Communications Commission (FCC), as well as LMR testing and intrinsic safety certification organizations.

Of concern to the committee was the effect the new standard would have on an industry already well-established and regulated, with millions of products in use. Of concern to the industry was the effect the new standard would have on manufacturers and the industry as a whole.

The intent of the meeting was to affirm the scope of the proposed document, define what the standard would and would not cover, and identify issues that required further research. It was determined that the proposed standard would cover the device itself and not the operating system it might use to support communications. There were many presentations, including an overview of LMRs as they currently exist, radio regulations, intrinsic safety, issues related to firefighter fatalities, existing tests and methods, other concerns related to testing, and current NFPA standards that touch on radios.

Consideration was also given to next-generation broadband and mission critical voice devices (FirstNet) that might be in use by the time this new standard is completed. With this in mind, the committee agreed that the standard should allow for future portable RF voice communication device (RF device) and RSM development and certification.

Research information and recommendations from the Department of Homeland Security (DHS), International Association of Fire Chiefs (IAFC), National Public Safety Telecommunications Council (NPSTC), IAFF, NIST, and NIOSH were also reviewed.

Fire service participants agreed that the RF device and RSM are life safety devices and should be functional and able to transmit and receive when exposed to the harsh firefighting environment. Today, ideally, all members operating in the hazard zone are equipped with an RF device that enables them to transmit and receive vital information, including — most importantly — a MAYDAY.

Initially, three task groups (TG) were formed, all led by representatives from the fire service:

- (1) Physical Properties TG — responsible for the RF devices physical design, including the placement and size of knobs, buttons, displays, and switches.
- (2) Environmental TG — responsible for the environment the RF devices might be subject to and the relevant testing to ensure functionality. Existing NFPA and TIA tests should be reviewed.
- (3) Feature Set TG — responsible for the programmable features and settings of radios, including but not limited to which buttons and switches perform dedicated functions such as the on-off switch, emergency button, audio output, and so forth.

The TC made the following determinations:

- (1) RSMs would be considered part of the RF device and that the RSM and the RF device would be tested together when made by the same manufacturer.
- (2) RSMs could be tested and certified compliant as stand-alone devices. This would allow the end user the option of combining certified devices, both RF devices and RSMs. Further, those devices would remain certified when connected to any other device certified to the standard.
- (3) The primary purpose of the RF device and RSM was to transmit and receive despite exposure to the harsh firefighting environment. Therefore, an industry acceptable test or “speech quality test” would be required initially as a baseline and again after each subsequent test, achieving at least the baseline quality to ensure continued performance of both the RF device and the RSM.

As the committee continued its work, the need to develop the standard was emphasized again when fires in Houston, Texas, on May 31, 2013; Boston, Massachusetts, on March 26, 2014; and New York City on July 5, 2014, killed a total of eight firefighters. The Internal Line of Duty Death Reports conducted by these fire departments determined that, although not the cause of the fatalities, issues with portable radios and RSMs were cited as issues that needed to be addressed.

Over time, many other relevant features and tests were discussed, accepted, or rejected by the committee. In 2013, during the early stages of the development of this standard, the very knowledgeable RF device manufacturers and their affiliates were skeptical and concerned — at that time, no RF device complied with the requirements being proposed. Seven years later, as the

first edition of NFPA 1802, *Standard on Two-Way, Portable RF Voice Communications Devices for Use by Emergency Services Personnel in the Hazard Zone*, enters its final phase of development, all Electronic Safety Equipment Technical Committee members and all those who participated in the development of NFPA 1802 should be commended for coming together and working as one. Their combined knowledge, expertise, and resources resulted in a standard that will provide RF devices and RSMs that better suit the needs of users.

In addition to the names printed in the front of this standard and the numerous manufacturer representatives and SMEs who have participated in its development, there are five other people who deserve to be recognized for their contributions to the technical committee during the process to create the first edition of NFPA 1802:

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- (2) Kate A. Remley and her staff, National Institute of Standards & Technology (NIST);
- (3) Gordon R. Sletmoe, Lebanon Fire District, OR;
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2021 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced and extracted publications can be found in Chapter 2 and Annex B.

Chapter 1 Administration

1.1 Scope. This standard shall identify the operating environment parameters, as well as the minimum requirements for the design, performance, testing, and certification of portable RF voice communications devices (RF devices) and remote speaker microphones (RSMs) for use by emergency services personnel (ESP) within the hazard zone during emergency incident operations without compromising compatibility with field emergency services communications networks.

1.1.1* This standard shall specify requirements for RF devices and RSMs used by ESP in the hazard zone as the primary voice communications link.

1.1.2 Certification.

1.1.2.1 RF devices and RSMs shall be permitted to be certified individually or as a combination of an RF device and an RSM.

1.1.2.2 Certified RF devices and RSMs shall remain certified when connected to any other RSMs certified to this standard.

1.1.3 Except where referenced by this standard, requirements of other standards shall not apply.

1.1.4 Any accessories or enhancements built into, attached to, or sold with an RF device or RSM shall be tested with those accessories and enhancements installed or attached to the RF device or RSM, as specified in Table 4.3.9, to ensure the performance and functions of the RF device or RSM.

1.1.5 Safety.

1.1.5.1 This standard shall not be construed as addressing all of the safety concerns, if any, associated with the use of this standard by testing facilities.

1.1.5.2 It shall be the responsibility of the persons and organizations that use this standard to establish safety and health practices and to determine the applicability of regulatory limitations prior to use of this standard for designing, manufacturing, and testing.

1.1.6 Nothing herein shall restrict any jurisdiction or manufacturer from exceeding these minimum requirements.

1.2 Purpose.

1.2.1 The purpose of this standard shall be to establish minimum requirements for RF devices and RSMs manufactured for emergency services use in the hazard zone.

1.2.2 Controlled laboratory tests used to determine compliance with the performance requirements of this standard shall not be deemed as establishing performance levels for all situations, environments, and conditions to which RF devices and RSMs could be exposed.

1.2.3 This standard shall not be interpreted or used as a detailed manufacturing or purchase specification, but it shall be permitted to be referenced in purchase specifications as minimum requirements.

1.3 Application.

1.3.1* This standard shall apply to all RF devices and RSMs for use by ESP in the hazard zone.

1.3.2 This standard shall also apply to RSMs not supplied with an RF device.

1.3.3 This standard shall apply to the design, performance, manufacturing, testing, and certification of new equipment for use by ESP.

1.3.4 Reserved.

1.3.5* This standard shall not apply to compatible devices and accessories that could be built into or attached to a certified RF device or RSM before or after purchase, but that are not necessary for the RF device or RSM to meet the requirements of this standard.

1.3.6* This standard shall not apply to criteria for use of an RF device or RSM by ESP in the hazard zone.

1.4 Units.

1.4.1 In this standard, values for measurement are followed by an equivalent in parentheses, but only the first stated value shall be regarded as the requirement.

1.4.2 Equivalent values in parentheses shall not be considered as the requirement because those values are approximate.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2019 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2018 edition.

2.3 Other Publications.

2.3.1 APCO Publications. APCO International, 351 N. Williamson Blvd., Daytona Beach, FL 32114-1112.

P25, *Standard of Requirements (P25 SoR)*, 2005.

2.3.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*, 2011.

ASTM D1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*, 2013.

2.3.3 ISO/IEC Publications. International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland.

ISO Guide 27, *Guidelines for corrective action to be taken by a certification body in the event of misuse of its mark of conformity*, 1983.

ISO 9001, *Quality management systems — Requirements*, 2008.

ISO 9001, *Quality management systems — Requirements*, 2015.

ISO 17493, *Clothing and equipment for protection against heat — Test method for convective heat resistance using a hot air circulating oven*, 2000.

ISO/IEC 17011, *Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies*, 2004.

ISO/IEC 17021-1, *Conformity assessment — Requirements for bodies providing audit and certification of management systems*, 2015.

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*, 2005, Technical Corrigendum 1, 2006.

ISO/IEC 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services*, 2012.

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*, Ed 2.2b, 2013.

2.3.4 ITU Publications. International Telecommunication Union (ITU), Place des Nations, 1211 Geneva 20, Switzerland.

ITU-T P.863, *Perceptual Objective Listening Quality Assessment*, 2018.

2.3.5 TIA Publications. Telecommunications Industry Association, 1320 North Courthouse Road, Suite 200, Arlington, VA 22201.

TIA-102.AABD, *Project 25 Trunking Procedures*, 2014.

TIA-102.CAAA-E, *Project 25 Digital C4FM/CQPSK Transceiver Measurement Methods*, 2016.

TIA-102.CAAB-E, *Land Mobile Radio Transceiver Performance Recommendations, Digital Radio Technology, C4FM/CQPSK Modulation*, 2019.

TIA-603-E, *Land Mobile FM or PM — Communications Equipment — Measurement and Performance Standards*, 2016.

ANSI/TIA-4950-A, *Requirements for Battery-Powered, Portable Land Mobile Radio Applications in Class I, II, and III, Division 1, Hazardous (Classified) Locations*, 2014.

TIA-5045, *Numeric Identifier for Conventional Analog Operation*, 2017.

2.3.6 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.

UL 913, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations*, 6th edition, 2002.

UL 121201, *Non-Incendive Electric Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, 2017.

2.3.7 USB Publications. Universal Serial Bus, USB Implementers Forum, 3855 SW 153rd Drive Beaverton, OR 97003, <http://www.usb.org/home>.

Universal Serial Bus Specification Revision 2.0, April 27, 2000.

2.3.8 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections. (Reserved)

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction

and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. An NFPA standard, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase “standards development process” or “standards development activities,” the term “standards” includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Acceptable. Considered by the authority having jurisdiction (AHJ) as adequate for satisfying goals, performance objectives, or performance criteria.

3.3.2 Accessory. An item, or items, that could be attached to a certified product, but are not necessary for the certified product to meet the requirements of this standard.

3.3.3 Alarm Signal. An audible warning that is identifiable as an indication that an emergency services person (ESP) is in need of assistance.

3.3.4 Alias. A unique sequence of alphanumeric characters, specifically identifying an RF device assigned by the AHJ.

3.3.5* Bluetooth. A wireless technology that allows data communications between devices over short ranges.

3.3.6 Certification Organization. An independent third-party organization that determines product compliance with the requirements of this standard using product testing and evaluation and that administers a labeling, listing, and follow-up program.

3.3.7 Certification/Certified. A system whereby a certification organization determines that a manufacturer has demonstrated the ability to produce a product that complies with the requirements of this standard, authorizes the manufacturer to use a label on listed products that comply with the requirements of this standard, and establishes a follow-up program conducted by the certification organization as a check on the methods the manufacturer uses to determine continued compliance of

labeled and listed products with the requirements of this standard.

3.3.8 Channel. An assigned operation range of frequencies; or a user-selectable frequency pair used for radio communications.

3.3.9* Compatible Device. Any electronic device that connects to the RF device or RSM and that participates in the exchange of a signal.

3.3.10 Compliance/Compliant. Meeting or exceeding all applicable requirements of this standard.

3.3.11 Compliant Product. Equipment that is certified to the applicable NFPA standard.

3.3.12 Component. Any material, part, or subassembly used in the construction of the compliant product.

3.3.13 Drip. To run or fall in drops or blobs.

3.3.14 EAB. See 3.3.15.

3.3.15 Emergency Alert Button (EAB). Electronic device button to assist in alerting of an emergency.

3.3.16 Emergency ID. Unit identification of a radio in an emergency state.

3.3.17 Emergency State/Mode. State of an RF device after a user has declared an emergency condition, usually characterized by a particular set of behaviors, displays, or audible alerts.

3.3.18 Failure Mode and Effects Analysis (FMEA). A risk assessment technique for systematically identifying potential failures in a system or a process.

3.3.19 FMEA. See 3.3.18.

3.3.20 Follow-Up Inspection Program. The sampling, inspections, tests, or other measures conducted by the certification organization on a periodic basis to determine the continued compliance of labeled and listed products that are being produced by the manufacturer to the requirements of this standard.

3.3.21 HATS. See 3.3.26.

3.3.22 Hazard Zone. The area where members might be exposed to a hazard or hazardous atmosphere; or a particular substance, device, event, circumstance, or condition that presents a danger to members of the fire department.

3.3.23* Hazard Zone Mode. A mode of operation of the device when in the hazard zone.

3.3.24 Hazardous (Classified) Location (HazLoc). A location where fire or explosion hazards might exist due to flammable gases, flammable liquid-produced vapors, combustible liquid-produced vapors, combustible dusts, or ignitable fibers/flyings.

3.3.25 HazLoc. See 3.3.24.

3.3.26 Head and Torso Simulator (HATS). A mannequin with built-in ear and mouth simulators that provides a realistic reproduction of the acoustic properties of an average adult human head and torso.

3.3.27 Icon. A symbol that represents an option, program, or system status.

3.3.28 Interoperability. The capability of components to exchange data or information, or mechanically interface, with other components.

3.3.29* Intrinsic Safety (IS). Type of protection where any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions.

3.3.30 Intrinsically Safe Circuit. A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions.

3.3.31 Intrinsically Safe System. An assembly of interconnected intrinsically safe apparatus, associated apparatus, and interconnecting cables, in that those parts of the system that are used in hazardous (i.e., classified) locations are intrinsically safe circuits.

3.3.32 IS. See 3.3.29.

3.3.33 Logical ID. A unique sequence of numeric characters identifying an RF device.

3.3.34 Manufacturer. The entity that directs and controls any of the following: compliant product design, compliant product manufacturing, or compliant product quality assurance; or the entity that assumes liability for the compliant product or provides the warranty for the compliant product.

3.3.35 Melt. A response to heat by a material resulting in evidence of flowing or dripping.

3.3.36* Mode. A means of categorizing a collection of features used in a specific operational situation.

3.3.37 Model. The collective term used to identify a group of individual elements or items of the same basic design and components from a single manufacturer produced by the same manufacturing and quality assurance procedures that are covered by the same certification.

3.3.38* Nonhazard Zone Mode. A mode of operation of the device, as defined by the AHJ, which has different operational features than the hazard zone mode of operation.

3.3.39 Nonincendive Equipment. Equipment having electrical/electronic circuitry that is incapable, under normal operating conditions, of causing ignition of a specified flammable gas-air, vapor-air, or dust-air mixture due to arcing or thermal means.

3.3.40* Out-of-Range. A condition when the communication between a system and an RF device is lost.

3.3.41 Perceptual Objective Listening Quality Assessment (POLQA). An objective test process for speech quality on telecommunications equipment that can be automated.

3.3.42 Pink Noise. Noise that contains constant energy per octave band.

3.3.43 POLQA. See 3.3.41.

3.3.44 Portable Radio. A two-way, portable voice communications device using radio frequencies that is either carried by an individual or worn on the body (see 3.3.50, *RF Device*).

3.3.45 Product. See 3.3.11, Compliant Product.

3.3.46* Product Label. A marking provided by the manufacturer for each compliant product containing compliance statements, certification statements, manufacturer and model information, or similar data.

3.3.47 Programmable Features. A feature or function that can be enabled or disabled by configuring the RF device or RSM prior to operation.

3.3.48 Radio Licensing Authority. The government authority in a country that issues licenses for use of radio frequencies by authorized agencies and individuals.

3.3.49 Remote Speaker Device/Microphone (RSD/RSM). A device that places the RF device microphone and speaker remotely from the RF device and near the face of the user.

3.3.50* RF Device. A radio system capable of both transmitting and receiving a modulated radio-frequency (RF) signal that is then converted to an audio or data signal, or both; used to transmit and receive signals.

3.3.51 RSD/RSM. See 3.3.49.

3.3.52 Safety Alert. The procedure by which a manufacturer notifies users, the marketplace, and distributors of potential safety concerns regarding a product.

3.3.53 Sample. The ensemble, element, component, or composite that is conditioned for testing; or ensembles, elements, items, or components that are randomly selected from the manufacturer's production line, from the manufacturer's inventory, or from the open market.

3.3.54 Sensitivity. The degree of response of a receiver or instrument to an incoming signal or to a change in the incoming signal.

3.3.55 Service Life. The period for which a compliant product might be useful before retirement.

3.3.56 Sound Pressure Level (SPL). The local pressure deviation from the ambient (i.e., average or equilibrium) atmospheric pressure caused by a sound wave.

3.3.57 Specimen. Taken from samples, the conditioned ensemble, element, item, or component that is tested.

3.3.58 SPL. See 3.3.56.

3.3.59 Talk Path. The specific channel, consisting of transmitting and receiving radio frequencies, chosen for field users to communicate on.

3.3.60* Talkgroup. A communications channel in a trunked system or a P25, *Standard of Requirements (P25 SoR)*, conventional system.

3.3.61* Telecommunications Industry Association (TIA). The leading trade association representing the global information and communications technology industry through standards development, policy initiatives, business opportunities, market intelligence, and networking events.

3.3.62 TIA. See 3.3.61.

3.3.63* Trunking Signaling Block (TSBK). A form of signaling that uses P25 digital protocol for ID, emergency, and similar messages.

3.3.64 TSBK. See 3.3.63.

3.3.65 User ID. A unique sequence of numeric characters (i.e., a logical ID) or alphanumeric characters assigned to the RF device as determined by the AHJ.

3.3.66* Voltage Standing Wave Ratio (VSWR). A measure of how efficiently radio-frequency power is transmitted from a power source.

3.3.67 VSWR. See 3.3.66.

3.3.68* Zone. A geographically defined area where communications are transmitted and received; or a collection of channels, talkgroups, or talk paths.

Chapter 4 Certification

4.1 General.

4.1.1 For the process of certification of RF devices and RSMs as being compliant with this standard, all RF devices and RSMs shall meet the requirements of Sections 4.1 through 4.8.

4.1.2 Certification and Accreditation.

4.1.2.1 All certification shall be performed by a certification organization that meets the requirements specified in Section 4.2 and that is accredited in accordance with ISO/IEC 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services*.

4.1.2.2 The accreditation shall be issued by an accreditation body operating in accordance with ISO/IEC 17011, *Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies*.

4.1.3 Manufacturers shall not claim compliance with portions or segments of the requirements of this standard and shall not use the NFPA name or the name or identification of this standard in any statements about their respective product(s) unless the product(s) is certified as compliant with all applicable requirements of this standard.

4.1.4 Where RF devices or RSMs are compliant, the product shall be labeled and listed.

4.1.5 Where RF devices or RSMs are compliant, the product shall also have a product label that meets the requirements specified in Section 5.1.

4.1.6 The certification organization's label, symbol, or identifying mark shall be one of the following:

- (1) Attached to the product label
- (2) Part of the product label
- (3) Immediately adjacent to the product label

4.2 Certification Program.

4.2.1 The certification organization shall not be owned or controlled by the manufacturers or vendors of the product being certified.

4.2.2 The certification organization shall be primarily engaged in certification work and shall not have a monetary interest in the product's ultimate profitability.

4.2.3 Accreditation.

4.2.3.1 The certification organization shall be accredited in accordance with ISO/IEC 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services*.

4.2.3.2 The accreditation shall be issued by an accreditation body operating in accordance with ISO/IEC 17011, *Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies*.

4.2.4 The certification organization shall refuse to certify products to this standard that do not comply with all applicable requirements of this standard.

4.2.5 The contractual provisions between the certification organization and the manufacturer shall specify that certification is contingent on compliance with all applicable requirements of this standard.

4.2.5.1 The certification organization shall not offer or confer any conditional, temporary, or partial certifications.

4.2.5.2 Manufacturers shall not be authorized to use any label or reference to the certification organization on products that are not compliant with all applicable requirements of this standard.

4.2.6 The certification organization shall have laboratory facilities and equipment available for conducting required tests to determine product compliance.

4.2.6.1 The certification organization laboratory facilities shall have a program in place and functioning for calibration of all instruments, and procedures shall be in use to ensure accurate control of all testing.

4.2.6.2 The certification organization laboratory facilities shall follow best practices regarding the use of laboratory manuals, form data sheets, documented calibration and calibration routines, performance verification, proficiency testing, and staff qualification and training programs.

4.2.7 The certification organization shall require the manufacturer to establish and maintain a quality assurance program that meets the requirements of Section 4.5.

4.2.7.1 The certification organization shall require the manufacturer to have a product recall system as specified in Section 4.8 as part of the manufacturers' quality assurance program.

4.2.7.2 The certification organization shall audit the manufacturer's quality assurance program to ensure that the quality assurance program provides continued product compliance with this standard.

4.2.8 The certification organization and the manufacturer shall evaluate any changes affecting the form, fit, or function of the compliant product to determine its continued certification to this standard.

4.2.9 The certification organization shall have a follow-up inspection program of the manufacturer's facilities of the compliant product with at least two random and unannounced visits per 12-month period to verify the product's continued compliance.

4.2.9.1 As part of the follow-up inspection program, the certification organization shall select samples of the compliant product at random from the manufacturer's production line, from the manufacturer's in-house stock, or from the open market.

4.2.9.2 Samples shall be evaluated by the certification organization to verify the product's continued compliance to ensure that the materials, components, and manufacturing quality

assurance systems are consistent with the materials, components, and manufacturing quality assurance that were inspected and tested by the certification organization during initial certification and recertification.

4.2.9.3 The certification organization shall be permitted to conduct specific testing to verify the product's continued compliance.

4.2.9.4 For products, components, and materials where prior testing, judgment, and experience of the certification organization have shown results to be in jeopardy of not complying with this standard, the certification organization shall conduct more frequent testing of sample product, components, and materials acquired in accordance with 4.2.9.1 against the applicable requirements of this standard.

4.2.10 The certification organization shall have in place a series of procedures, as specified in Section 4.6, that address reports of situations in which a compliant product is subsequently found to be hazardous.

4.2.11 Appeals.

4.2.11.1 The certification organization's operating procedures shall provide a mechanism for the manufacturer to appeal decisions.

4.2.11.2 The procedures shall include the presentation of information from both sides of a controversy to a designated appeals panel.

4.2.12 Name and Label Protection.

4.2.12.1 The certification organization shall be in a position to use legal means to protect the integrity of its name and label.

4.2.12.2 The name and label shall be registered and legally defended.

4.3 Inspection and Testing.

4.3.1 For both initial certification and recertification of compliant products, the certification organization shall conduct both inspection and testing as specified in Section 4.3.

4.3.2 All inspections, evaluations, conditioning, and testing for certification or for recertification shall be conducted by a certification organization's testing laboratory that is accredited in accordance with the requirements of ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*.

4.3.2.1 The certification organization's testing laboratory's scope of accreditation to ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*, shall encompass testing of RF devices.

4.3.2.2 The accreditation of a certification organization's testing laboratory shall be issued by an accreditation body operating in accordance with ISO/IEC 17011, *Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies*.

4.3.3 A certification organization shall be permitted to utilize conditioning and testing results conducted by a product or component manufacturer for certification or recertification, provided the manufacturer's testing laboratory meets the requirements specified in 4.3.3.1 through 4.3.3.5.

4.3.3.1 The manufacturer's testing laboratory shall be accredited in accordance with the requirements of ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*.

4.3.3.2 The manufacturer's testing laboratory's scope of accreditation to ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*, shall encompass testing of RF devices.

4.3.3.3 The accreditation of a manufacturer's testing laboratory shall be issued by an accreditation body operating in accordance with ISO/IEC 17011, *Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies*.

4.3.3.4 The certification organization shall approve the manufacturer's testing laboratory.

4.3.3.5 The certification organization shall determine the level of supervision and witnessing of the conditioning and testing for certification or recertification conducted at the manufacturer's testing laboratory.

4.3.4 Sampling levels for testing and inspection shall be established by the certification organization and the manufacturer to ensure that products certified to this standard are compliant, unless such sampling levels are specified herein.

4.3.5 Inspection and evaluation by the certification organization shall include a review of all product labels to ensure that all required label attachments, compliance statements, certification statements, and other product information are at least as specified for RF devices in Section 5.1.

4.3.6 Inspection and evaluation by the certification organization shall include an evaluation of any symbols and pictorial graphic representations used on product labels or in user information, as permitted in 5.1.5, to ensure that the symbols are explained in the product's user information package.

4.3.7 Inspection and evaluation by the certification organization shall include a review of the user information required by Section 5.2 to ensure that the information has been developed and is available.

4.3.8 Inspection and evaluation by the certification organization for determining compliance with the design requirements specified in Chapter 6 shall be performed on whole or complete products.

4.3.9 Testing to determine compliance of the RF device with the performance requirements specified in Chapter 7 shall be conducted by the certification organization in accordance with the specified testing requirements of Chapter 8 and in the order as specified in Table 4.3.9.

4.3.9.1 Testing to determine compliance of RSMs with the performance requirements specified in Chapter 7 that can be connected to the RF device shall be conducted by the certification organization in accordance with the specified testing requirements of Chapter 8 and in the order as specified in Table 4.3.9.1.

4.3.9.2 Testing shall be performed on new RF devices or RSMs.

4.3.9.3 Testing shall be performed on specimens representative of materials and components used in the actual construction of the compliant product.

Table 4.3.9 Order of Testing

Specimen 1–3	Specimen 4–6	Specimen 7–9	Specimen 10–12	Specimen 13–15	Specimen 16–18	Specimen 19–21	Components
Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Display Surface Abrasion Test (Section 8.7)
Heat and Flame Test (Section 8.9)	Power Source Performance Test (Section 8.18)	Impact Acceleration Resistance Test (Section 8.5)	Water Drainage Test (Section 8.13)	Case Integrity Test (Section 8.12)	TIA Transmit Power (Section 8.15)	Tumble Vibration Test (Section 8.14)	—
Speech Quality Test (Section 8.2)	Vibration Test (Section 8.4)	Cable Pullout Test (Section 8.11)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	TIA Carrier Frequency Stability (Section 8.16)	Speech Quality Test (Section 8.2)	—
Antenna VSWR Swept Frequency Test (Section 8.20)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Corrosion Test (Section 8.6)	High Temperature Functionality Test (Section 8.8) includes Speech Quality Test (Section 8.2)	TIA Receiver Sensitivity (Section 8.17)	Antenna VSWR Swept Frequency Test (Section 8.20)	—
—	—	Antenna VSWR Swept Frequency Test (Section 8.20)	Speech Quality Test (Section 8.2)	Product Label Durability Test (Section 8.10)	Electronic Temperature Stress Test (Section 8.19)	—	—
—	—	—	Product Label Durability Test (Section 8.10)	Antenna VSWR Swept Frequency Test (Section 8.20)	Heat and Immersion Leakage Resistance (Section 8.3)	—	—
—	—	—	Antenna VSWR Swept Frequency Test (Section 8.20)	—	Product Label Durability Test (Section 8.10)	—	—
—	—	—	—	—	Speech Quality Test (Section 8.2)	—	—
—	—	—	—	—	Antenna VSWR Swept Frequency Test (Section 8.20)	—	—

4.3.9.4 The certification organization also shall be permitted to use sample materials cut from a representative product.

4.3.9.5 Where any manufacturer-supplied accessories or enhancements are built into, attached to, or detachable from the RF devices or RSMs for use in the hazard zone, the certification organization shall do the following:

- (1) Inspect and evaluate the RF devices and RSMs as specified in Chapter 6
- (2) Test the RF devices and RSMs as specified in Chapter 8

4.3.9.6 The RF devices and RSMs shall meet all the performance requirements specified in Chapter 7 with those accessories and enhancements installed or attached to ensure that the performance and functions of the RF devices and RSMs are not reduced or otherwise negatively affected.

4.3.10 For evaluation and testing for certification purposes, the certification organization shall accept from the manufacturer only product or product components that are the same in

every respect as the actual final product or product component.

4.3.11 The certification organization shall not allow any modifications, pretreatment, conditioning, or other such special processes of the product or any product component prior to the product's submission for evaluation and testing by the certification organization.

4.3.12 The certification organization shall not allow the substitution, repair, or modification —other than as specifically permitted herein — of any product or any product component during testing.

4.3.13 The certification organization shall not allow test specimens that have been conditioned and tested for one method to be reconditioned and tested for another test method unless specifically permitted in the test method.

4.3.14 Certification of Changes.

4.3.14.1 Material changes in the form, fit, or function of a compliant product shall necessitate new inspection and testing

Table 4.3.9.1 Test Matrix Table

Specimen 1–3	Specimen 4–6	Specimen 7–9	Specimen 10–12	Specimen 13–15	Specimen 16–18	Specimen 19–21	Component
Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Display Surface Abrasion Test (Section 8.7)
Heat and Flame Test (Section 8.9)	Power Source Performance Test (Section 8.18)	Impact Acceleration Resistance Test (Section 8.5)	Water Drainage Test (Section 8.13)	Case Integrity Test (Section 8.12)	Electronic Temperature Stress Test (Section 8.19)	Tumble Vibration Test (Section 8.14)	—
Speech Quality Test (Section 8.2)	Vibration Test (Section 8.4)	Cable Pullout Test (Section 8.11)	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Heat and Immersion Leakage Resistance (Section 8.3)	Speech Quality Test (Section 8.2)	—
—	Speech Quality Test (Section 8.2)	Speech Quality Test (Section 8.2)	Corrosion Test (Section 8.6)	High Temperature Functionality Test (Section 8.8) includes Speech Quality Test (Section 8.2)	Product Label Durability Test (Section 8.10)	—	—
—	—	—	Speech Quality Test (Section 8.2)	Product Label Durability Test (Section 8.10)	Speech Quality Test (Section 8.2)	—	—
—	—	—	Product Label Durability Test (Section 8.10)	—	—	—	—

to verify compliance to all applicable requirements of this standard that the certification organization determines can be affected by such change.

4.3.14.2 This recertification shall be conducted before labeling the modified product as being compliant with this standard.

4.3.15 Certification Data.

4.3.15.1 The manufacturer shall maintain all design, performance, inspection, and test data from the certification organization used in the certification of the manufacturer's compliant product.

4.3.15.2 The manufacturer shall provide such data, upon request, to the purchaser or authority having jurisdiction (AHJ).

4.3.16 Accessory Certification.

4.3.16.1 Where an RF device submitted for certification to this standard is also submitted with an accessory or compatible device that is built into or attached to the RF device, or sold for later attachment to the RF device, and an NFPA standard exists for the product performance associated with the accessory or compatible device, the accessory or compatible device shall be certified to the standard associated with the accessory or compatible device.

4.3.16.2 In all cases, such accessories or compatible devices shall not degrade the performance of the RF device.

4.4 Annual Verification of Product Compliance.

4.4.1 Recertification.

4.4.1.1 All RF devices and RSMs that are certified as compliant with this standard shall undergo recertification on an annual basis.

4.4.1.2 This recertification shall include the following:

- (1) Inspection and evaluation to all design requirements as required by this standard on all manufacturer's models and components
- (2) Testing to all performance requirements as required by this standard on all manufacturer's models and components within the following protocols:
 - (a) Where a test method incorporates testing both before and after preconditioning and the test generates quantitative results, recertification testing shall be limited to the conditioning that yielded the worst-case test result during the initial certification for the model or component.
 - (b) Where a test method requires testing of three specimens, a minimum of one specimen shall be tested for annual recertification.
 - (c) Where a test method requires testing of five or more specimens, a minimum of two specimens shall be tested for annual recertification.

4.4.2 Samples of manufacturer's models and components for recertification acquired from the manufacturer or a component supplier during random and unannounced visits as part of the follow-up inspection program in accordance with 4.2.9 shall be permitted to be used toward annual recertification.

4.4.3 Certification Data.

4.4.3.1 The manufacturer shall maintain all design, performance inspections, and test data from the certification organization used in the recertification of manufacturer's models and components.

4.4.3.2 The manufacturer shall provide such data, upon request, to the purchaser or AHJ.

4.5 Manufacturers' Quality Assurance Program.

4.5.1 The manufacturer shall provide and operate a quality assurance program that meets the requirements of Section 4.5, including a product recall system as specified in 4.2.7.1 and Section 4.8.

4.5.2 The operation of the quality assurance program shall evaluate and test compliant product production to the requirements of this standard to ensure that production remains in compliance.

4.5.3 The manufacturer shall be registered to ISO 9001, *Quality management systems — Requirements*.

4.5.3.1 Registration to the requirements of ISO 9001, *Quality management systems — Requirements*, shall be conducted by a registrar that is accredited in accordance with ISO/IEC 17021-1, *Conformity assessment — Requirements for bodies providing audit and certification of management systems*.

4.5.3.2 The scope of the ISO registration shall include at least the design and manufacturing systems management for the product being certified.

4.5.3.3 The registrar shall affix the accreditation mark on the ISO registration certificate.

4.5.4 Any entity that meets the definition of *manufacturer* as specified in 3.3.34 and therefore is considered to be the "manufacturer," but does not manufacture or assemble the compliant product, shall meet the requirements specified in Section 4.5.

4.5.5 Where the manufacturer uses subcontractors in the construction or assembly of the compliant product, the locations and names of all subcontractor facilities shall be documented and provided to the manufacturer's ISO registrar and the certification organization.

4.6 Failure Mode and Effects Analysis (FMEA) for RF Devices and RSMs.

4.6.1* An FMEA shall be applied throughout the development process.

4.6.2 The FMEA shall do the following:

- (1) Address RF devices or RSMs
- (2) Identify and prioritize those critical failures that could have a serious effect on the safety and reliability of a device in the anticipated operating environments

4.6.3 Failure Mode.

4.6.3.1 The FMEA shall tabulate potential failure modes and their effects on the performance of an RF device or RSM.

4.6.3.2 The failure mode shall describe how the system might fail.

4.6.4* FMEA Use.

4.6.4.1 The device manufacturer shall use FMEA to address the reduction of risk of random and systematic failures of the RF device or RSM by using as low as reasonably practical (ALARP) region activities, as shown in Figure 4.6.4.1.

4.6.4.2 The device manufacturer shall include the risk priority number (RPN) corresponding to the upper limit of the ALARP region in the FMEA report.

4.6.5 ALARP Limits.

4.6.5.1 Where a device system RPN is above the upper limit of the ALARP region, as determined by the manufacturer, one or more of the practices specified in 4.6.5.2 shall be permitted.

4.6.5.2 Verification of the manufacturers' design and testing practices shall include documentation of at least temperature, vibration, and wetness exposure data; hours of operation; and management of change information.

4.6.6 The FMEA report shall be provided to the certification organization.

4.7 Hazards Involving Compliant Product.

4.7.1 Hazardous Product Reporting Procedure.

4.7.1.1 The certification organization shall establish procedures for where a compliant product is reported as hazardous.

4.7.1.2 These procedures shall comply with the provisions of ISO Guide 27, *Guidelines for corrective action to be taken by a certification body in the event of misuse of its mark of conformity*, and as modified herein.

4.7.2 Where a report of a hazard involved with a compliant product is received by the certification organization, the validity of the report shall be investigated.

4.7.3 With respect to a compliant product, a hazard shall be a condition, or create a situation, that results in exposing life, limb, or property to a dangerous or imminently dangerous condition.

4.7.4 Where a specific hazard is identified, the determination of action for the certification organization and the manufacturer to undertake shall take into consideration the severity of the hazard and its consequences to the safety and health of users.

4.7.5 Where it is established that a hazard is involved with a compliant product, the certification organization shall determine the scope of the hazard, including products, model numbers, serial numbers, factory production facilities, production runs, and quantities involved.

4.7.6 The certification organization's investigation shall include, but not be limited to, the extent and scope of the

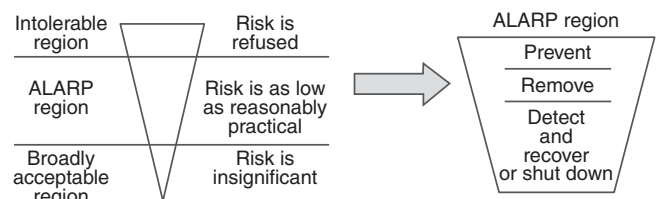


FIGURE 4.6.4.1 ALARP Region Activities.

problem as it might apply to other compliant product or compliant product components manufactured by other manufacturers or certified by other certification organizations.

4.7.7 The certification organization shall also investigate reports of a hazard where compliant product is gaining widespread use in applications not foreseen when the standard was written, such applications in turn being ones for which the product was not certified, and no specific scope of application has been provided in the standard, and no limiting scope of application was provided by the manufacturer in written material accompanying the compliant product at the point of sale.

4.7.8 The certification organization shall require the manufacturer of the compliant product or the manufacturer of the compliant product component, if applicable, to assist the certification organization in the investigation and to conduct its own investigation as specified in Section 4.8.

4.7.9 Where the facts indicating a need for corrective action are conclusive and the certification organization's appeal procedures referenced in 4.2.11 have been followed, the certification organization shall initiate corrective action immediately, provided there is a manufacturer to be held responsible for such action.

4.7.10 Where the facts are conclusive and corrective action is indicated, but there is no manufacturer to be held responsible, such as when the manufacturer is out of business or the manufacturer is bankrupt, the certification organization shall immediately notify relevant governmental and regulatory agencies and issue a notice to the user community about the hazard.

4.7.11 Where the facts are conclusive and corrective action is indicated, the certification organization shall take one or more of the following corrective actions:

- (1) Parties authorized and responsible for issuing a safety alert shall be notified when, in the opinion of the certification organization, such a safety alert is necessary to inform the users.
- (2) Parties authorized and responsible for issuing a product recall shall be notified when, in the opinion of the certification organization, such a recall is necessary to protect the users.
- (3) The mark of certification shall be removed from the product.
- (4) Where a hazardous condition exists and it is not practical to implement the corrective actions in 4.7.11(1), 4.7.11(2), or 4.7.11(3) or where the responsible parties refuse to take corrective action, the certification organization shall notify relevant governmental and regulatory agencies and issue a notice to the user community about the hazard.

4.7.12 The certification organization shall provide a report to the organization or individual identifying the reported hazardous condition and notify that organization or individual of the corrective action indicated or that no corrective action is indicated.

4.8 Manufacturers' Investigation of Complaints and Returns.

4.8.1 Manufacturers shall provide corrective action in accordance with ISO 9001, *Quality management systems — Requirements*, for investigating written complaints and returned products.

4.8.2 Manufacturers' records of returns and complaints related to safety issues shall be retained for at least 5 years.

4.8.3 Where the manufacturer discovers, during the review of specific returns or complaints, that a compliant product or compliant product component can constitute a potential safety risk to end users and is possibly subject to a safety alert or product recall, the manufacturer shall immediately contact the certification organization and provide all information about its review to assist the certification organization with the investigation.

4.9 Manufacturers' Safety Alert and Product Recall Systems.

4.9.1 Manufacturers shall establish a written safety alert system and a written product recall system that describes the procedures to be used in the event that they decide or are directed by the certification organization to either issue a safety alert or conduct a product recall.

4.9.2 The manufacturers' safety alert and product recall systems shall provide the following:

- (1) The establishment of a coordinator and responsibilities by the manufacturer for the handling of safety alerts and product recalls
- (2) A method of notifying all dealers, distributors, purchasers, users, and the NFPA about the safety alert or product recall that can be initiated within 1 week following the manufacturer's decision to issue a safety alert or to conduct a product recall or after the manufacturer has been directed by the certification organization to issue a safety alert or conduct a product recall
- (3) Techniques for communicating the nature of the safety alert or product recall and, in particular, the specific hazard or safety issue found to exist
- (4) Procedures for removing product that is recalled and for documenting the effectiveness of the product recall
- (5) A plan for repairing or replacing product or for compensating purchasers for returned product

Chapter 5 Product Labeling and Information

5.1 Product Label Requirements.

5.1.1 Every compliant RF device and RSM shall have a product label permanently attached to the complete assembled product.

5.1.2 Multiple label pieces shall be permitted to carry all statements and information required to be on the product label; however, all label pieces that the product label comprises shall be located adjacent to each other.

5.1.3 Labels and Lettering.

5.1.3.1 The certification organization's label, symbol, or identifying mark shall be attached to the product label or be part of the product label.

5.1.3.2 The label, symbol, or identifying mark shall be at least 6 mm ($\frac{1}{4}$ in.) in height.

5.1.3.3 All letters shall be at least 1.5 mm ($\frac{1}{32}$ in.) in height.

5.1.3.4 Arial font in capital letters shall be used for all label lettering.

5.1.4 All worded portions of the required product label shall be at least in English.

5.1.5 Symbols and other pictorial graphic representations shall be permitted to be used to supplement worded statements on the product label(s).

5.1.6 The compliance image as shown in Figure 5.1.6 shall be printed on all RF device labels, all certified accessory labels, and all RSM labels.

5.1.7 Each RF device, rechargeable power source, certified accessory, and RSM shall be marked directly with the serial number and the year and month of manufacture.

5.2 User Information.

5.2.1 The manufacturer shall provide with each product at least the informational material and user instructions specified within this section.

5.2.2 At the time of purchase, the manufacturer shall provide to the purchaser an information sheet with each product that documents at least the following:

- (1) Date of manufacture
- (2) Model number
- (3) Serial number
- (4) Lot number, if applicable

5.2.3 Information and materials intended for the end user in the field regarding use shall be provided on at least the following topics:

- (1) Safety considerations
- (2) Recommended preuse (daily/shift) and periodic (monthly, quarterly, annually as recommended by the manufacturer) inspections, including connections to RSMs and attachment of accessories
- (3) Limitations of use
- (4) Power source requirements, type, and brand
- (5) Estimated operation time on fully charged power source in each available mode
- (6) Low-power source visual indicator and power supply replacement/recharging procedures, as applicable
- (7) Location and description of device features, controls, knobs, buttons, displays, sounds, and their operational use, including any features that are programmable and can be defined by the AHJ
- (8) Device/feature/RSM failure and fallback indications and operations
- (9) Marking recommendations and restrictions to prevent damage to the case or impairment of operation
- (10) Recommended storage practices

Certification
organization
logo to be
placed here

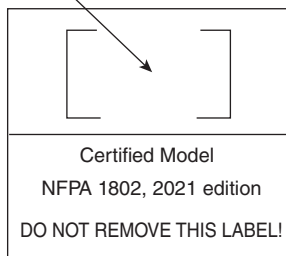


FIGURE 5.1.6 Compliance Label.

- (11) Cleaning instructions and precautions for a typical fire-fighting environment
- (12) Disinfecting procedures if exposed to chemical or biological hazards
- (13) Periodic maintenance frequency and details
- (14) Guidelines for requesting service and repair

5.2.4 Information and operational materials intended for RF communications systems administrators shall be provided on at least the following topics:

- (1) Information and training regarding the availability, selection, and programming of RF devices and RSM programmable features and options
- (2) Information and training regarding design and implementation of the RF devices and RSMs
- (3) Information regarding periodic maintenance, warranty, service, repair, and unit replacement and retirement considerations for the RF devices and RSMs
- (4) Maximum rated volume and associated volume control setting
- (5) Maximum RF transmit power in all bands and modes of operation

5.2.5 The following statement shall appear on the first page of all operating manuals provided as specified in 5.2.3 and 5.2.4:

**THIS DEVICE MEETS THE REQUIREMENTS OF
NFPA 1802, STANDARD ON TWO-WAY, PORTABLE RF VOICE
COMMUNICATIONS DEVICES FOR USE BY EMERGENCY SERV-
ICES PERSONNEL IN THE HAZARD ZONE, 2021 EDITION.**

Chapter 6 Design Requirements

6.1 General Design Requirements.

6.1.1 All RF devices and all RSMs shall meet the applicable design requirements specified in 9.3.6 of NFPA 1221.

6.1.2 Interoperability.

6.1.2.1 All certified RF devices shall be interoperable with all certified RSMs.

6.1.2.2 The RF device shall be capable of being interoperable with wired and wireless certified RSMs.

6.1.2.3 RF devices shall not utilize or incorporate any proprietary software, firmware, hardware, or physical design that will prevent an RSM from meeting the requirements of this standard.

6.1.3 All RF devices and RSMs shall have at least the applicable design requirements specified in this chapter when inspected and evaluated by the certification organization as specified in Section 4.3.

6.1.4* Transmission modes shall include, at a minimum, analog conventional FM and, when required by the AHJ, P25 conventional transmission modes.

6.1.4.1 All RF devices shall have a visual indicator that displays the remaining capacity of the power source when the RF device is powered on.

6.1.4.2 The power source visual indicator shall display the state of the available capacity from full to nearly depleted as follows and as shown in Figure 6.1.4.2:

- (1) Four segments displayed — 76 to 100 percent available power source.
- (2) Three segments displayed — 51 to 75 percent available power source.
- (3) Two segments displayed — 26 to 50 percent available power source.
- (4) One segment displayed — 0 to 25 percent available power source.
- (5) The power source visual indicator flashes when 25 percent or less capacity remains.
- (6) The RF device emits an audible alert recurring every 2 minutes when 25 percent or less capacity remains.

6.1.5 Service Life.

6.1.5.1 Unless otherwise specified, all operational controls, including, but not limited to, switches, buttons, and keys, shall be rated for a service life of not less than 50,000 cycles.

6.1.5.2 Rotary knobs shall be rated for a service life of not less than 10,000 cycles.

6.1.6 All controls shall be designed to prevent unintentional activation, deactivation, and change of operation.

6.1.7 All controls and connectors shall be capable of being operated by a gloved hand.

6.1.7.1 The gloves shall comply with the structural fire-fighting glove requirements of NFPA 1971.

6.1.7.2 The gloves shall meet the following additional requirements:

- (1) The gloves shall be in as-received condition.
- (2) The gloves shall be size 76w as specified in NFPA 1971.
- (3) The outer shell shall be a minimum of 110.2 g/m² (3.25 oz/yd²) American-sourced and -tanned cowhide.
- (4) The thermal liner system shall be a minimum of 254.3 g/m² (7.5 oz/yd²).

6.2 Hazard Zone Mode.

6.2.1 Capability.

6.2.1.1* All RF devices shall be capable of both the hazard zone mode and the nonhazard zone mode.

6.2.1.2 The minimum volume of the RF device in the hazard zone mode shall be 24 dB, +0/-6 dB, below the sound pressure level (SPL) as specified in 6.4.2.

76–100%	
51–75%	
26–50%	
0–25% Flashing	

FIGURE 6.1.4.2 Power Source Visual Indicator.

6.2.2 All RF devices shall have the capability to enable the nonhazard zone mode via programmable switch activation, or by being preprogrammed to a channel talkgroup or talk path.

6.2.3 When initially powered on, the RF device shall default to the hazard zone mode.

6.2.4* The RF device in the hazard zone mode shall be capable of being programmed by the AHJ to be powered off with two separate actions.

6.3 Location of Controls and Features.

6.3.1 The RF device shall include the following:

- (1) Speaker
- (2) Microphone
- (3) Minimum of one programmable side button capable of being programmed as required by the AHJ
- (4)* Two-position programmable switch capable of being programmed as required by the AHJ
- (5)* Three-position programmable switch capable of being programmed as required by the AHJ

6.3.2 The front of the RF device shall be the side facing the viewer when the push-to-talk (PTT) button is located on the left side.

6.3.3 The top of the RF device shall have the following controls and features:

- (1) Power/volume knob
- (2) Selector knob
- (3) EAB (emergency alert button)
- (4) External antenna, if so equipped
- (5) Display
- (6) Transmit/receive indicator
- (7) Two programmable selector switches, one capable of at least three positions and one capable of at least two positions, capable of being programmed as required by the AHJ

6.3.4 Any additional controls or features on the top of the RF device shall not interfere with any of the required controls.

6.3.5 Left Side.

6.3.5.1 The left side of the RF device shall include the following:

- (1) PTT button
- (2)* At least one programmable button

6.3.5.2 Any additional controls or features on the left side of the RF device shall not interfere with any of the required controls.

6.3.6* Time-Out Timer.

6.3.6.1 The RF device shall have a transmit time-out timer, which shall be set at the factory for 1 minute.

6.3.6.2 This time-out timer shall be capable of being set by programming by the AHJ to values between 30 seconds and 180 seconds.

6.4 Power/Volume Knob.

6.4.1 The RF device shall have a power/volume knob that rotates clockwise to power on the RF device.

6.4.1.1 The power/volume knob shall have an audible and tactile click during the transition from power off to power on and the transition from power on to power off.

6.4.1.2 The power/volume knob shall control the volume.

6.4.1.2.1 A clockwise rotation of the power/volume knob shall increase the volume.

6.4.1.2.2 A counterclockwise rotation of the power/volume knob shall decrease the volume.

6.4.2 The RF device, or an RSM containing a loudspeaker, shall be capable of producing a sound pressure level of no less than 88 dBA with the volume control set to its maximum position when measured by the method specified in TIA-603-E, *Land Mobile FM or PM — Communications Equipment — Measurement and Performance Standards*, Section 2.1.20.

6.4.3 When the RF device is powered off in the hazard mode, it shall have the following voice annunciation at the volume specified in 6.12.5.1: “powering off.”

6.5 Selector Knob.

6.5.1 General.

6.5.1.1 The RF device shall have a programmable selector knob.

6.5.1.2 The selector knob shall be differentiated in size and shape from the power/volume knob.

6.5.2* The selector knob shall have the following functions and features:

- (1) Minimum of 16 positions
- (2) Detent at each position
- (3) Hard stops at the minimum and maximum positions
- (4) Turning resistance designed to minimize accidental rotation
- (5) Ability to change channels, talkgroups, or talk paths

6.6 Display.

6.6.1 The RF device shall include a primary display of at least eight characters visible without scrolling, with at least six additional characters visible with continuous scrolling.

6.6.2 Backlight Illumination.

6.6.2.1 The primary display shall be capable of being illuminated by means of backlighting when any RF device control is manipulated.

6.6.2.2 The backlight illumination time shall be programmable.

6.6.3 The display shall be backlit on the RF device that initiated the emergency mode, and be backlit on all RF devices that are receiving the emergency message, until reset in accordance with 6.8.9.

6.6.3.1 Display backlights required by this standard shall meet the design requirements of 6.15.1.1.

6.6.3.2 The backlight illumination time for an RF device receiving an emergency activation shall be programmable.

6.6.4 Readability.

6.6.4.1 All displays shall be readable from a distance of 609.6 mm (2 ft) in all modes when backlit and in a completely dark room.

6.6.4.2 All displays shall be readable from a distance of 609.6 mm (2 ft) in all modes when backlit and in daylight.

6.7 Visual Indicators. The RF device shall have visual indicators to inform the user of event conditions as specified in Section 6.15.

6.8 Emergency Alert Button (EAB).

6.8.1 The EAB shall be located adjacent to the base of the external antenna, if so equipped, or, if not so equipped, adjacent to a guiding feature on the top of the RF device.

6.8.2 The EAB shall be international orange in color.

6.8.3 The EAB shall comprise a minimum of 113 mm² (0.175 in.²) of projected surface area.

6.8.4 The EAB shall be designed to minimize accidental activation.

6.8.5* Activation/Deactivation.

6.8.5.1 The EAB shall be activated after a continuous press of no less than 1 second and no more than 3 seconds, as determined by the AHJ.

6.8.5.2 After EAB activation, the EAB shall be capable of being programmed to be deactivated after a subsequent continuous press of at least 2 seconds.

6.8.6 The activation of the alert button shall cause the RF device to transmit an emergency alert in accordance with TIA-102.AABD, *Project 25 Trunking Procedures*.

6.8.7 The RF device shall transmit the user ID at the highest RF power the RF device is capable of transmitting and in compliance with the licensing authority.

6.8.7.1 Subsequent emergency transmissions shall be at the highest RF power the RF device is capable of transmitting and in compliance with the radio licensing authority until emergency activation is cleared.

6.8.7.2 The emergency signal shall use the trunking signaling block (TSBK) protocol when operating in analog conventional mode as specified in TIA-5045, *Numeric Identifier for Conventional Analog Operation*.

6.8.7.2.1* The AHJ shall be permitted to select optional protocols in addition to the TSBK protocol, based on operational need.

6.8.8 The RF device shall have one of the following capabilities for voice transmission upon activation of the emergency button:

- (1)* Remain on selected channels, talkgroups, or talk paths
- (2)* Revert to preprogrammed transmission channels, talkgroups, or talk paths

6.8.8.1 Voice transmission, as specified in 6.8.7.1, shall be at the highest RF power the RF device is capable of transmitting and in compliance with the radio licensing authority.

6.8.8.2 Subsequent voice transmissions from the RF device that initiated the emergency signal shall be at the highest RF power the RF device is capable of transmitting until emergency activation is cleared.

6.8.9 The displayed emergency indication shall remain activated until reset by the initiating user as determined by the AHJ.

6.8.9.1 The receiving RF device shall be capable of allowing the AHJ to do the following:

- (1) Configure it to emit a distinct audible tone for 3 sec $\pm$ 500 ms at maximum volume upon receipt of an emergency activation from another RF device
- (2) Display user data by referring to an internally stored ID database
- (3) Program the RF device to increase its audio output to maximum volume regardless of knob position

6.8.9.2 The receiving RF device shall display the user ID of the initiating RF device.

6.8.9.2.1 The user ID shall be permitted to be cleared from the display at the cessation of the emergency activation.

6.8.9.2.2* Additional emergency alarms received during an incident shall be displayed together with prior emergency alarms of the same incident that have not been cancelled.

6.8.9.3 ID Display.

6.8.9.3.1 The RF device shall have the capability of displaying the user ID of at least 20 active emergency alerts.

6.8.9.3.2 The RF device shall be capable of displaying an ID of a minimum of 14 alphanumeric characters.

6.9 Remote Speaker Microphone.

6.9.1 All voice announcements and audible notifications from the RF device shall also be audible through the connected RSM.

6.9.2 The RSM shall have at least one PTT button.

6.9.3 The RSM shall have an EAB that meets the requirements of Section 6.8.

6.9.3.1 The EAB shall be located at the top of the RSM.

6.9.4 Visual Indicators.

6.9.4.1 The RSM shall be permitted to have visual indicators to inform the user of event conditions as specified in Section 6.15.

6.9.4.2 The RF device shall control the visual indicator color and status for the RSM with the data commands as specified in Table 6.21.1(a) and Table 6.21.1(b).

6.9.5* Programmable Button.

6.9.5.1 The RSM shall be permitted to include at least one programmable option button.

6.9.5.2 The RSM shall be permitted to specify the state of the programmable button, pressed or released, with the data commands specified in Table 6.21.1(a) and Table 6.21.1(b).

6.9.6 The RSM shall be permitted to connect to compatible devices via a wired or wireless connection.

6.10 RF Device Connector (RFDC).

6.10.1 An RF device or RSM using a wired connection shall connect with a 10-pin miniature version of US MIL-DTL-55116 (M55116) or equivalent.

6.10.1.1 The RF device shall have an RFDC plug.

6.10.1.2 The RSM and compatible device shall have an RFDC jack.

6.10.1.3 The RFDC pin assignments shall be as specified in Figure 6.10.1.3 with requirements as specified in 6.10.1.3.1 through 6.10.1.3.10.

6.10.1.3.1 Power+.

6.10.1.3.1.1 Pin B shall be Power+, a DC voltage capable of providing power for a connected RSM or compatible device.

6.10.1.3.1.2 Power+ shall meet the requirements in Table 6.10.2.

6.10.1.3.2 GND. Pin C shall be GND, also known as system ground, the Power+ current return path and the logic voltage signal reference.

6.10.1.3.3 D+.

6.10.1.3.3.1 Pin D shall be reserved for D+, one of the digital signal lines required for USB over which relevant commands are exchanged between RF device and RSM or other compatible device.

6.10.1.3.3.2 D+ shall meet the requirements specified in the Universal Serial Bus Specification Revision 2.0.

6.10.1.3.4 D-.

6.10.1.3.4.1 Pin E shall be D-, the digital signal line complementing D+ for USB.

6.10.1.3.4.2 D- shall meet the requirements specified in the Universal Serial Bus Specification Revision 2.0.

6.10.1.3.5 Speaker+.

6.10.1.3.5.1 Pin F shall be Speaker+, an RF device analog output capable of directly driving a loud speaker element.

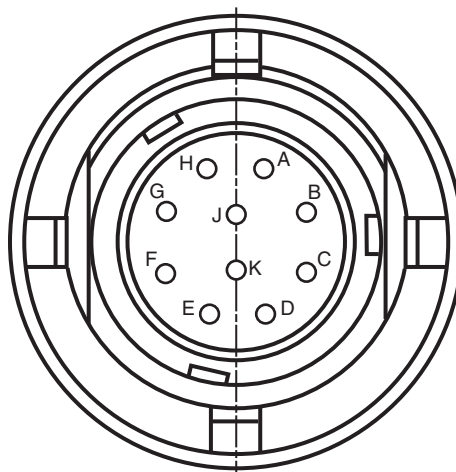


FIGURE 6.10.1.3 RFDC Pin Assignments.

6.10.1.3.5.2 Speaker+ shall meet the requirements in Table 6.10.2.

6.10.1.3.6 Speaker–.

6.10.1.3.6.1 Pin G shall be Speaker–, an RF device analog output complementary to Speaker+.

6.10.1.3.6.2 Speaker– shall meet the requirements in Table 6.10.2.

6.10.1.3.7 PTT.

6.10.1.3.7.1 Pin J shall be PTT, the logical state of an RSM or compatible device's PTT.

6.10.1.3.7.2 Logic LOW (0) shall indicate PTT is activated (i.e., pressed).

6.10.1.3.7.3 Logic HIGH (1) shall indicate the PTT is deactivated (i.e., released).

6.10.1.3.7.4 PTT shall meet the requirements in Table 6.10.2.

6.10.1.3.8 Emergency.

6.10.1.3.8.1 Pin K shall be Emergency, the logical state of an RSM or compatible device's EAB.

6.10.1.3.8.2 Logic LOW (0) shall indicate EAB is activated (i.e., pressed).

6.10.1.3.8.3 Logic HIGH (1) shall indicate the EAB is deactivated (i.e., released).

6.10.1.3.8.4 EAB shall meet the requirements in Table 6.10.2.

6.10.1.3.9 MIC+.

6.10.1.3.9.1 Pin A shall be Mic+, which shall be both a microphone element DC bias as well as the analog small signal output from the same microphone element.

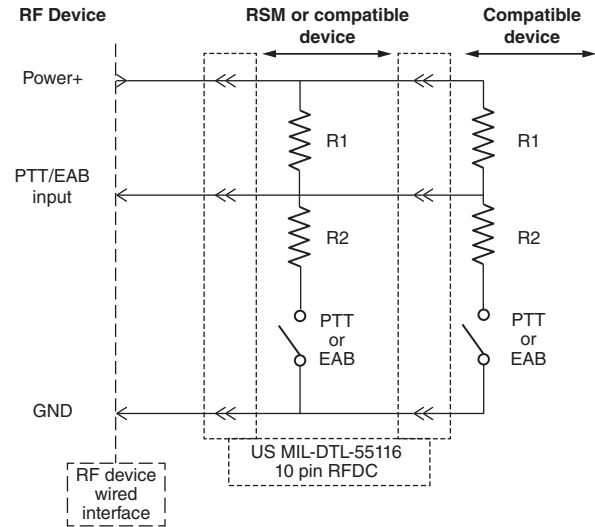
6.10.1.3.9.2 Microphone element DC bias as well as the microphone small signal shall meet the requirements in Table 6.10.2.

6.10.1.3.10 MIC–. Pin H shall be Mic–, the analog ground return for Mic+.

6.10.2 Where the RF device, RSM, or compatible device is equipped with the wired connection as specified in Section 6.10, it shall meet the requirements as specified in Table 6.10.2.

6.10.3 The PTT and EAB circuit topology shall be as specified in Figure 6.10.3.

6.10.4 The RFDC shall be capable of being manipulated into its mate by a gloved hand as specified in 6.1.6.



NOTE: Figure depicts the same circuit for the EAB and the PTT. The EAB (pin K) and PTT input (pin J) on the RF device are separate inputs.

FIGURE 6.10.3 PTT and EAB Circuit Topology.

Table 6.10.2 Minimum Interface Electrical Requirements

Signal Name	RF Device		RSM or Compatible Device		Compatible Device		Conditions
	INPUT	OUTPUT	INPUT	OUTPUT	INPUT	OUTPUT	
POWER+(pin B)/GND(pin C)							
Supply voltage		5.25 vdc – 4.75 vdc		5.25 vdc – 4.75 vdc			Measured at respective output, reference to GND
Supply current		500 mA minimum		100 mA minimum			
Speaker+(pin F)/Speaker – (pin G)							
Speaker drive power		1.5 W minimum					Measured at respective input, BTL configuration
Speaker impedance			8 ohms minimum		8 ohms minimum		
Peak-to-peak voltage		20 v _{p-maximum}					
Mic+(pin A)/Mic– (pin H)							
Microphone signal				6.4 mV _{rms} – 10 mV _{rms}		6.4 mV _{rms} – 10 mV _{rms}	Microphone input stimulus 94 dB SPL
Microphone bias voltage		9.0 vdc – 4.5 vdc					Open circuit
		6.0 vdc – 2.3 vdc					1 mA Mic+ /Mic– load
PTT(pin J), Emergency Activation Button (pin K)							
R1				400 kΩ ± 5%		400 kΩ ± 5%	Reference Figure 6.10.3
R2				100 kΩ ± 5%		100 kΩ ± 5%	

6.11 Failure Detection of Connected RSMs.

6.11.1 The RF device shall detect a failure of a wired RSM or total loss of connection within 500 ms of the failure in hazard zone mode.

6.11.2 The RF device shall detect a failure of Bluetooth® devices or total loss of connection within 5 seconds of the failure in hazard zone mode.

6.11.3 When a failure as specified in 6.11.1 or 6.11.2 occurs, at a minimum, the RF device shall perform the following actions:

- (1) All functions of the RF device shall be enabled, including those functions that had been disabled by connection to the RSM.
- (2) An audible alert message, “Failed Accessory,” shall be broadcast at maximum volume.
- (3) A visual alert message, “FAIL ACC” shall appear on the RF device display.
- (4) A change to the backlight as specified in 6.15.1 shall occur.

6.11.4 Audible and visual alert messages specified in 6.11.3 shall be canceled when the user completes any one of the following actions:

- (1) Reinitiating a pairing with or reconnecting to a wireless accessory
- (2) Power cycling the RF device
- (3) Connecting a new or repaired wired accessory

6.12 Voice Announcement.

6.12.1 Language.

6.12.1.1 The RF device shall be equipped with a voice announcement in English.

6.12.1.2 Voice announcements in additional languages shall be permitted.

6.12.2 The voice announcement shall be active by default.

6.12.2.1 Voice announcement shall commence within 500 ms of powering on or switching channels, talkgroups, or talk paths, unless superseded by higher priority voice announcements.

6.12.2.2 Receive Audio.

6.12.2.2.1 Receive audio shall have priority over any voice announcements.

6.12.2.2.2 Receive audio shall override such announcements if they both occur simultaneously.

6.12.2.2.3 Any overridden voice annunciation shall follow within 5 seconds of detecting the last PTT or received audio.

6.12.3 Order of Announcement.

6.12.3.1 In the event of simultaneous events, announcements shall be made according to the following list of precedence:

- (1) Zone
- (2) Channels, talkgroups, or talk paths
- (3) Emergency, as specified in Section 6.8
- (4) Failure of an RSM as specified in Section 6.11
- (5) Out of range, if applicable in accordance with Section 6.13
- (6) Self-diagnostic failure as described in Section 6.17
- (7) Power off

6.12.3.2 Prerecorded voice files, user-created or voice synthesis files, or any combination thereof, shall be permitted to be used for any voice announcement, as determined by the AHJ.

6.12.4 Channel, talkgroup, or talk path name announcements shall be required.

6.12.5 Voice Announcement Sound Levels.

6.12.5.1 Channel, talkgroup, talk path voice announcements, and other preprogrammed voice announcements in the hazard zone mode and when transitioning from the hazard zone mode to the nonhazard zone mode shall be at a minimum of 82 dBA measured at 1 m, + 0.1/–0 m, perpendicularly to the RF device speaker output with the sound level meter set to A-weighting with a fast response time (LAF).

6.12.5.1.1 The max-hold function (if available) shall be permitted to be used to hold the maximum value observed by the meter for the specified period of time.

6.13* Out-of-Range Detection. Where the RF device operates on a system that has an out-of-range capability, the RF device shall detect if it is out-of-range within 1.0 minute.

6.14* Audible and Visible Event Indications.

6.14.1 Out-of-Range Indication.

6.14.1.1 The RF device shall detect if it is in-range and connected to a system, or out-of-range and loss of connection to a system; where applicable to the system type.

6.14.1.2 The RF device shall, within one (1) minute of detecting out-of-range and loss of connection to a system, display the following indications:

- (1) All displays shall be backlit-flashing red when the RF device is out of range.
- (2) The RF device shall emit an audible tone every 15 seconds $\pm$ 1 second, and the tone shall last 1 second, +0.5/–0 second, at 70 percent of factory set max volume level.

6.14.1.3 The AHJ shall have the ability to program the out of range volume level to no less than 50 percent of factory set max volume.

6.14.1.4 The AHJ shall have the ability to program a hold off time of 0 to 120 seconds to eliminate nuisance warnings.

6.14.1.5 The RF device shall return to normal display, and the sound shall cease when it detects it is no longer out of range and has reestablished connection to the system.

6.15 Visible Event Indications. See A.6.14.

6.15.1 LEDs.

6.15.1.1 All LEDs and display backlights on the RF device and RSM shall illuminate as indicated during the following event conditions:

- (1) Emergency: indicated by flashing orange when an emergency alarm signal is initiated; indicated by flashing red when an emergency alarm signal is received
- (2) Connected RSM failure: indicated by solid orange within 500 ms of detecting a failure as specified in 6.11.1
- (3) Over-temperature: indicated by solid orange immediately upon detecting an internal over-temperature event as specified in Section 6.16

- (4) Out-of-range: indicated by flashing yellow within one (1) minute of detecting out-of-range as specified in Section 6.14
- (5) Transmit and receive LED: receive, indicated by solid green; transmit, indicated by solid red

6.15.1.2 LEDs shall have the following operational states:

- (1) ON: LED is continuously illuminated
- (2) OFF: LED is not illuminated
- (3) FLASHING: LED provides a continuous sequence of On/Off illumination states at a 1 Hz frequency and 50 percent duty cycle.

6.15.1.3 Bluetooth.

6.15.1.3.1 Continuous blue shall indicate the Bluetooth link is paired and active.

6.15.2 When simultaneous events occur the indications priority shall be in order as listed in 6.15.1.

6.16 Internal Over-Temperature Event Indications.

6.16.1* The RF device shall detect an internal over-temperature event.

6.16.1.1 An RSM or compatible device shall be permitted to detect an internal over-temperature event.

6.16.1.2 The over-temperature limit shall be designated by the RF device or compatible device manufacturer.

6.16.2 An over-temperature event shall occur any time internal temperature exceeds the manufacturer's designated temperature for 30 seconds $\pm$ 5 seconds.

6.16.3 Detection and Reporting.

6.16.3.1 The RF device shall detect an over-temperature event in both the RF device itself and any RSM that is so equipped to detect an internal over-temperature event.

6.16.3.2 An RSM shall be permitted to report an internal over-temperature event with the internal temperature data command as specified in Table 6.21.1(a) and Table 6.21.1(b).

6.16.4 The over-temperature event shall be displayed as "OVER TMP" on the RF device's primary display as specified in 6.6.1.

6.16.5 The over-temperature event shall be audibly announced "Over Temp" at maximum volume.

6.16.5.1 The over-temperature announcement shall be repeated every 5 minutes $\pm$ 15 seconds, regardless of the number of recorded over-temperature events, until reset by the AHJ service shop.

6.16.6 The over-temperature condition shall be recorded in the RF device's memory.

6.16.6.1 The start time of the over-temperature event shall be recorded when the event starts.

6.16.6.2 The end time and maximum temperature of the over-temperature event shall be recorded when the event ends.

6.16.6.3* Each over-temperature record shall indicate if it occurred in the RF device or a connected capable RSM.

6.16.7 Exposure.

6.16.7.1 If the RF device has been exposed to more than 10 minutes $\pm$ 30 seconds of cumulative over-temperature conditions, an audible announcement shall be made that states, "RF DEVICE HAS HAD LONG EXPOSURE TO EXTREME TEMPERATURES."

6.16.7.2 If the capable RSM has been exposed to more than 10 minutes $\pm$ 30 seconds of cumulative over-temperature conditions, an audible announcement shall be made that states, "THE OPTIONAL COMPONENT HAS HAD LONG EXPOSURE TO EXTREME TEMPERATURES."

6.17 Device Self-Checks.

6.17.1 The RF device shall perform mandatory self-checks to verify operation when the unit is initially powered up, periodic self-checks while it remains powered up, and periodic self-diagnostics every 5 minutes, at a minimum.

6.17.1.1 The RF device shall display a visual indication when it has failed the self-check.

6.17.1.2 The display shall be backlit red when the RF device does not pass the self-check.

6.17.1.3 The RF device shall have a voice annunciation of radio failure if the self-diagnostic tests fail.

6.17.2 The following functions shall be tested in self-check:

- (1)* RSM connectivity to the RF device
- (2) Loss of antenna connection to the RF device
- (3) Temperature exposure over manufacturer recommended overheat temperature
- (4) Battery with at least 50 percent of the total capacity available (power-up only)

6.17.3 Upon connecting an RSM to an RF device that is turned on, the RSM check shall take place automatically and thereafter on the periodic self-checks.

6.18 Database Requirements.

6.18.1 The RF device shall contain a database to store information related to operations.

6.18.2 The database shall reside in nonvolatile, nonremovable memory.

6.18.3 ID Storage.

6.18.3.1 The database shall be capable of storing user ID information.

6.18.3.2 The database shall be capable of storing a minimum of 3000 user ID entries.

6.18.3.3 The user ID entry shall include the signaling-specific logical ID as well as an alias, if available, of at least 14 alphanumeric characters.

6.18.4 The RF device shall be capable of storing a list of user ID entries containing a minimum of the last 20 emergency activations, as specified in 6.8.9.3.

6.18.5 The RF device shall be capable of storing data logs as specified in Section 6.19.

6.19 Data Logging.

6.19.1 Memory.

6.19.1.1 RF devices shall incorporate data logging in nonvolatile memory.

6.19.1.2 At a minimum, each of the following events shall be identified, recorded, and date and time stamped in coordinated universal time in the data log:

- (1) RF device is turned on.
- (2) Emergency button is activated.
- (3) User input, button press, or switch is activated.
- (4) Power source levels are at initial power on and then at 75 percent, 50 percent, 25 percent, 10 percent, and 5 percent capacity.
- (5) RF device is turned off.
- (6) Channel, talkgroup, talk path, zone, mode, deck, bank, or mission plan is selected.
- (7) Internal electronics temperature exceeded the limit specified by the manufacturer.

6.19.2 The data logging information shall be downloadable by the emergency services organization.

6.19.3 The data logging shall have a minimum capacity of logging the 2000 most recent events.

6.20 RF Wireless Interface (RFWI).

6.20.1 The RF device shall be capable of operating with a wireless RSM using classic Bluetooth® audio.

6.20.1.1 The RF device shall support the Bluetooth® headset profile (HSP).

6.20.1.2 The RF device shall exchange speaker and microphone audio with a wireless RSM via HSP.

6.20.1.3 The RF device shall be capable of supporting the Bluetooth serial port profile (SPP).

6.20.1.4 The RF device shall exchange the data command and data response sets specified in Table 6.21.1(a) and Table 6.21.1(b) and Table 6.21.2(a) and Table 6.21.2(b) with a wireless RSM via SPP.

6.20.1.5 The RF device shall be capable of Bluetooth secure simple pairing using “Just Works” mode.

6.20.1.6 The RF device shall be Bluetooth certified.

6.20.2 The RF device shall meet the connectivity requirements specified in 6.20.2.1 through 6.20.2.5.

6.20.2.1 The RF device shall remain paired to the last RSM or compatible device.

6.20.2.2 Upon power up, the RF device shall attempt to reconnect to the last paired RSM or compatible device.

6.20.2.3 The RF device shall have a minimum effective range of 1 m (3.3 ft).

6.20.2.4 The RF device shall operate in the presence of six Bluetooth audio devices within a 5 m (16.4 ft) spherical radius.

6.20.2.5 The RF device shall attempt to restore a lost Bluetooth connection.

6.20.3 A wireless RSM or compatible device shall be capable of the requirements specified in 6.20.3.1 through 6.20.3.8.

6.20.3.1 A wireless RSM or compatible device shall be Bluetooth certified.

6.20.3.2 A wireless RSM or compatible device shall support the HSP.

6.20.3.3 A wireless RSM or compatible device shall support the SPP.

6.20.3.4 A wireless RSM or compatible device shall be permitted to support the functionality specified in Section 6.10.

6.20.3.5 Button, LED, and control functionality specified in Section 6.9 shall be supported with the data commands and responses specified in Table 6.21.1(a) and Table 6.21.1(b) and Table 6.21.2(a) and Table 6.21.2(b) over SPP.

6.20.3.6 Failure Detection.

6.20.3.6.1 If capable, upon detecting failure of any minimum operational requirements outlined in Section 6.9, a wireless compatible device shall intentionally end the wireless link to an RF device without notice.

6.20.3.6.2 Such action shall generate the RF device failure response of Section 6.11.

6.20.3.7 A wireless RSM or compatible device shall be permitted to report an internal over-temperature event with the data command specified in Table 6.21.1(a) and Table 6.21.1(b) over SPP.

6.20.3.8 A wireless RSM or compatible device shall be permitted to indicate to the RF device an intentional power-off procedure has been activated with the closing connection data command specified in Table 6.21.1(a) and Table 6.21.1(b) over SPP.

6.20.4 An RF device shall be permitted to connect with more than one Bluetooth RSM or compatible device at a time.

6.20.5 A wireless RSM or compatible device shall be permitted to stand alone or be integrated into other equipment.

6.21 Data Commands.

6.21.1 The RF device shall support the data command set specified in Table 6.21.1(a) and Table 6.21.1(b).

6.21.2 A wired or wireless RSM shall be permitted to support the data command set specified in Table 6.21.2(a) and Table 6.21.2(b).

6.22* Hazardous Location Requirements.

6.22.1 General. The RF device and RSMs shall meet the requirements of this standard either for nonincendive equipment or for intrinsically safe systems.

6.22.2 Nonincendive Equipment. The RF device and RSM shall at a minimum be suitable for use in Class I, Division 2, Groups A, B, C, and D; Class II, Division 2, Groups F and G; and Class III, Divisions 1 and 2 hazardous (classified) locations, and with a temperature class of T3 through T6 inclusive, as demonstrated by being certified as nonincendive equipment in accordance with UL 121201, *Non-Incendive Electric Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*.

Table 6.21.1(a) Data Response Set Requirements

Command	Format	ACK Required	Notes
PTT - Press	+PTT=P	No	PTT button pressed RSM -> RF device
+PTT=P received	+PTT=P<cr><lf>OK	No	+PTT=P received RF device -> RSM
PTT - Release	+PTT=R	No	PTT button released RSM -> RF device
+PTT=R received	+PTT=R<cr><lf>OK	No	+PTT=R received RF device -> RSM
EAB - Press	+EMER=P	No	EAB pressed RSM -> RF device
+EMER=P received	+EMER=P<cr><lf>OK	No	+EMER=P received RF device -> RSM
EAB - Release	+EMER=R	No	EAB released RSM -> RF device
+EMER=R received	+EMER=R<cr><lf>OK	No	+EMER=R received RF device -> RSM
Radio Volume	+VGM=#0-15 +VGS=#0-15	Yes	
Closing Connection	+ CLOSE	Yes	Wireless RSM intentionally closing connection – not an error or lost link
LED Control*	+LED:0xid:0xstate:0xRRGGBB	Yes	ID: 8 bit representation of LED. State: 8 bit representation of LED behavior. Color: 24 bit RGB representation of color.
Programmable Button - Press	+BTN1=P	No	Programmable button pressed RSM -> RF device
+BTN1=P received	+BTN1=P<cr><lf>OK	No	+BTN1=P received RF device -> RSM
Programmable Button - Release	+BTN1=R	No	Programmable button released RSM -> RF device
+BTN1=R received	+BTN1=R<cr><lf>OK	No	+BTN1=R received RF device -> RSM
Internal Temperature	+TEMP=[NNN]	Yes	Temperature in degrees Fahrenheit

Table 6.21.1(b) Data Response Set Requirements—ACK and NACK Commands

Command	Format	Notes
ACK	<cr><lf>OK<cr><lf>	Command received successfully
NACK	<cr><lf>ERROR<cr><lf>	Error with command

Table 6.21.2(a) LED Command ID Value Table

ID	Indicator Type	Comments
0	Emergency	
1	Compatible device failure	
2	Over temperature	
3	Out of range	
4	TX/RX	
5	Bluetooth pairing	
6 and greater	Reserved	

Table 6.21.2(b) LED Command State Value Table

State	LED Behavior	Comments
0	OFF	
1	Steady ON	
2	Flashing	
3 and greater	Reserved	

6.22.2.1 Interconnection.

6.22.2.1.1 Interconnection of this nonincendive equipment (i.e., RF devices and RSMs) shall be by means of a plug and jack that complies with the requirements as specified in Section 6.10.

6.22.2.1.2 The electrical parameters for this interconnection shall be in accordance with Table 6.22.2.1.2.

6.22.3 Intrinsically Safe Systems.

6.22.3.1 The RF devices and RSMs shall be permitted to be certified for use in Class I, Division 1, Groups C and D; Class II, Division 1, Groups E, F, and G; and Class III, Divisions 1 and 2 hazardous (classified) locations, and with a temperature class of T3 through T6 inclusive, as demonstrated by being certified as an intrinsically safe system in accordance with ANSI/TIA-4950-A, *Requirements for Battery-Powered, Portable Land Mobile Radio Applications in Class I, II, and III, Division 1, Hazardous (Classified) Locations*, or UL 913, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations*.

6.22.3.2 RF devices that are certified as an intrinsically safe system in accordance with ANSI/TIA-4950-A, *Requirements for Battery-Powered, Portable Land Mobile Radio Applications in Class I, II, and III, Division 1, Hazardous (Classified) Locations*, or UL 913, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations*, shall only be used with the RSM evaluated as part of the system.

Table 6.22.2.1.2 Electrical Parameters for Nonincendive Equipment

	RF device or RSMs (female connection)	Requirement	RSMs (male connection)	
RF device or RSMs as source (female connection)	$U_o = 8\text{ V}$	$U_o \leq U_i$	$U_i = 10\text{ V max}$	RSMs as sink (male connection)
	$I_o = 500\text{ mA}$	$I_o \leq I_i$	$I_i = 1\text{ A max}$	
	$C_o = 69\text{ }\mu\text{F}$	$C_o \geq C_i + C_{\text{cable}}^*$	$C_i = 68\text{ }\mu\text{F max}$	
	$L_o = 320\text{ }\mu\text{H}$	$L_o \geq L_i + L_{\text{cable}}^*$	$L_i = 315\text{ }\mu\text{H max}$	
	RSMs (male connection)	Requirement	RF device or RSMs (female connection)	
RSMs as source (male connection)	$U_o = 8\text{ V}$	$U_o \leq U_i$	$U_i = 10\text{ V max}$	RF device or RSMs as sink (female connection)
	$I_o = 500\text{ mA}$	$I_o \leq I_i$	$I_i = 1\text{ A max}$	
	$C_o = 1\text{ }\mu\text{F}$	$C_o \geq C_i + C_{\text{cable}}^*$	$C_i = 0.5\text{ }\mu\text{F max}$	
	$L_o = 320\text{ }\mu\text{H}$	$L_o \geq L_i + L_{\text{cable}}^*$	$L_i = 315\text{ }\mu\text{H max}$	

Note: RF devices and RSMs, certified as nonincendive equipment in accordance with the requirements of this standard, allow for the interchangeability of any such RSM with any such RF device.

*Assumption for cable capacitance and inductance: 200 pF/m and 1 $\mu\text{H}/\text{m}$.

Chapter 7 Performance Requirements

7.1 RF Device and RSM Requirements.

7.1.1 The RF device shall be tested for speech quality in the analog mode as specified in Section 8.2.

7.1.1.1 If equipped with digital mode, the RF device shall be tested in the analog mode in addition to any digital modes as specified in Section 8.2.

7.1.1.2* The RF device or RSM shall have a minimum speech quality result of 2.5.

7.1.2 Display Surface.

7.1.2.1 RF device and RSM display surfaces shall be tested for abrasion resistance as specified in Section 8.7.

7.1.2.2 RF device and RSM display surfaces shall not exhibit an average delta haze greater than 14 percent.

7.1.3 Vibration Resistance.

7.1.3.1 The RF device and RSM shall be tested for resistance to vibration as specified in Section 8.4.

7.1.3.2 The RF device and RSM shall have a minimum speech quality result of 2.5.

7.1.3.3 The RF device shall be evaluated for functioning of data logging as specified in Section 6.19.

7.1.4 Heat and Immersion Leakage.

7.1.4.1 The RF device and RSM shall be tested for heat and immersion leakage resistance as specified in Section 8.3.

7.1.4.2 The RF device and RSM shall have no water leakage inside the electronics compartment(s) and the power source compartment(s).

7.1.4.3 The RF device and RSM shall have a speech quality result of 2.5.

7.1.4.4 Portable, hand-held communication RF devices and RSMs shall be evaluated per 8.3.5 and 8.3.6.

7.1.4.5 The RF device shall be evaluated for proper functioning of data logging as specified in Section 6.19.

7.1.5 Heat Resistance.

7.1.5.1 The RF devices and RSMs shall be tested for resistance to heat as specified in Section 8.8.

7.1.5.2 The RF devices and RSMs shall not melt, drip, or ignite.

7.1.5.3 The RF devices and RSMs shall have a minimum speech quality result of 2.5.

7.1.5.4 The RF devices shall be evaluated for functionality of data logging as specified in Section 6.19.

7.1.6 Ingress Protection.

7.1.6.1 The RF devices and RSMs shall be tested for ingress protection (IP) rating as specified in IEC 60529, *Degrees of protection provided by enclosures (IP Code)*.

7.1.6.2 The RF devices and RSMs shall have a rating of IP6X.

7.1.7 Impact Resistance.

7.1.7.1 The RF devices and RSMs shall be tested for resistance to impact as specified in Section 8.5.

7.1.7.2 The RF devices and RSMs shall have a minimum speech quality result of 2.5.

7.1.7.3 The RF device shall be evaluated for functionality of data logging as specified in Section 6.19.

7.1.8 Corrosion Resistance.

7.1.8.1 The RF devices and RSMs shall be tested for resistance to corrosion as specified in Section 8.6.

7.1.8.2 The RF devices and RSMs shall have a minimum speech quality result of 2.5.

7.1.9 Integrity.

7.1.9.1 The RF devices and RSMs shall be tested for integrity as specified in Section 8.12.

7.1.9.2 The RF devices and RSMs shall have no case, housing, or closure damage.

7.1.9.3 The RF devices and RSMs shall have a minimum speech quality result of 2.5.

7.1.9.4 The RF device shall be evaluated for functionality of data logging as specified in Section 6.19.

7.1.10 Cable Pullout.

7.1.10.1 The RF devices and RSMs shall be tested for cable pullout as specified in Section 8.11.

7.1.10.2 The RF devices and RSMs shall have a minimum value of 156 N +9/-0 N (35 lbf +2/-0 lbf) in the direction of the wiring.

7.1.10.3 Separation of interconnecting wiring of any specimen shall constitute failing performance.

7.1.11 Heat and Flame Resistance.

7.1.11.1 The RF devices and RSMs shall be tested for resistance to heat and flame as specified in Section 8.9.

7.1.11.2 The RF devices and RSMs shall not have the after-flame exceed 2.2 seconds.

7.1.11.3 The RF devices and RSMs shall have nothing fall off.

7.1.11.4 The RF devices and RSMs shall not fall from their mounted position.

7.1.11.5 The RF devices and RSMs shall function as follows:

- (1) The RF devices and RSMs shall be activated using the power/volume knob as specified in Section 6.4.
- (2) The selector knob shall function as specified in Section 6.5.
- (3) The emergency button shall function as specified in Section 6.9.
- (4) The display shall function as specified in Section 6.6.
- (5) The remote mic audio connection shall function as specified in Section 6.10.

7.1.11.6 The RF device shall be evaluated for proper functioning of data logging as specified in Section 6.19.

7.1.12 Durability and Legibility.

7.1.12.1 The RF device and RSMs shall be tested for durability and legibility as specified in Section 8.10.

7.1.12.2 Product labels shall remain attached to the RF devices and RSMs.

7.1.12.3 Product labels shall be able to be read by the untrained eye for the following exposures:

- (1) Corrosion
- (2) Heat resistance
- (3) Durability

7.1.13 Water Drainage.

7.1.13.1 RF devices and RSMs shall be tested for water drainage as specified in Section 8.13.

7.1.13.2 The RF device shall be evaluated for functionality of data logging as specified in Section 6.19.

7.1.14 Control Functions. After pairing or connecting the RF device to RSMs, each shall be evaluated and function as follows:

- (1) The RF device and RSMs shall be activated using the power/volume knob as specified in Section 6.4.
- (2) The selector knob shall function as specified in Section 6.5.
- (3) The emergency button shall function as specified in Section 6.9.
- (4) The display shall function as specified in Section 6.6.
- (5) The remote speaker microphone shall function as specified in Section 6.10.

7.1.15 Electronic Temperature Stress.

7.1.15.1 RF devices and RSMs shall be tested for resistance to electronic temperature stress as specified in Section 8.19.

7.1.15.2 The RF device shall receive and display the user ID of another RF device in the analog mode.

7.1.15.3 The RF device shall transmit its user ID to another RF device in the analog mode.

7.1.16 Tumble-Vibration Resistance.

7.1.16.1 RF devices and RSMs shall be tested for resistance to vibration as specified in Section 8.14.

7.1.16.2 The RF device and RSM shall have a minimum speech quality result of 2.5.

7.1.16.3 The RF device shall be evaluated for functioning of data logging as specified in Section 6.19.

7.2 RF Device Requirements.

7.2.1 The RF device shall be tested for continuous operation as specified in Section 8.18.

7.2.1.1 The RF device shall be capable of continuous operation for at least 8 hours on a standard-duty cycle of 10-10-80 at the RF device's maximum allowable transmit power for the band of operation.

7.2.1.2 Testing.

7.2.1.2.1 The RF device shall be tested according to Section 8.15 and meet the requirements for carrier output power 2.2.1 (analog) as specified in TIA-603-E, *Land Mobile FM*

or PM — Communications Equipment — Measurement and Performance Standards, and RF power output 3.2.1 (digital) as specified in TIA-102.CAAB-E, *Land Mobile Radio Transceiver Performance Recommendations, Digital Radio Technology, C4FM/CQPSK Modulation*.

7.2.1.2.2 Transmit power shall not decrease by more than 1 dB for the first 8 hours.

7.2.1.3 The RF device shall be tested according to Section 8.16 and meet the requirements for carrier frequency stability 2.2.2 (analog) as specified in TIA-603-E, *Land Mobile FM or PM — Communications Equipment — Measurement and Performance Standards*, and operating frequency accuracy 3.2.2 (digital) as specified in TIA-102.CAAB-E, *Land Mobile Radio Transceiver Performance Recommendations, Digital Radio Technology, C4FM/CQPSK Modulation*.

7.2.1.4 The RF device shall be tested according to Section 8.17 and meet the Class A requirements for reference sensitivity 2.1.4 (analog) as specified in TIA-603-E, *Land Mobile FM or PM — Communications Equipment — Measurement and Performance Standards*, and reference sensitivity 3.1.4 (digital) as specified in TIA-102.CAAB-E, *Land Mobile Radio Transceiver Performance Recommendations, Digital Radio Technology, C4FM/CQPSK Modulation*.

7.3 RF Antenna Requirements.

7.3.1 The RF antenna shall be tested in accordance with Section 8.20.

7.3.2 The RF antenna shall exhibit a voltage standing wave ratio (VSWR) increase of no more than 41 percent across the bandwidth.

Chapter 8 Test Methods**8.1 Sample Preparation.****8.1.1 Application.**

8.1.1.1 The sample preparation procedures contained in 8.1.2 through 8.1.4 shall apply to each test method in this chapter, as specifically referenced in each test method.

8.1.1.2 Only the specific sample preparation procedure(s) referenced in each test method shall be applied to that test method.

8.1.1.3 Samples shall be complete devices.

8.1.1.4 Specimens for testing shall be complete devices.

8.1.1.5 A minimum of three specimens shall be tested.

8.1.1.6 Specimens shall be set as follows:

- (1) Volume shall be set to maximum or as specified by the manufacturer.
- (2)* FM modulation shall be set to analog.
- (3) Channel bandwidth shall be set as follows:
 - (a) VHF/UHF/700 — narrowband (12.5 kHz)
 - (b) 800 band non-NPSPAC channels — 25 kHz
 - (c) 800 band NPSPAC channels — 20 kHz
- (4) Transmit power shall be set to maximum or as specified by the manufacturer.
- (5) Hazard zone mode shall be enabled.

8.1.2 Room Temperature Conditioning Procedure.

8.1.2.1 Specimens shall be conditioned at a temperature of $22^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($72^{\circ}\text{F} \pm 5^{\circ}\text{F}$) and relative humidity (RH) of 50 percent ± 25 percent for at least 4 hours.

8.1.2.2 Testing shall begin within 5 minutes of the specimens being removed from the conditioning.

8.1.3 Cold Temperature Conditioning Procedure.

8.1.3.1 Specimens shall be exposed to a temperature of -20°C , $+0/-3^{\circ}\text{C}$ (-4°F , $+0/-5^{\circ}\text{F}$) for at least 4 hours.

8.1.3.2 Testing shall begin within 30 seconds of the specimens being removed from the conditioning.

8.1.4 Elevated Temperature Conditioning Procedure.

8.1.4.1 Specimens shall be exposed to a temperature of 71°C , $+1/-0^{\circ}\text{C}$ (160°F , $+2/-0^{\circ}\text{F}$) for at least 4 hours.

8.1.4.2 Testing shall begin within 30 seconds of the specimens being removed from the conditioning.

8.2 Speech Quality Test.

8.2.1 Apparatus.

8.2.1.1 Testing Chamber. Testing shall be conducted in a chamber having the following characteristics, at a minimum:

- (1) Construction shall be hemi-anechoic.
- (2) Ambient noise level inside the chamber shall be at least NC-25.
- (3) Walls and ceiling shall be ≥ 90 percent absorptive for equal to or less than 200 Hz.
- (4) Clearance from test specimens shall be ≥ 1 m (≥ 3.3 ft).

8.2.1.2 Acoustic Treatment. All room surfaces above the floor shall be acoustically treated for internal acoustic absorption as well as for external noise mitigation.

8.2.1.3 Simulator. A G.R.A.S. KEMAR head and torso simulator (HATS), type 45BM or equivalent, shall be used for testing.

8.2.1.3.1 Tone.

8.2.1.3.1.1 The mouth simulator shall be capable of producing 1 kHz sine tone at a sound pressure level of 112 dBA as measured at 25 mm (1 in.) with the mouth reference point un-equalized.

8.2.1.3.1.2 The total harmonic distortion (THD) shall be ≤ 3 percent.

8.2.1.3.2 Frequency.

8.2.1.3.2.1 The mouth simulator frequency response shall be able to be equalized flat ± 1 dB between 100 Hz and 10 kHz.

8.2.1.3.2.2 The response shall be -15 dB or less at 100 Hz and -20 dB or less at 15 kHz.

8.2.1.4 Sound Pressure Level (SPL) Meter. The SPL meter having the following characteristics shall be used:

- (1) The SPL meter shall be capable of measuring an equivalent continuous sound pressure level (L_{eq}) using an A-weighted filter.
- (2) The SPL meter shall have a dynamic range from 30 dBA (or less) to 130 dBA (or greater).
- (3) The SPL meter shall display the measurement to at least 0.1 dBA.

8.2.1.5 Pink Noise Generator. A pink noise analog audio signal generator shall be used.

8.2.1.5.1 The pink noise analog audio signal generator shall be capable of generating pink noise and sine waves from -80 dBU to -2 dBU in one-dBU steps, with a THD+N of -90 dB (0.0032 percent) at 8 dBU noise floor type 25 μv .

8.2.1.5.2 The pink noise analog audio signal generator shall have the following characteristics:

- (1) A frequency range of 10 Hz to 20 kHz adjustable in one-digit steps resolution ± 0.01 percent
- (2) An amplitude accuracy of ± 0.5 dB or less

8.2.1.6 Digital Equalizer.

8.2.1.6.1 A digital equalizer shall be used.

8.2.1.6.2 The digital equalizer shall be capable of equalizing the frequency response of the HATS mannequin within ± 1 dB flat between 100 Hz and 10 kHz.

8.2.1.7 Microphone. A microphone having the following characteristics shall be used:

- (1) The microphone shall be a condenser type.
- (2) The microphone polar pattern shall be omnidirectional.
- (3) The frequency response shall be flat ± 0.5 dB from 100 Hz to 15 kHz.
- (4) The residual noise shall be ≤ -30 dB.
- (5) The microphone shall accept signals of at least 130 dBA.

8.2.1.8* Speech Quality Analyzer. The speech quality analyzer shall have the following characteristics:

- (1) Measures perceptual objective listening quality according to ITU-T P.863, *Perceptual Objective Listening Quality Assessment*, in narrowband operation
- (2) Samples 16-bit linear audio input signal at 8 kHz or 16 kHz
- (3) Handles voice files from 6 to 20 seconds in length
- (4) Represents measurement result as the POLQA MOS value

8.2.1.9 Radio Test Set/Service Monitor. An Aeroflex 3920 or equivalent radio test set/service monitor having the following characteristics shall be used:

- (1) The radio test set/service monitor shall be capable of receiving and transmitting analog FM and P25 signals.
- (2) The radio test set/service monitor shall operate over the frequency range of devices under test.
- (3) The radio test set/service monitor shall be P25 phase 1 and phase 2 compatible.

8.2.1.10 Artificial Mouth. The artificial mouth shall be calibrated as follows (*see Figure 8.2.1.10*):

- (1) The pink noise test signal from the HATS shall be equalized flat with pink noise from 100 Hz to 10 kHz to ± 1 dB on a $\frac{1}{3}$ octave scale and adjusted to achieve an A-weighted sound level of 97 dBA ± 0.5 dB at the mouth reference point (MRP), 50 mm ± 3 mm (2 in. $\pm \frac{1}{8}$ in.) from the HATS' mouth.
- (2) The levels for the 125 Hz octave band (the 100 Hz, 125 Hz, 160 Hz $\frac{1}{3}$ octave bands) shall be reduced by 10 dB.
- (3) The levels for the 250 Hz octave band (the 200 Hz, 250 Hz, 315 Hz $\frac{1}{3}$ octave bands) shall be reduced by 2 dB.

- (4) The speech quality test signal “Male1_1st_Set_8k.wav” shall be applied and the SPL adjusted until an average (SPL) (Leq) of 95 dBA ± 0.5 dBA is achieved, over a period of time of 45 seconds ± 15 seconds.

8.2.1.11 Artificial Ear. The artificial ear shall be calibrated as follows (see Figure 8.2.1.11):

- (1) The microphone calibrator shall be applied to the artificial ear and set to the level specified by the manufacturer.
- (2) The audio analyzer shall be calibrated according to the calibration procedure specified by the audio analyzer manufacturer.

8.2.1.12 Speech Quality Measurement Setup.

8.2.1.12.1 The speech quality measurement shall be activated in the audio analyzer.

8.2.1.12.2 Each speech quality measurement shall be recorded for each test signal as follows:

- (1) Four excitation speech signals, two male and two female, shall be selected by the audio analyzer as follows:
 - (a) Male1_1st_Set_8k.wav
 - (b) Male2_1st_Set_8k.wav
 - (c) Female1_1st_Set_8k.wav
 - (d) Female2_1st_Set_8k.wav
- (2) The mode shall be narrowband.
- (3) Automatic gain control shall be disabled.
- (4) The four speech quality readings shall be calculated and reported.

8.2.1.13 RF Device RFDC Transmit Audio Speech Quality Test.

The RF device RFDC transmit audio speech quality test shall be conducted in accordance with the following procedure (see Figure 8.2.1.13):

- (1) The radio test set/service monitor shall have de-emphasis enabled, IF bandwidth of 12.5 kHz, and audio band pass filter of 300 Hz to 3.0 kHz.
- (2) For wired connection, the audio signal from the speech quality test set shall be fed to the transmitting specimen via the RFDC at a level as specified by the manufacturer.
- (3)* The audio signal from the radio test set/service monitor to the speech quality test shall be adjusted to achieve a 0.0 dBu nominal level.
- (4) The RF signal between the RF device test set and the device under test (DUT) shall be directly connected (i.e., wired).

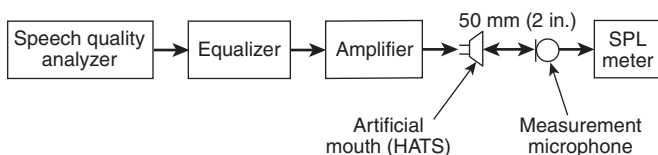


FIGURE 8.2.1.10 Calibration of the Artificial Mouth.

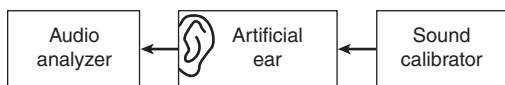


FIGURE 8.2.1.11 Calibration of the Artificial Ear.

- (5) The measurement shall be started and the speech quality reading measured and reported.

8.2.1.14 RF Device Bluetooth® Transmit Audio Speech Quality Test. The RF device Bluetooth® transmit audio speech quality test shall be conducted in accordance with the following procedure (see Figure 8.2.1.14):

- (1) The radio test set/service monitor shall have de-emphasis enabled, IF bandwidth of 12.5 kHz, and audio band pass filter of 300 Hz to 3.0 kHz.
- (2) The audio signal from the speech quality test set shall be fed to the transmitting specimen via Bluetooth® as specified by the manufacturer.
- (3)* The audio signal from the radio test set/service monitor to the speech quality test shall be adjusted to achieve a 0.0 dBu nominal level.
- (4) The RF signal between the RF device test set and the device under test (DUT) shall be directly connected (i.e., wired).
- (5) The measurement shall be started and the speech quality reading measured and reported.

8.2.1.15 RF Device Internal Microphone Transmit Audio Speech Quality Test. The RF device internal microphone transmit audio speech quality test shall be conducted in accordance with the following procedure (see Figure 8.2.1.15):

- (1) The RF device shall be set in accordance with the following procedure:
 - (a) The RF device shall be mounted in front of the artificial mouth via the manufacturer-provided fixture.

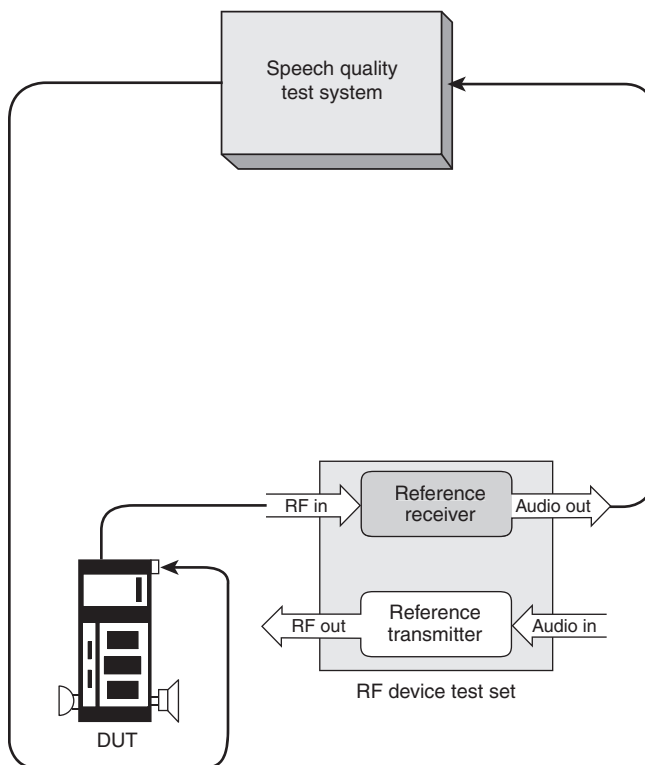


FIGURE 8.2.1.13 Measurement Setup for RF Device RFDC Transmit Audio Speech Quality Test.

- (b) The RF device internal microphone shall be centered to the artificial mouth at a horizontal axis distance of 50 mm $\pm$ 5 mm (2 in. $\pm$ 0.2 in.).
- (2) The radio test set/service monitor shall have de-emphasis enabled, IF bandwidth of 12.5 kHz, and audio band pass filter of 300 Hz to 3.0 kHz.
- (3) The audio signal shall be adjusted from the radio test set/service monitor to the speech quality test set for 0.0 dBu nominal.
- (4) The audio signal from the speech quality test set shall be fed to the transmitting specimen via the calibrated mouth.
- (5) The RF signal between the RF device test set and the DUT shall be directly connected (i.e., wired).
- (6) The measurement shall be started and the speech quality result reading reported.

8.2.1.16 RF Device RFDC Receive Audio Speech Quality Test. The RF device RFDC receive audio speech quality test shall be conducted in accordance with the following procedure (see Figure 8.2.1.16):

- (1) The volume of the RF device shall be set to the maximum rated audio as specified by the manufacturer.
- (2) The audio output shall be scaled and ground referenced for the speech quality test system to achieve the best mean opinion score (MOS).
- (3) The RF device test set/service monitor shall have pre-emphasis enabled and transmit power set initially to a level that provides a power level measured at the device under test (DUT) of -60 dBm $\pm$ 3 dBm.

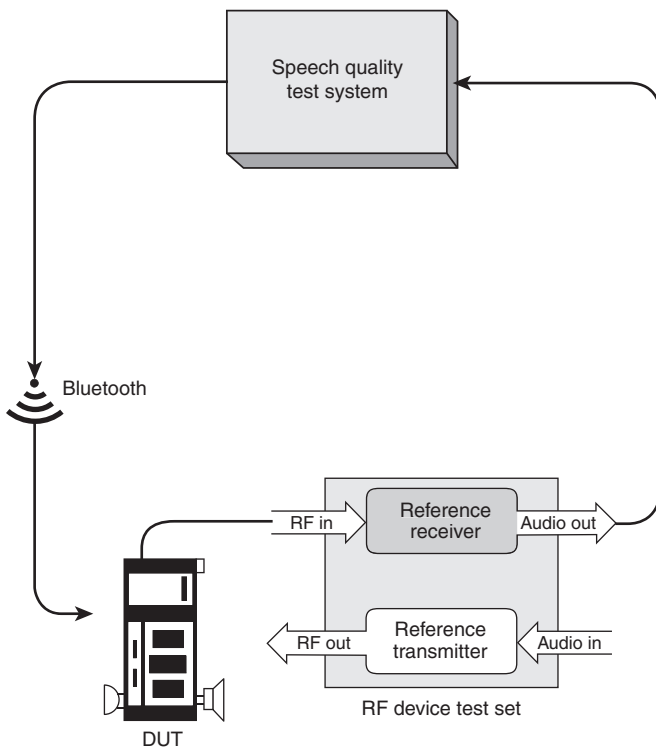


FIGURE 8.2.1.14 Measurement Setup for RF Device Bluetooth® Transmit Audio Speech Quality Test.

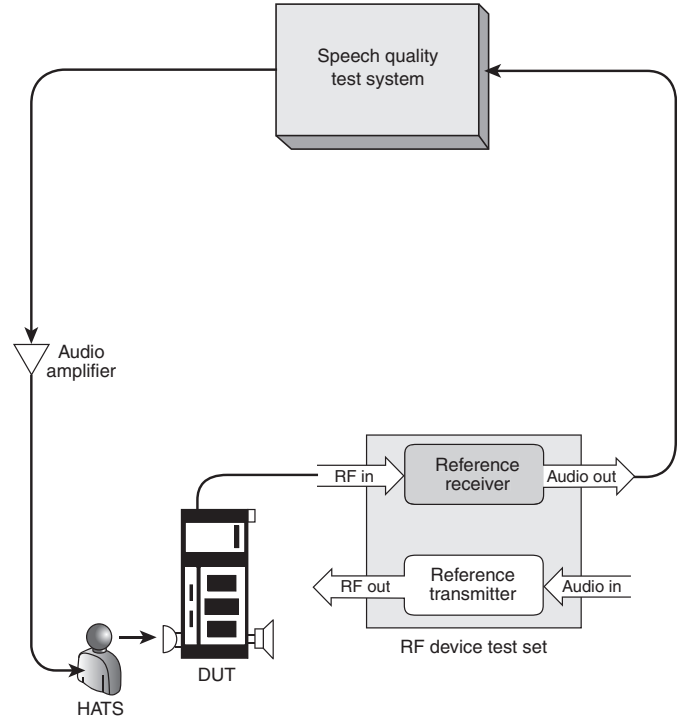


FIGURE 8.2.1.15 Measurement Setup for RF Device Internal Mic Transmit Audio Speech Quality Test.

- (4) The audio levels shall be adjusted from the speech quality test system until the FM peak modulation is between 2.0 kHz and 2.2 kHz from the service monitor using the “Male1_1st_Set_8k.wav” file.
- (5) The RF signal between the RF device test set and the DUT shall be directly connected (i.e., wired).
- (6) The measurement shall be started and the speech quality result measured and reported.

8.2.1.17 RF Device Bluetooth® Receive Audio Speech Quality Test. The RF device Bluetooth® receive audio speech quality test shall be conducted in accordance with the following procedure (see Figure 8.2.1.17):

- (1) The volume of the RF device shall be set to the maximum rated audio as specified by the manufacturer.
- (2) The audio output shall be scaled and ground referenced for the speech quality test system to achieve the best MOS.
- (3) The RF device test set/service monitor shall have pre-emphasis enabled and transmit power set initially to a level that provides a power level measured at the device under test (DUT) of -60 dBm $\pm$ 3 dBm.
- (4) The audio levels shall be adjusted from the speech quality test system until the FM peak modulation is between 2.0 kHz and 2.2 kHz from the service monitor using the “Male1_1st_Set_8k.wav” file.
- (5) The RF signal between the RF device test set and the DUT shall be directly connected (i.e., wired).
- (6) The measurement shall be started and the speech quality result measured and reported.

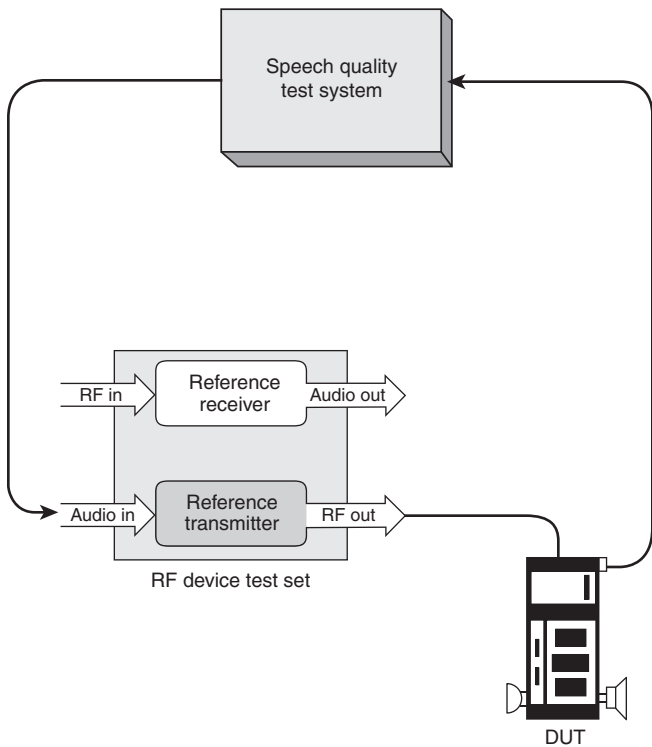


FIGURE 8.2.1.16 Measurement Setup for RF Device RFDC Receive Audio Speech Quality Test.

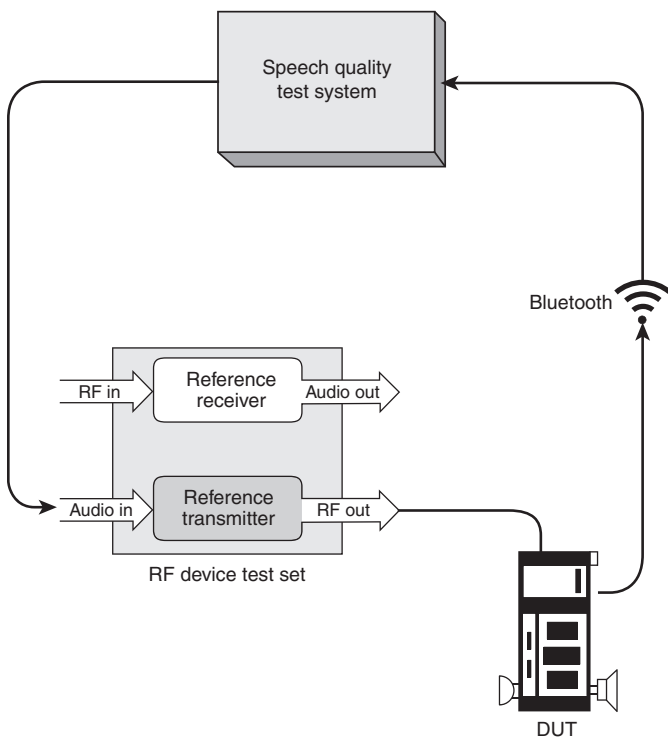


FIGURE 8.2.1.17 Measurement Setup for RF Device Bluetooth® Receive Audio Speech Quality Test.

8.2.1.18 RF Device Speaker Receive Audio Speech Quality Test. The RF device speaker receive audio speech quality test shall be conducted in accordance with the following procedure (see Figure 8.2.1.18):

- (1) The receiving RF device speaker shall be set in accordance with the following procedure:
 - (a) The receiving RF device speaker shall be mounted in front of the artificial ear via the manufacturer-provided fixture.
 - (b) The RF device speaker shall be centered to the artificial ear at a horizontal distance of 50 mm $\pm$ 5 mm (2 in. $\pm$ 0.2 in.).
- (2) The volume of the RF device shall be set to the maximum rated audio as specified by the manufacturer.
- (3) The RF device test set/service monitor shall have pre-emphasis enabled and transmit power initially set to a level that provides a power level measured at the device under test (DUT) of -60 dBm $\pm$ 3 dBm.
- (4) The audio levels shall be adjusted from the speech quality test system until the FM peak modulation is between 2.0 kHz and 2.2 kHz from the radio test set/service monitor using the "Male1_1st_Set_8k.wav" file.
- (5) The input sensitivity of the speech quality analyzer shall be set to the level of the artificial ear calibration to maximize MOS (see 8.2.1.11).
- (6) The RF signal between the RF device test set and the DUT shall be directly connected (i.e., wired).
- (7) The measurement shall be started and the speech quality result reading reported.

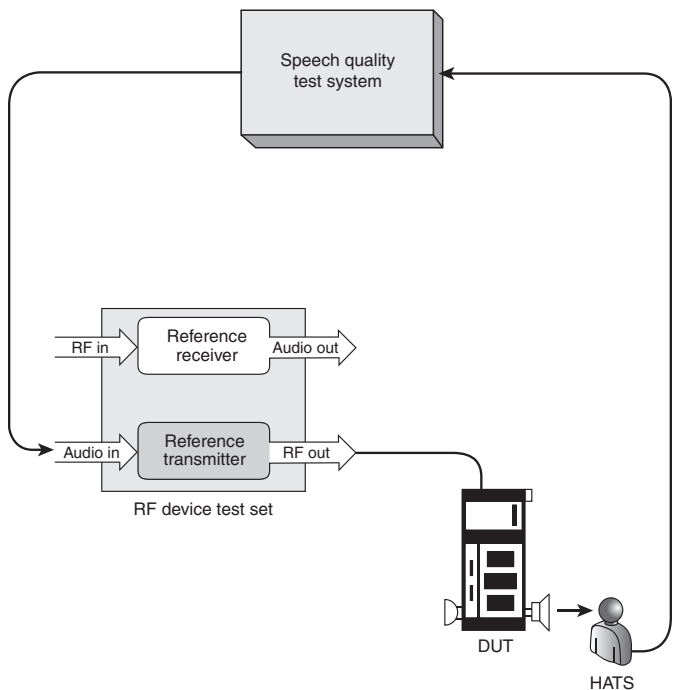


FIGURE 8.2.1.18 Measurement Setup for RF Device Speaker Receive Audio Speech Quality Test.

8.2.1.19 Wired RSM Audio Speech Quality Test. The wired RSM audio speech quality test shall be conducted in accordance with the following procedure (*see Figure 8.2.1.19*):

- (1) The RSM shall be set in accordance with the following procedure:
 - (a) The RSM shall be mounted in front of the artificial mouth via the manufacturer-provided fixture.
 - (b) The wired RSM shall be centered to the artificial mouth at a horizontal axis distance of 50 mm ± 5 mm (2 in. ± 0.2 in.).
- (2) The audio signal from the speech quality test set shall be fed to the RSM specimen via the calibrated mouth.
- (3) The RSM shall be biased as specified by the manufacturer.
- (4) The input level of the speech quality test shall be set to accommodate the audio level from the speaker microphone.
- (5) The measurement shall be started and the speech quality result reading reported.

8.2.1.20 Wireless RSM Audio Speech Quality Test. The wireless RSM audio speech quality test shall be conducted in accordance with the following procedure (*see Figure 8.2.1.20*):

- (1) The RSM shall be set in accordance with the following procedure:
 - (a) The RSM shall be mounted in front of the artificial mouth via the manufacturer-provided fixture.
 - (b) The wireless RSM shall be centered to the artificial mouth at a horizontal axis distance of 50 mm ± 5 mm (2 in. ± 0.2 in.).
- (2) The audio signal from the speech quality test set shall be fed to the RSM specimen via the calibrated mouth.
- (3) The measurement shall be started and the speech quality result reading reported.

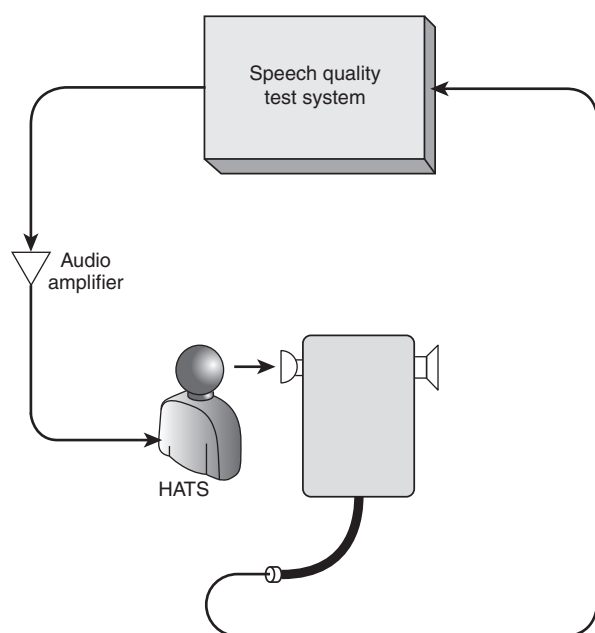


FIGURE 8.2.1.19 Measurement Setup for Wired RSM Audio Speech Quality Test.

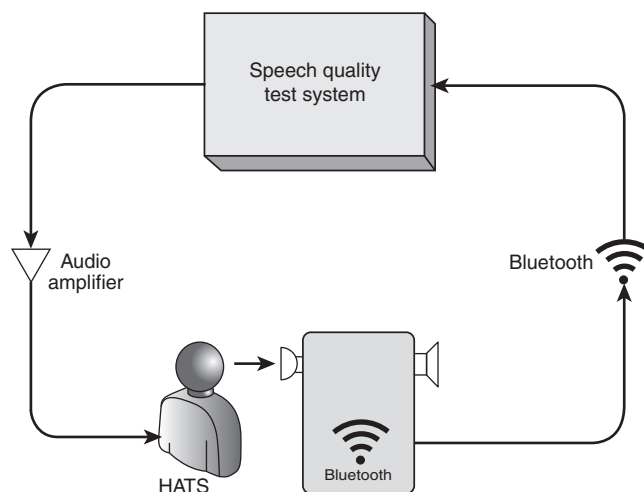


FIGURE 8.2.1.20 Measurement Setup for Wireless RSM Audio Speech Quality Test.

8.2.1.21 Wired RSM Speaker Audio Speech Quality Test. The wired RSM speaker audio speech quality test shall be conducted according to the following procedure (*see Figure 8.2.1.21*):

- (1) The RSM shall be set according to the following procedure:
 - (a) The RSM shall be mounted in front of the artificial ear via the manufacture-provided fixture.
 - (b) The wired RSM speaker shall be centered to the artificial ear at a horizontal distance of 50 mm ± 5 mm (2 in. ± 0.2 in.).
- (2) The output level of the speech quality test shall be set to provide a 2.8 VRMS nominal signal to the speaker microphone.
- (3) The input sensitivity of the speech quality analyzer shall be set to the level of the artificial ear calibration (*see 8.2.1.11*).
- (4) The measurement shall be started and the speech quality result reading reported.

8.2.1.22 Wireless RSM Speaker Audio Speech Quality Test. The wireless RSM speaker audio speech quality test shall be conducted in accordance with the following procedure (*see Figure 8.2.1.22*):

- (1) The RSM shall be set according to the following procedure:
 - (a) The RSM shall be mounted in front of the artificial ear via the manufacturer-provided fixture.
 - (b) The wireless RSM speaker shall be centered to the artificial ear at a horizontal distance of 50 mm ± 5 mm (2 in. ± 0.2 in.).
- (2) The output level of the speech quality test shall be set to provide 80 percent Bluetooth modulation to the speaker microphone.
- (3) The input sensitivity of the speech quality analyzer shall be set to the level of the artificial ear calibration (*see 8.2.1.11*).
- (4) The measurement shall be started and the speech quality result reported.

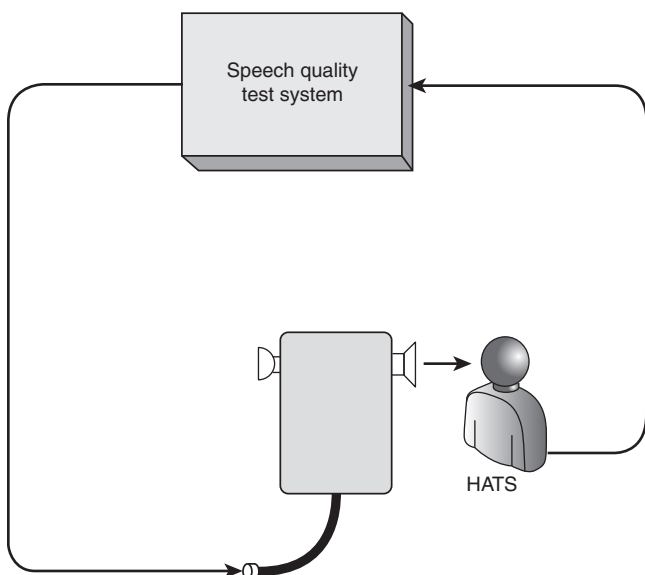


FIGURE 8.2.1.21 Measurement Setup for Wired RSM Speaker Audio Speech Quality Test.

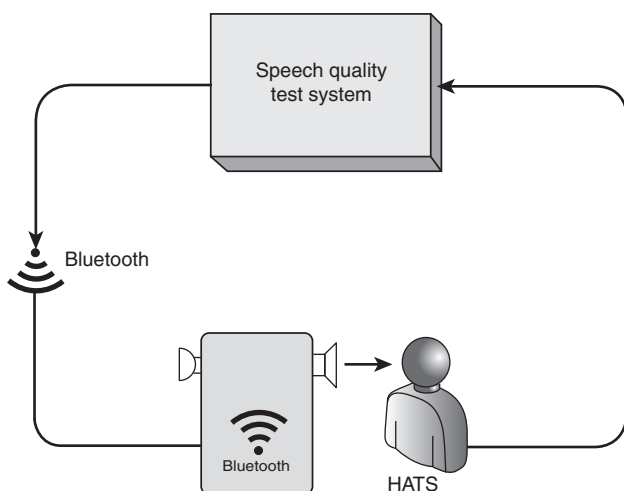


FIGURE 8.2.1.22 Measurement Setup for Wireless RSM Speaker Audio Speech Quality Test.

8.3 Heat and Immersion Leakage Resistance.

8.3.1 Application. This test method shall apply to all devices.

8.3.2 Samples.

8.3.2.1 Samples shall be complete devices.

8.3.2.2 Samples shall be conditioned as specified in 8.1.2.

8.3.3 Specimens.

8.3.3.1 Specimens for testing shall be complete devices.

8.3.3.2 A minimum of three specimens shall be tested.

8.3.3.3 Specimens shall be set as specified in 8.1.1.6.

8.3.3.4 Specimens shall be tested in accordance with 8.3.5 and 8.3.6.

8.3.4 Apparatus.

8.3.4.1 A test oven having minimum dimensions of 915 mm depth × 915 mm width × 1220 mm height (36 in. depth × 36 in. width × 48 in. height) shall be provided.

8.3.4.1.1 The test oven shall have an airflow rate of 38 m/min to 76 m/min (125 ft/min to 250 ft/min) at the standard temperature and pressure of 22°C (72°F) at 1 atmosphere measured at the center point of the oven.

8.3.4.1.2 A test thermocouple shall be positioned so that it is level with the horizontal centerline of a mounted specimen.

8.3.4.2 A test water container capable of covering the uppermost point of the specimen with a depth of 1.5 m (4.9 ft) of water shall be provided.

8.3.4.2.1 The water container shall maintain the devices at that depth.

8.3.4.2.2 The water temperature shall be 22°C ±3°C (72°F ±5°F).

8.3.5 Test Procedure 1.

8.3.5.1 Test Oven.

8.3.5.1.1 Specimens shall be placed in a test oven that has been preheated to 177°C, +5/−0°C (350°F, +10/−0°F).

8.3.5.1.2 Test exposure time of 15 minutes shall begin.

8.3.5.2 Specimen Removal.

8.3.5.2.1 After the test exposure time of 15 minutes, the specimens shall be removed from the oven and within 30 seconds immersed in the test water container for 15 minutes.

8.3.5.2.2 After 15 minutes, the specimens shall be removed from the test water container and wiped dry.

8.3.5.3 Specimens shall be subject to 8.3.5.1 and 8.3.5.2 for six complete cycles.

8.3.5.4 Water Leakage.

8.3.5.4.1 After the sixth cycle, the power source compartment of the specimens shall be opened and inspected for water leakage to determine pass or fail performance.

8.3.5.4.2 Where the device does not fail this portion of the test, the power source shall be reinstalled.

8.3.5.5 After the sixth cycle, the speech quality measurement shall be conducted as specified in Section 8.2 to determine the pass or fail performance.

8.3.5.6 Following the speech quality measurement, the specimen shall be operated to the manufacturer's instructions as specified in Sections 6.2 through 6.7 to determine functionality and pass or fail performance.

8.3.5.7 Specimen Testing.

8.3.5.7.1 After determining functionality, the specimen shall be tested and meet the requirements in Section 7.2.

8.3.5.7.2 The specimen shall meet the requirements as specified in Section 7.2 without degradation.

8.3.6 Test Procedure 2.

8.3.6.1 Reimmersion.

8.3.6.1.1 Following Test Procedure 1, the specimens shall be reimmersed in the test water container for an additional 5 minutes, +30/−0 seconds.

8.3.6.1.2 The power source compartment(s), if so equipped, shall be opened, and the power source shall not be installed.

8.3.6.2 After the 5-minute immersion, the specimens shall be removed from the test water container and wiped dry.

8.3.6.3 The electronic compartment(s) of the specimens shall be opened and inspected for water leakage to determine pass or fail performance.

8.3.7 Report.

8.3.7.1 The speech quality result measured after the heat and immersion leakage test shall be recorded and reported.

8.3.7.2 The functionality of the specimens shall be recorded and reported.

8.3.7.3 The requirements in Section 7.2 shall be tested, recorded, and reported.

8.3.8 Interpretation.

8.3.8.1 Pass or fail performance shall be determined for each specimen.

8.3.8.2 Failure of one or more specimens shall constitute failing performance.

8.4 Vibration Test.

8.4.1 Application. This test method shall apply to all devices.

8.4.2 Samples.

8.4.2.1 Samples shall be complete devices.

8.4.2.2 Samples shall be conditioned as specified in 8.1.2.

8.4.3 Specimens.

8.4.3.1 Specimens for testing shall be complete devices.

8.4.3.2 A minimum of three specimens shall be tested.

8.4.3.3 Specimens shall be set as specified in 8.1.1.6.

8.4.3.4 Specimens shall be conditioned at a temperature of 22°C ±3°C (72°F ±5°F), and a relative humidity of 50 percent ±25 percent, for at least 4 hours.

8.4.3.5 Specimens shall be tested within 5 minutes after removal from conditioning.

8.4.4 Apparatus.

8.4.4.1 Product shall be tested on a typical package tester within the compartments specified in 8.4.4.2 through 8.4.4.4.

8.4.4.2 Compartments shall be set up as specified in Figure 8.4.4.2(a) and Figure 8.4.4.2(b).

8.4.4.2.1 The sides and the base of the compartments shall be constructed of nominal 6 mm (¼ in.) stainless steel.

8.4.4.2.2 The top of the compartments shall remain open.

370 mm, ± 6 mm × 370 mm, ± 6 mm (14¾ in., ± ¼ in. × 14¾ in., ± ¼ in.)	370 mm, ± 6 mm × 370 mm, ± 6 mm (14¾ in., ± ¼ in. × 14¾ in., ± ¼ in.)	735 mm, ± 13 mm × 735 mm, ± 13 mm (29 in., ± ½ in. × 29 in., ± ½ in.)
370 mm, ± 6 mm × 370 mm, ± 6 mm (14¾ in., ± ¼ in. × 14¾ in., ± ¼ in.)	370 mm, ± 6 mm × 370 mm, ± 6 mm (14¾ in., ± ¼ in. × 14¾ in., ± ¼ in.)	
735 mm, ± 13 mm × 735 mm, ± 13 mm (29 in., ± ½ in. × 29 in., ± ½ in.)		735 mm, ± 13 mm × 735 mm, ± 13 mm (29 in., ± ½ in. × 29 in., ± ½ in.)

FIGURE 8.4.4.2(a) Vibration Table Compartments — Top View (Not to Scale).

370 mm, ± 6 mm × 610 mm, ± 13 mm (14¾ in., ± ¼ in. × 24 in., ± ½ in.)	370 mm, ± 6 mm × 610 mm, ± 13 mm (14¾ in., ± ¼ in. × 24 in., ± ½ in.)	735 mm, ± 13 mm × 610 mm, ± 13 mm (29 in., ± ½ in. × 24 in., ± ½ in.)
Vibration table surface		

FIGURE 8.4.4.2(b) Vibration Table Compartments — Side View (Not to Scale).

8.4.4.2.3 There shall be no burrs, sharp edges, surface discontinuities, or fasteners on the internal surfaces of the holding boxes.

8.4.4.3 The large compartments shall encase the complete devices that are larger than 5161 mm² (8 in.²).

8.4.4.4 The small compartments shall encase the complete devices that are smaller than 5161 mm² (8 in.²).

8.4.5 Procedure.

8.4.5.1 Test specimens shall be placed unrestrained in the compartments specified in 8.4.4.2.

8.4.5.2 Test specimens shall not be tied down.

8.4.5.3 The basic movement of the bed of the test table shall be a 25 mm orbital path such as can be obtained on a standard package tester operating in synchronous mode at 250 rpm ±5 rpm.

8.4.5.4 The test duration shall be 3 hours.

8.4.5.5 The speech quality measurement shall be conducted as specified in Section 8.2 to determine pass or fail performance.

8.4.5.6 Following the speech quality measurement, the specimen shall be operated to the manufacturer's instructions as specified in Sections 6.2 through 6.7 to determine functionality and pass or fail performance.

8.4.5.7 Specimens shall be operated according to the manufacturer's instructions to determine functionality for data logging as specified in Section 6.16 to determine pass or fail performance.

8.4.5.8 After determining functionality, the specimen shall be tested and meet the requirements in Section 7.2.

8.4.6 Report.

8.4.6.1 The speech quality result measured after the vibration resistance test shall be recorded and reported.

8.4.6.2 The functionality of the specimens shall be recorded and reported.

8.4.6.3 The requirements in Section 7.2 shall be tested, recorded, and reported.

8.4.7 Interpretation.

8.4.7.1 Pass or fail performance shall be determined for each specimen.

8.4.7.2 Failure of one or more specimens shall constitute failing performance for this test.

8.5 Impact Acceleration Resistance Test.

8.5.1 Application. This test method shall apply to all devices.

8.5.2 Samples.

8.5.2.1 Samples shall be complete devices.

8.5.2.2 Samples shall be conditioned as specified in 8.1.2.

8.5.3 Specimens.

8.5.3.1 Specimens for testing shall be complete devices.

8.5.3.2 A minimum of three specimens shall be tested.

8.5.3.3 Specimens shall be set as specified in 8.1.1.6.

8.5.4 Procedure.

8.5.4.1 Three specimens of product shall be subjected to a series of impact acceleration tests.

8.5.4.1.1 One test specimen for ambient temperature conditioning shall be exposed to a temperature of $22^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($72^{\circ}\text{F} \pm 5^{\circ}\text{F}$), for at least 4 hours.

8.5.4.1.2 One test specimen for cold temperature conditioning shall be exposed to a temperature of $-20^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ($-4^{\circ}\text{F} \pm 2^{\circ}\text{F}$), for at least 4 hours.

8.5.4.1.3 One test specimen for elevated temperature conditioning shall be exposed to a temperature of $71^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ($160^{\circ}\text{F} \pm 2^{\circ}\text{F}$) for at least 4 hours.

8.5.4.2 Each product tested shall be complete with power source.

8.5.4.3 Postconditioning.

8.5.4.3.1 After conditioning, product shall be turned to the "on" position.

8.5.4.3.2 Testing shall begin within 30 seconds of removal from conditioning.

8.5.4.4 Following each conditioning, the product shall be dropped a total of eight times from a distance of 3 m (9.8 ft) onto a concrete surface so that impact is on each face and on one corner and one edge of the product.

8.5.4.5 The entire series of drops shall be completed within 10 minutes of removal from conditioning.

8.5.4.6 Specimens shall be visually evaluated to determine that the device enclosure has not incurred damage that affects normal operation or enclosure integrity.

8.5.4.7 The speech quality measurement shall be conducted as specified in Section 8.2 to determine pass or fail performance.

8.5.4.8 Following the speech quality measurement, the specimen shall be operated to the manufacturer's instructions as specified in Sections 6.2 through 6.7 to determine functionality and pass or fail performance.

8.5.4.9 Specimens shall be operated according to the manufacturer's instructions to determine functionality for data logging as specified in Section 6.16 and pass or fail performance.

8.5.4.10 After determining functionality, the specimen shall be tested and meet the requirements in Section 7.2.

8.5.5 Report.

8.5.5.1 The speech quality result measured after the accelerated impact resistance test shall be recorded and reported.

8.5.5.2 The functionality of the specimens shall be recorded and reported.

8.5.5.3 The requirements in Section 7.2 shall be tested, recorded, and reported.

8.5.6 Interpretation.

8.5.6.1 Pass or fail performance shall be determined for each specimen.

8.5.6.2 Failure of one or more specimens shall constitute failing performance for this test.

8.6 Corrosion Test.

8.6.1 Application. This test method shall apply to all devices.

8.6.2 Samples. Samples shall be complete devices.

8.6.3 Specimens.

8.6.3.1 Specimens for testing shall be complete devices.

8.6.3.2 A minimum of three specimens shall be tested.

8.6.3.3 Specimens shall be set as specified in 8.1.1.6.

8.6.3.4 Specimens shall be conditioned at a temperature of $22^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($72^{\circ}\text{F} \pm 5^{\circ}\text{F}$), and a relative humidity of 50 percent ± 25 percent, for at least 4 hours.

8.6.3.5 Specimens shall be tested within 5 minutes after removal from conditioning.

8.6.4 Procedure.

8.6.4.1 Test Parameters.

8.6.4.1.1 Specimens shall be tested in accordance with ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*.

8.6.4.1.2 Salt spray shall be 5 percent saline solution.

8.6.4.1.3 Test exposure shall be for 48 hours, +30/−0 minutes.

8.6.4.1.4 The chamber shall be stabilized at a temperature of 35°C ±3°C (95°F ±5°F).

8.6.4.2 Specimens shall be placed in the chamber in the typical operating position as used by first responders, as specified by the manufacturer.

8.6.4.3 At the conclusion of the salt spray period, specimens shall be stored in an environment of 22°C ±3°C (72°F ±5°F) at 50 percent ±5 percent relative humidity for a minimum of 48 hours.

8.6.4.4 Following the conditioning period, specimens shall be tested within 60 seconds of removal from conditioning.

8.6.4.5 The speech quality measurement shall be conducted as specified in Section 8.2 to determine pass or fail performance.

8.6.4.6 The specimen shall be operated to the manufacturer's instructions as specified in Sections 6.2 through 6.7 to determine functionality and pass or fail performance.

8.6.4.7 After determining functionality, the specimen shall be tested and meet the requirements specified in Section 7.2.

8.6.5 Report.

8.6.5.1 The speech quality result measured after the corrosion test shall be recorded and reported.

8.6.5.2 The functionality of the specimens shall be recorded and reported.

8.6.5.3 The requirements in Section 7.2 shall be tested, recorded, and reported.

8.6.6 Interpretation.

8.6.6.1 Pass or fail performance shall be determined for each specimen.

8.6.6.2 Failure of one or more specimens shall constitute failing performance for this test.

8.7 Display Surface Abrasion Test.

8.7.1 Application. This test shall apply to all devices.

8.7.2 Samples. Samples shall be complete display surfaces or representative plaques from devices.

8.7.3 Specimens.

8.7.3.1 Specimens for testing shall be complete devices' display surfaces or representative plaques.

8.7.3.2 Four specimens shall be taken.

8.7.3.3 One of the specimens shall be the setup specimen.

8.7.3.4 The test specimen shall include all of the following criteria:

- (1) The specimen shall be a square measuring 50 mm × 50 mm (2 in. × 2 in.).
- (2) At least 38 mm (1 ½ in.) of the 50 mm × 50 mm (2 in. × 2 in.) square shall be taken from the display surface.

8.7.3.5 Each of the specimens shall be cleaned in the following manner:

- (1) The specimen shall be rinsed with clean tap water.
- (2) The specimen shall be washed with a solution of nonionic/low-phosphate detergent and water using a clean, soft gauze pad.
- (3) The specimen shall be rinsed with deionized water.
- (4) The specimen shall be blown dry with clean compressed air or nitrogen.

8.7.3.6 Samples shall be conditioned as specified in 8.1.2.

8.7.3.7 Specimens shall be tested within 5 minutes after removal from conditioning.

8.7.4 Apparatus. The test apparatus shall be constructed in accordance with Figure 8.7.4(a) and Figure 8.7.4(b).

8.7.5 Procedure.

8.7.5.1 The haze of the specimen shall be measured using a haze meter in accordance with ASTM D1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*, and recorded with the following additions:

- (1) The haze shall be measured in the middle 2 mm² of the specimen.
- (2) The specimen shall be repositioned to achieve the maximum haze value within the area defined in 8.7.5.1(1).
- (3) The haze meter shall have a specified aperture of 22 mm.
- (4) The haze meter shall have a visual display showing 0.1 percent resolution.
- (5) The haze meter shall be calibrated before and after each day's use following procedures specified in ASTM D1003, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*.

8.7.5.2 Placement.

8.7.5.2.1 The setup specimen shall be placed cover side up in the test apparatus specimen holder.

8.7.5.2.2 The specimen holder shall be configured with a flat surface under the lens or with an inner radius support.

8.7.5.3 Cylinder.

8.7.5.3.1 The pad holder shall consist of a cylinder 9.5 mm (0.4 in.) high and 25 mm (1 in.) in diameter with a radius of curvature equal to the radius of curvature of the outside of the lens in the display area ±0.25 diopter.

8.7.5.3.2 This cylinder shall be rigidly affixed to the stroking arm by a #10-32 UNF threaded rod.

8.7.5.4 The pad shall be a Blue Streak M306M wool felt polishing pad 23 mm (0.9 in.) in diameter.

8.7.5.5 Abrasive Disc.

8.7.5.5.1 The abrasive disc shall be made from 3M Part Number 7415, wood finishing pad.

8.7.5.5.2 A disc 23 mm (0.9 in.) in diameter shall be cut from the abrasive sheet.

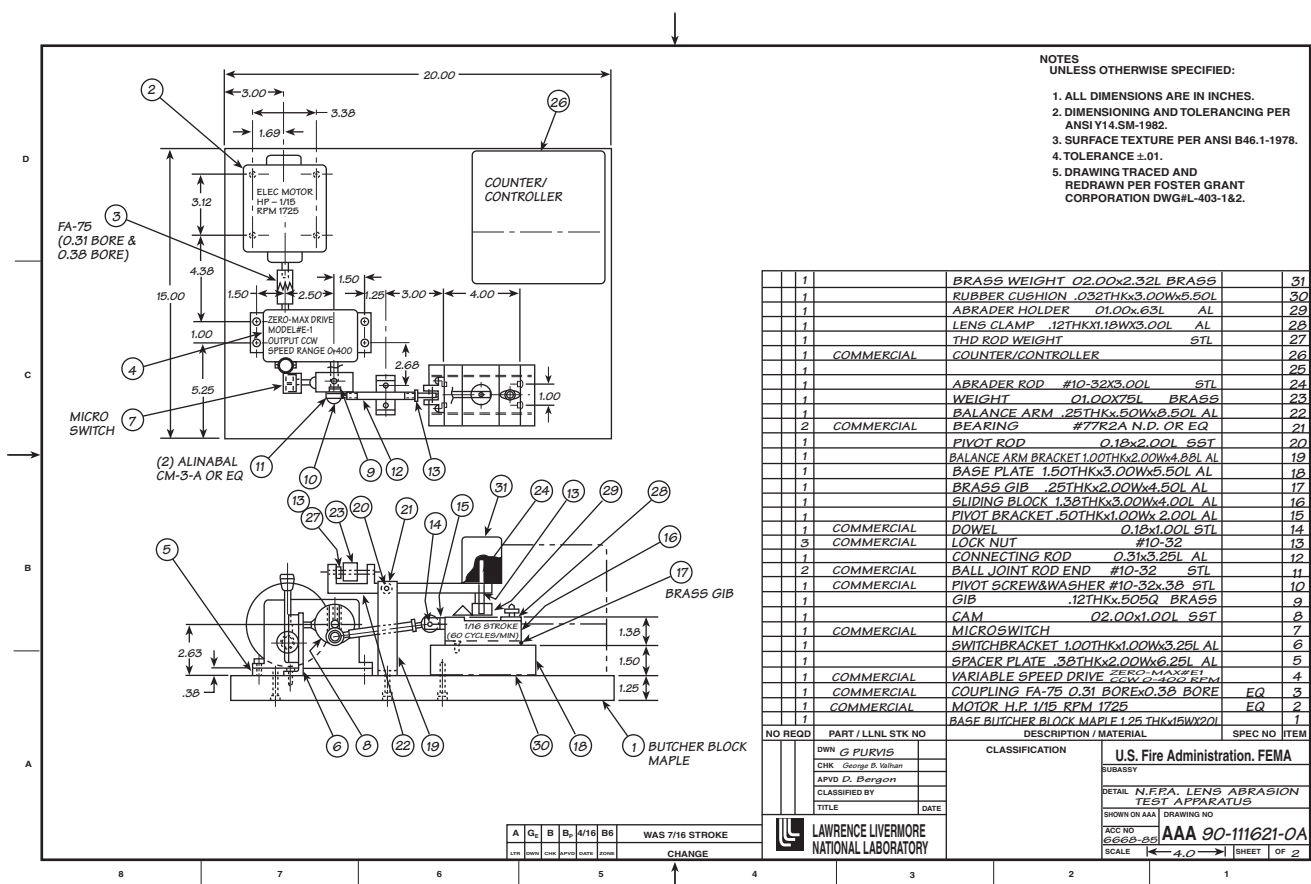


FIGURE 8.7.4(a) Lens Abrasion Tester.

8.7.5.5.3 The marked side of the disc shall be placed against the pad.

8.7.5.5.4 Care shall be exercised to maintain this orientation for each abrasive disc throughout the testing.

8.7.5.6 Stroking Arm.

8.7.5.6.1 The pad holder, pad, and abrasive disc shall be installed on the stroking arm.

8.7.5.6.2 The stroking arm shall be leveled to ± 3 degrees by adjusting the threaded pin.

8.7.5.6.3 The pin shall be secured to prevent rotation of the pad holder.

8.7.5.6.4 The axis of curvature of the pad holder shall be coincident with the axis of curvature of the lens.

8.7.5.6.5 The stroking arm shall be counterbalanced with the pad holder, pad, and abrasive disc in place.

8.7.5.7 The set-up specimen shall be replaced with one of the three specimens to be tested.

8.7.5.8 A 1000 g ± 5 g (2.7 lb ± 0.16 oz) test weight shall be installed on the pin above the test sample.

8.7.5.9 The test shall be run for 200 cycles ± 1 cycle with one cycle consisting of a complete revolution of the eccentric wheel.

8.7.5.10 Stroke.

8.7.5.10.1 The length of stroke shall be 14 mm ($\frac{1}{2}$ in.), producing a pattern 38 mm ($1\frac{1}{2}$ in.) long.

8.7.5.10.2 The frequency of the stroke shall be 60 cycles per minute ± 1 cycle per minute.

8.7.5.10.3 The center of the stroke shall be within ± 2 mm (± 0.08 in.) of the center of the specimen.

8.7.5.11 Specimen Removal.

8.7.5.11.1 The specimen shall be removed and cleaned following the test procedure.

8.7.5.11.2 The abrasive disc shall be discarded.

8.7.5.12 The haze of the sample shall be measured following the test procedure.

8.7.5.13 The delta haze shall be calculated by subtracting the initial haze from the final haze.

8.7.5.14 The testing steps specified in 8.7.5.7 through 8.7.5.13 shall be repeated two times with a new sample and abrasive disc each time.

8.7.6 Report. The three delta haze values shall be averaged, recorded, and reported.

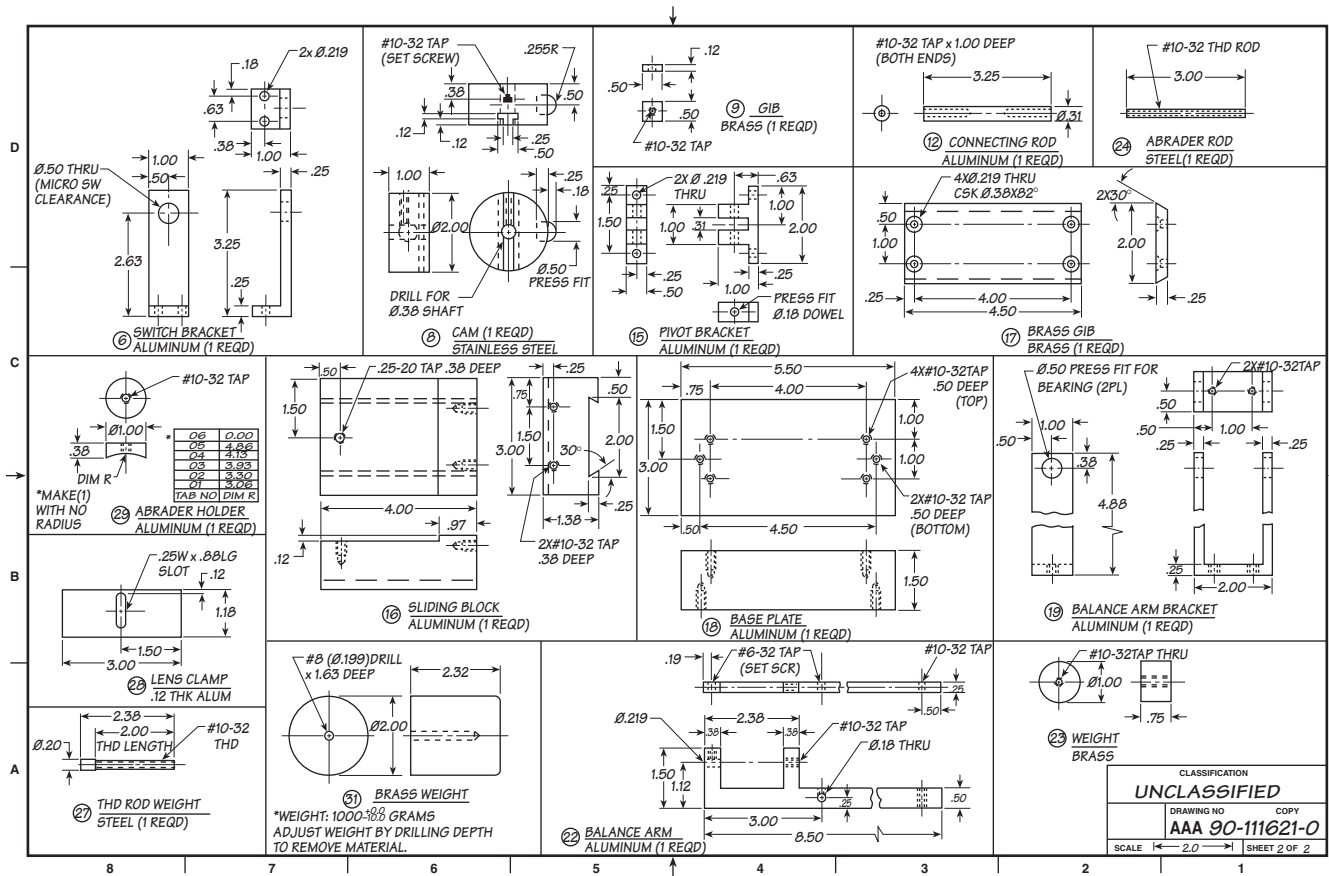


FIGURE 8.7.4(b) Lens Abrasion Tester (Details).

8.7.7 Interpretation. The average delta haze shall be evaluated to determine pass or fail.

8.8 High-Temperature Functionality Test.

8.8.1 Application. This test method shall apply to all devices.

8.8.2 Samples.

8.8.2.1 Samples shall be complete devices.

8.8.2.2 Samples shall be conditioned as specified in 8.1.2.

8.8.3 Specimens.

8.8.3.1 Specimens for testing shall be complete devices.

8.8.3.2 A minimum of three specimens shall be tested.

8.8.3.3 Specimens shall be set as specified in 8.1.1.6.

8.8.3.4 Samples shall be conditioned as specified in 8.1.2.

8.8.3.5 Specimens shall be tested within 5 minutes after removal from conditioning.

8.8.4 Apparatus. The test oven shall be as specified in ISO 17493, *Clothing and equipment for protection against heat — Test method for convective heat resistance using a hot air circulating oven.*

8.8.5 Procedure.

8.8.5.1 Testing shall be performed in accordance with ISO 17493, *Clothing and equipment for protection against heat — Test method for convective heat resistance using a hot air circulating oven*, using the following parameters:

- (1) A test fixture capable of accommodating the device being tested shall be used.
- (2) The test temperature shall be 260°C, +6/−0°C (500°F, +10/−0°F).
- (3) Specimens shall be mounted in the “as worn” position on a test fixture.
- (4) Specimens shall not touch any oven surface.
- (5) The test fixture shall not degrade the oven recovery time.
- (6) The test fixture shall be designed to allow the specimens to be attached in the same configuration as the specimens’ mounting assembly attaches to the specimens.

8.8.5.2 The test fixture with the specimen attached shall be placed in the test oven perpendicular with the front surface facing perpendicular to the airflow of the oven.

8.8.5.3 The specimen shall be set to the “on” mode.

8.8.5.4 Position.

8.8.5.4.1 There shall be no obstructions between the specimen and the airflow.

8.8.5.4.2 The test fixture shall position the specimen equidistant from all interior oven surfaces.

8.8.5.5 Oven Door.

8.8.5.5.1 The test oven door shall not remain open more than 15 seconds.

8.8.5.5.2 The air circulation shall be shut off while the door is open and turned on when the door is closed.

8.8.5.6 Recovery Time.

8.8.5.6.1 The total test oven recovery time shall not exceed 30 seconds.

8.8.5.6.2 The thermocouple reading shall remain at 260°C, +6/−0°C (500°F, +10/−0°F) for the duration of the test.

8.8.5.7 Exposure Time.

8.8.5.7.1 The test specimen, mounted as specified, shall be exposed in the test oven for 5 minutes, +15/−0 seconds.

8.8.5.7.2 The test exposure time shall begin when the test thermocouple recovers to 260°C, +6/−0°C (500°F, +10/−0°F).

8.8.5.8 Within 30 seconds of removal from the oven, the speech quality measurement shall be initiated as specified in Section 8.2 to determine pass or fail performance.

8.8.5.9 Within 3 minutes of removal from the oven, initiation of the specimen's functional evaluation shall occur per the manufacturer's instructions as specified in Sections 6.2 through 6.7 to determine pass or fail performance.

8.8.5.10 Specimens shall operate according to the manufacturer's instructions to determine functionality for data logging as specified in Section 6.16 and pass or fail performance.

8.8.5.11 After determining functionality, the specimen shall be tested and meet the requirements specified in Section 7.2.

8.8.6 Report.

8.8.6.1 The speech quality result measured after the heat resistance test shall be recorded and reported.

8.8.6.2 The functionality of the specimens shall be recorded and reported.

8.8.6.3 The requirements in Section 7.2 shall be tested, recorded, and reported.

8.8.7 Interpretation.

8.8.7.1 Pass or fail performance shall be determined for each specimen.

8.8.7.2 Failure of one or more specimens shall constitute failing performance for this test.

8.9 Heat and Flame Test.

8.9.1 Application. This test method shall apply to all devices.

8.9.2 Samples. Samples shall be complete devices.

8.9.3 Specimens.

8.9.3.1 Specimens for testing shall be complete devices.

8.9.3.2 A minimum of three specimens shall be tested.

8.9.3.3 Specimens shall be set as specified in 8.1.1.6.

8.9.3.4 Samples shall be conditioned as specified in 8.1.2.

8.9.3.5 Specimens shall be tested within 5 minutes after removal from conditioning.

8.9.4 Apparatus.

8.9.4.1 Specimens shall be attached to the front or rear of the test mannequin by the retention system, in accordance with the manufacturer's instructions, by means of a loop, belt, or other means, on the outside or over the mannequin protective clothing.

8.9.4.2 Instructions.

8.9.4.2.1 The manufacturer shall provide instructions for mounting the RF device on the mannequin.

8.9.4.2.2 Specimens shall be attached to the mannequin in accordance with the manufacturer's instructions.

8.9.4.3 Heat and Flame Test Apparatus.

8.9.4.3.1 The heat and flame test apparatus shall be as specified in Figure 8.9.4.3.1(a) and Figure 8.9.4.3.1(b).

8.9.4.3.2 The heat and flame test apparatus shall not be supplied by the device manufacturer.

8.9.4.4 Test Oven.

8.9.4.4.1 The test oven shall be a horizontal forced-circulating-air oven with an internal velocity of 61 m/min (200 ft/min).

8.9.4.4.2 The test oven shall have minimum dimensions of 915 mm depth × 915 mm width × 1220 mm height (36 in. × 36 in. × 48 in.).

8.9.5 Procedure.

8.9.5.1 For calibration prior to the heat and flame test, the calibration mannequin shown in Figure 8.9.4.3.1(b) shall be exposed to direct flame contact for 10 seconds using the heat and flame test apparatus.

8.9.5.2 All peak temperature readings shall be within a temperature range of 815°C to 1150°C (1500°F to 2102°F).

8.9.5.3 The average mean of all peak temperature readings shall not be higher than 950°C (1742°F).

8.9.5.4 The test oven recovery time, after the door is closed, shall not exceed 60 seconds.

8.9.5.5 Temperature.

8.9.5.5.1 Specimens mounted on the test fixture shall first be placed in the test oven, which has been preheated to 95°C ±2°C (203°F ±5°F), for 15 minutes, +15/−0 seconds.

8.9.5.5.2 The test exposure time of 15 minutes shall begin after the door is closed and the oven temperature recovers to 95°C (203°F).

8.9.5.6 At the completion of the 15-minute exposure at 95°C ±2°C (203°F ±5°F), the specimen mounted on the test fixture shall be moved out of the oven and into the center of the burner array.

8.9.5.7 Flame Contact.

8.9.5.7.1 The product shall then be exposed to direct flame contact for 10 seconds, +1/4/−0 seconds.

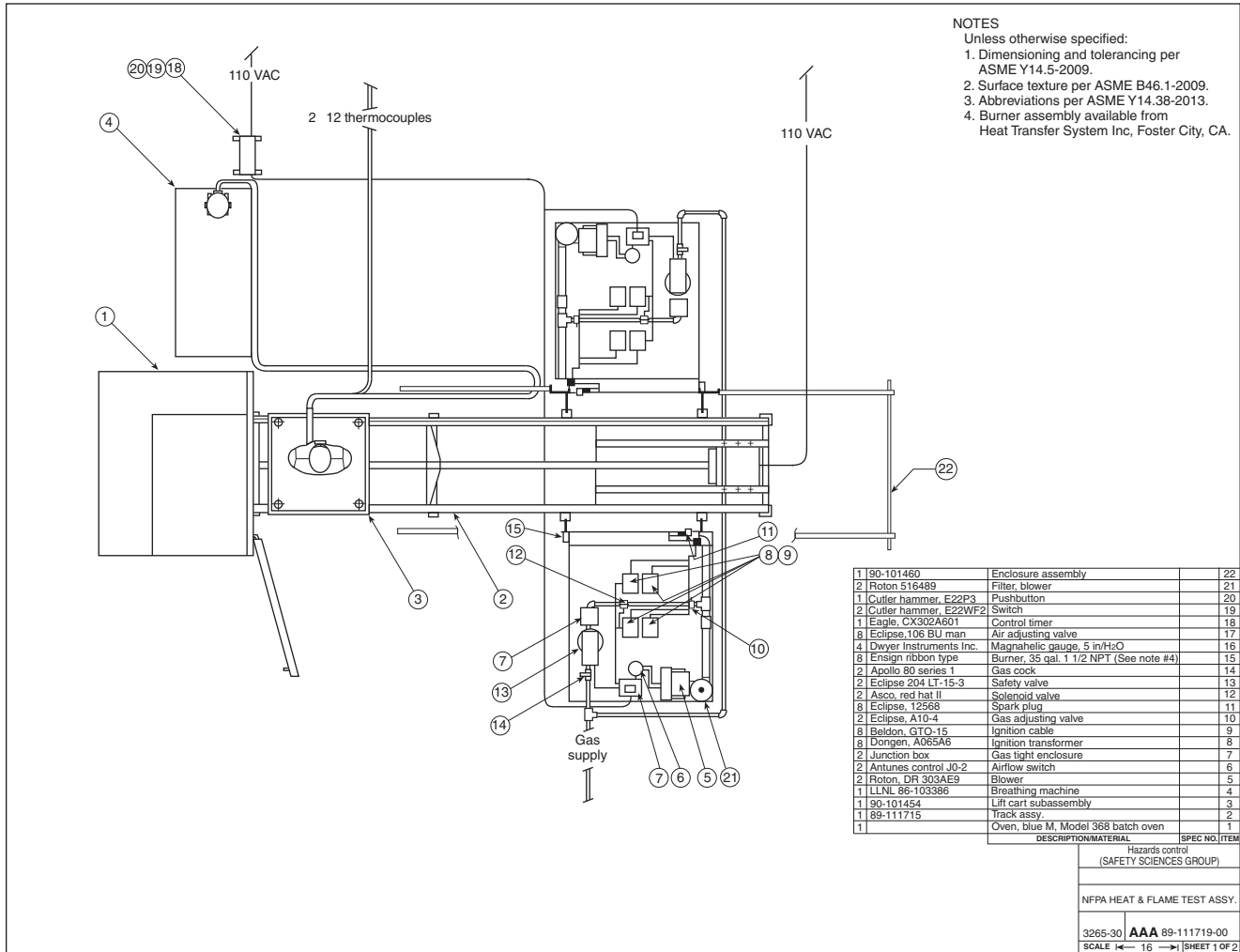


FIGURE 8.9.4.3.1(a) Heat and Flame Test Apparatus: Top View.

8.9.5.7.2 This exposure shall begin within 20 seconds of the product being removed from the test oven.

8.9.5.8 The speech quality measurement shall be conducted as specified in Section 8.2 to determine pass or fail performance.

8.9.5.9 Following the speech quality measurement, the specimen shall be operated to the manufacturer's instructions to determine functionality and pass or fail performance.

8.9.5.10 After determining functionality, the specimen shall be tested and meet the requirements specified in Section 7.2.

8.9.6 Report.

8.9.6.1 Any afterflame of the test specimen exceeding 2.2 seconds shall be recorded and reported.

8.9.6.2 Anything falling from the test specimen shall be recorded and reported.

8.9.6.3 Any test specimen falling from the mounted position shall be recorded and reported.

8.9.6.4 The speech quality result measured after the heat and flame resistance test shall be recorded and reported.

8.9.6.5 The functionality of the specimens as specified in Sections 6.2 through 6.7 shall be recorded and reported.

8.9.6.6 The requirements of Section 7.2 shall be tested, recorded, and reported.

8.9.7 Interpretation.

8.9.7.1 Pass or fail performance shall be determined for each specimen.

8.9.7.2 Failure of one or more specimens shall constitute failing performance for this test.

8.9.7.3 Any test specimen exceeding 2.2 seconds of afterflame shall constitute failing performance.

8.9.7.4 Any test specimen having parts or other items falling off shall constitute failing performance.

8.9.7.5 Any test specimen falling from its mounted position shall constitute failing performance.

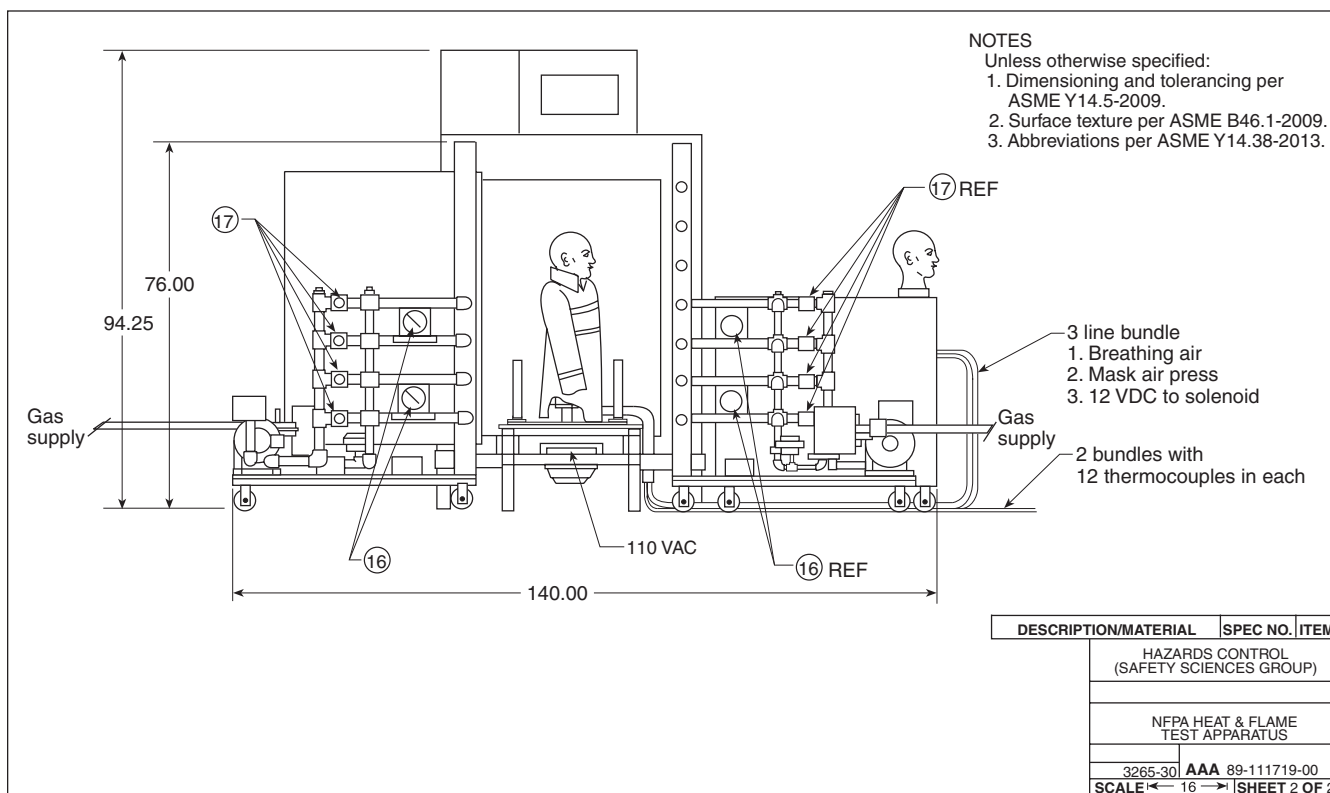


FIGURE 8.9.4.3.1(b) Heat and Flame Test Apparatus: Side View.

8.9.7.6 Specimens shall be operated according to the manufacturer's instructions to determine functionality for data logging as specified in Section 6.16 and pass or fail performance.

8.10 Product Label Durability Test.

8.10.1 Application. This test method shall apply to all product labels.

8.10.2 Samples. Samples shall be complete devices.

8.10.3 Specimens.

8.10.3.1 Specimens for testing shall be complete devices with product labels attached.

8.10.3.2 A minimum of three specimens shall be tested.

8.10.3.3 Samples shall be conditioned as specified in 8.1.2.

8.10.4 Procedure.

8.10.4.1 Specimens with all product labels attached shall be subjected to the tests specified in Sections 8.3, 8.6, and 8.8.

8.10.4.2 After each test, the specimen product labels shall be examined at a distance of 305 mm (12 in.) by the unaided eye with 20/20 vision or vision corrected to 20/20.

8.10.4.3 The product labels shall be permitted to be wiped clean with an untreated cloth prior to being examined.

8.10.5 Report. The legibility of each product label shall be recorded and reported.

8.10.6 Interpretation. Any specimen failing the test shall constitute failing performance.

8.11 Cable Pullout Test.

8.11.1 Application. This test method shall apply to devices and any associated assemblies with interconnecting wiring.

8.11.2 Samples. Samples shall be complete devices.

8.11.3 Specimens.

8.11.3.1 Specimens for testing shall be complete devices with any associated assemblies with interconnecting wiring.

8.11.3.2 A minimum of three specimens shall be tested.

8.11.3.3 Specimens shall be set as specified in 8.1.1.6.

8.11.3.4 Samples shall be conditioned as specified in 8.1.2.

8.11.4 Apparatus. A mass of known weight with the means for attachment to wiring shall be provided.

8.11.5 Procedure.

8.11.5.1 Samples shall be conditioned as specified in 8.1.4.

8.11.5.2 A force of 156 N, +9/-0 N (35 lbf, +2/-0 lbf) shall be applied at a rate of 2.0 in./min (± 0.5 in./min), in an axial direction to the wiring of the specimen tested.

8.11.5.3 The functionality of the specimens as specified in Sections 6.2 through 6.7 shall be recorded and reported.

8.11.6 Report.

8.11.6.1 Observations of the nonseparation and separation of interconnecting wiring shall be recorded and reported.

8.11.6.2 The speech quality measurement shall be conducted as specified in Section 8.2 to determine pass or fail performance.

8.11.6.3 Following the speech quality measurement, the specimen shall be operated to the manufacturer's instructions as specified in Sections 6.2 through 6.7 to determine functionality and pass or fail performance.

8.11.7 Interpretation.

8.11.7.1 Pass or fail performance shall be determined for each specimen.

8.11.7.2 Failing performance of one or more specimens shall constitute failing performance for this test.

8.12 Case Integrity Test.

8.12.1 Application. This test method shall apply to all devices.

8.12.2 Samples.

8.12.2.1 Samples shall be complete devices.

8.12.2.2 Samples shall be conditioned as specified in 8.1.2.

8.12.3 Specimens.

8.12.3.1 Specimens for testing shall be complete devices.

8.12.3.2 Specimens shall be set as specified in 8.1.1.6.

8.12.4 Procedure.

8.12.4.1 Specimens shall be subjected to a test weight of 200 kg, +2/-0 kg (442 lb, +4.4/-0 lb).

8.12.4.2 The test weight shall be applied to each of the following surfaces of the specimen case, housing, or enclosure:

- (1) Right
- (2) Left
- (3) Front
- (4) Back

8.12.4.3 The test weight shall be placed so as to avoid impact loading.

8.12.4.4 The test weight shall remain on each surface of the specimen case for 1 minute, +15/-0 seconds.

8.12.4.5 After removal of the test weight, each surface of the specimen case, housing, and enclosure shall be examined for damage.

8.12.5 The speech quality measurement shall be conducted as specified in Section 8.2 to determine pass or fail performance.

8.12.6 Following the speech quality measurement, the specimen shall be operated to the manufacturer's instructions as specified in Sections 6.2 through 6.7 to determine functionality and pass or fail performance.

8.12.7 After determining functionality, the specimen shall be tested and meet the requirements specified in Section 7.2.

8.12.8 Report.

8.12.8.1 The speech quality result measured after the case integrity test shall be recorded and reported.

8.12.8.2 The functionality of the specimens shall be recorded and reported.

8.12.8.3 The requirements of Section 7.2 shall be tested, recorded, and reported.

8.12.9 Interpretation.

8.12.9.1 Pass or fail performance shall be determined for each specimen.

8.12.9.2 Failure of one or more specimens shall constitute failing performance for this test.

8.13 Water Drainage Test.

8.13.1 Application. This test method shall apply to all devices.

8.13.2 Samples.

8.13.2.1 Samples shall be complete devices.

8.13.2.2 Samples shall be conditioned as specified in 8.1.2.

8.13.3 Specimens.

8.13.3.1 Specimens for testing shall be complete devices.

8.13.3.2 Specimens shall be set as specified in 8.1.1.6.

8.13.3.3 A minimum of three specimens shall be tested.

8.13.4 Procedure.

8.13.4.1 Specimens shall be subjected to three water drainage tests.

8.13.4.1.1 The first test shall have the specimens positioned with the speaker oriented in the position it is intended to be worn, in accordance with the manufacturer's instructions.

8.13.4.1.2 The second test shall have the specimens positioned with the speaker oriented horizontally and facing up.

8.13.4.1.3 A third test shall have the specimen positioned where the speaker is oriented in a position that will retain the greatest volume of water.

8.13.4.2 Water shall be introduced into all openings, indentations, and grilles of the specimens until water overflows from each such opening, indentation, and grille.

8.13.4.3 The filling method shall ensure that no air bubbles remain in any of the openings, indentations, and grilles.

8.13.4.4 The speech quality result shall be measured and recorded starting at the 60-second mark, +5/-0 seconds, to determine pass or fail performance.

8.13.5 Report.

8.13.5.1 The speech quality result measured after the water drainage test shall be recorded and reported.

8.13.5.2 The functionality of the specimens as specified in Sections 6.2 through 6.7 shall be recorded and reported.

8.13.6 Interpretation.

8.13.6.1 Pass or fail performance shall be determined for each specimen.

8.13.6.2 Failure of one or more specimens shall constitute failing performance for this test.

8.14 Tumble — Vibration Test.

8.14.1 Application. This test method shall apply to all RF devices and RSMs.

8.14.2 Samples.

8.14.2.1 Samples shall be complete RF devices and RSMs.

8.14.2.2 Samples shall be conditioned as specified in 8.1.2.

8.14.3 Specimens.

8.14.3.1 Specimens for testing shall be complete RF devices and RSMs.

8.14.3.2 A minimum of three specimens shall be tested.

8.14.4 Apparatus. The tumble test apparatus shall be as specified in Figure 8.14.4.

8.14.5 Procedure.

8.14.5.1 The test specimens shall be placed unrestrained in the tumbling apparatus.

8.14.5.2 Only one specimen shall be tested at a time.

8.14.5.3 The tumbling apparatus shall be run at a speed of 15 rpm $\pm$ 1 rpm.

8.14.5.4 The test shall be run for a duration of 3 hours, +5/–0 minutes.

8.14.5.5 Specimens shall be operated according to the manufacturer's instructions to determine functionality as specified in 7.1.1 and pass or fail performance.

8.14.5.6 Upon completion of the test duration, specimens shall be operated according to the manufacturer's instructions to determine functionality for data logging as specified in Section 6.19 and pass or fail performance.

8.14.5.7 The speech quality level shall be measured as specified in 7.1.1 to determine pass or fail performance.

8.14.6 Report.

8.14.6.1 The specimen speech quality level shall be measured, recorded, and reported.

8.14.6.2 The functionality of the specimens shall be recorded and reported.

8.14.6.3 The requirements in Section 7.2 shall be tested, recorded, and reported.

8.14.7 Interpretation.

8.14.7.1 Pass or fail performance shall be determined for each specimen.

8.14.7.2 Any one specimen failing the test shall constitute failing performance.

8.15 TIA Transmit Power.

8.15.1 Application. This test method shall apply to all RF devices.

8.15.2 Samples.

8.15.2.1 Samples shall be complete devices.

8.15.2.2 Samples shall be conditioned as specified in 8.1.2.

8.15.3 Specimens.

8.15.3.1 Specimens for testing shall be complete devices.

8.15.3.2 A minimum of three specimens shall be tested.

8.15.3.3 Specimens shall be tested within 5 minutes after removal from conditioning.

8.15.4 Procedure. Specimens shall be tested for carrier output power as specified in 2.2.1 of TIA-603-E, *Land Mobile FM or PM — Communications Equipment — Measurement and Performance Standards*, and RF power output as specified in 2.2.1 of TIA-102.CAAA-E, *Project 25 Digital C4FM/CQPSK Transceiver Measurement Methods*.

8.15.5 Report. The carrier output power and the RF power output shall be recorded and reported.

8.15.6 Interpretation.

8.15.6.1 Pass or fail performance shall be determined for each specimen.

8.15.6.2 Failing performance of one or more specimens shall constitute failing performance for this test.

8.16 TIA Carrier Frequency Stability.

8.16.1 Application. This test method shall apply to all RF devices.

8.16.2 Samples.

8.16.2.1 Samples shall be complete devices.

8.16.2.2 Samples shall be conditioned as specified in 8.1.2.

8.16.3 Specimens.

8.16.3.1 Specimens for testing shall be complete devices.

8.16.3.2 A minimum of three specimens shall be tested.

8.16.3.3 Specimens shall be tested within 5 minutes after removal from conditioning.

8.16.4 Procedure. Specimens shall be tested for carrier frequency stability as specified in 2.2.2 of TIA-603-E, *Land Mobile FM or PM — Communications Equipment — Measurement and Performance Standards*, and operating frequency accuracy as specified in 2.2.2 of TIA-102.CAAA-E, *Project 25 Digital C4FM/CQPSK Transceiver Measurement Methods*.

8.16.5 Report. The carrier frequency stability and the operating frequency accuracy shall be recorded and reported.

8.16.6 Interpretation.

8.16.6.1 Pass or fail performance shall be determined for each specimen.

8.16.6.2 Failing performance of one or more specimens shall constitute failing performance for this test.

8.17 TIA Receiver Sensitivity.

8.17.1 Application. This test method shall apply to all RF devices.

8.17.2 Samples.

8.17.2.1 Samples shall be complete devices.

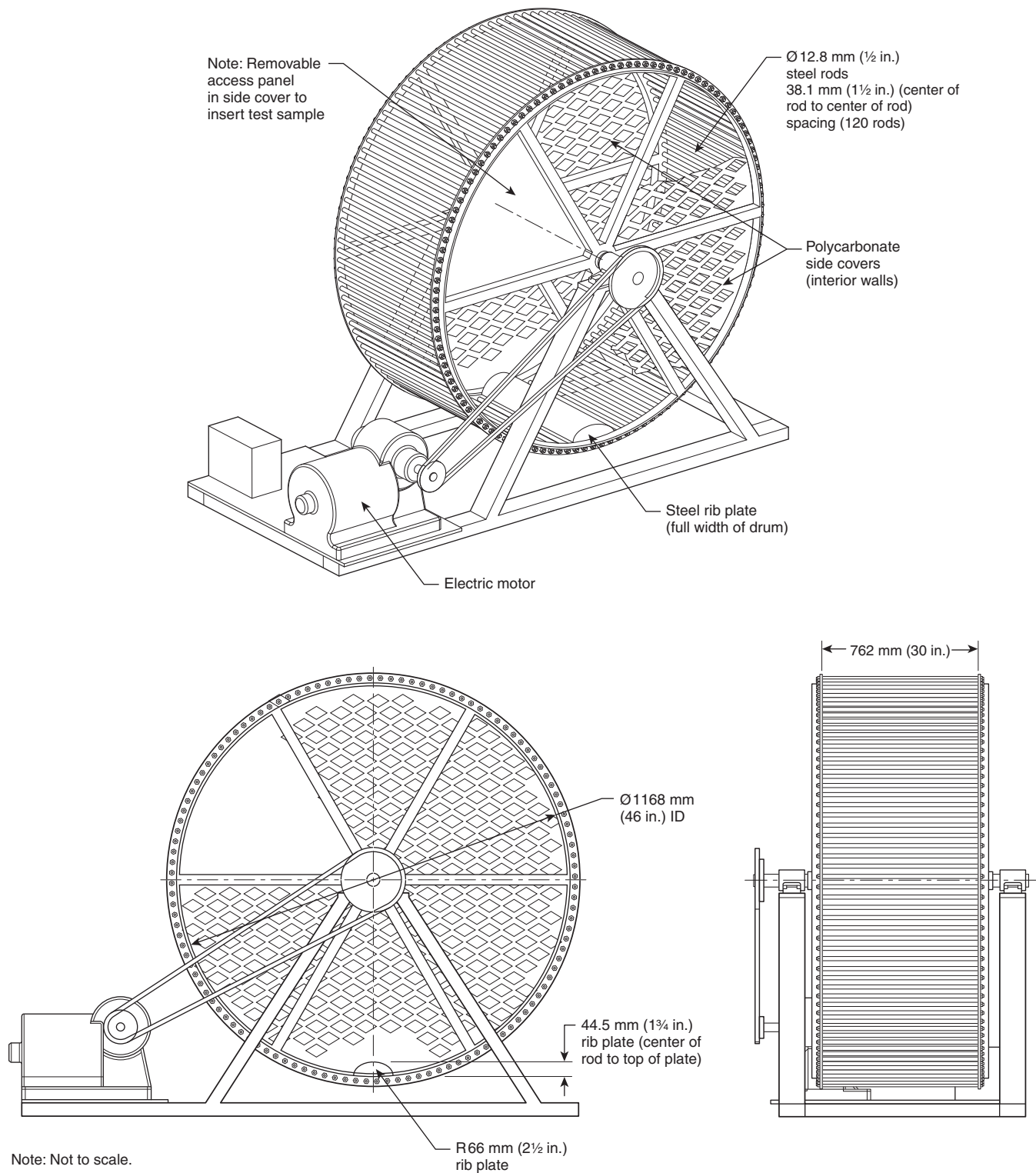


FIGURE 8.14.4 Tumble Test Apparatus.

8.17.2.2 Samples shall be conditioned as specified in 8.1.2.

8.17.3 Specimens.

8.17.3.1 Specimens for testing shall be complete devices.

8.17.3.2 A minimum of three specimens shall be tested.

8.17.3.3 Specimens shall be tested within 5 minutes after removal from conditioning.

8.17.4 Procedure. Specimens shall be tested for reference sensitivity (analog) as specified in 2.1.4 of TIA-603-E, *Land Mobile FM or PM — Communications Equipment — Measurement and Performance Standards*, and reference sensitivity (digital) as specified in 2.1.4 of TIA-102.CAAA-E, *Project 25 Digital C4FM/CQPSK Transceiver Measurement Methods*.

8.17.5 Report. The reference sensitivity (analog) and reference sensitivity (digital) shall be recorded and reported.

8.18 Power Source Performance Test.

8.18.1 Application. This test method shall apply to all RF devices.

8.18.2 Samples.

8.18.2.1 Samples shall be complete devices.

8.18.2.2 Samples shall be conditioned as specified in 8.1.2.

8.18.3 Specimens.

8.18.3.1 Specimens for testing shall be complete devices.

8.18.3.2 A minimum of three specimens shall be tested.

8.18.4 Procedure.

8.18.4.1 The RF device shall be continuously operated for at least 8 hours on a standard-duty cycle of 10-10-80 at maximum rated transmit power.

8.18.4.2 The RF device shall be tested for carrier output power as specified in 2.2.1 of TIA-603-E, *Land Mobile FM or PM — Communications Equipment — Measurement and Performance Standards*, and RF power output as specified in 2.2.1 of TIA-102.CAAA-E, *Project 25 Digital C4FM/CQPSK Transceiver Measurement Methods*.

8.18.4.3 Transmit power shall not decrease by more than 1 dB for the first 8 hours as specified in 7.2.1.2.1.

8.18.5 Report.

8.18.5.1 The delta power shall be calculated by subtracting the final transmit power from the initial transmit power.

8.18.5.2 Delta power shall be recorded and reported.

8.18.5.3 The functionality of the specimens shall be recorded and reported.

8.18.6 Interpretation.

8.18.6.1 Pass or fail performance shall be determined for each specimen.

8.18.6.2 Failing performance of one or more specimens shall constitute failing performance for this test.

8.19 Electronic Temperature Stress Test.

8.19.1 Application. This test method shall apply to all RF devices.

8.19.2 Samples.

8.19.2.1 Samples shall be conditioned as specified in 8.1.2.

8.19.2.2 A minimum of three specimens shall be tested.

8.19.3 Procedure.

8.19.3.1 Each specimen shall be subjected to a series of three temperature stress tests identified as Test Procedure 1, for elevated temperature, in 8.19.4; Test Procedure 2, for low operating temperature, in 8.19.5; and Test Procedure 3, for temperature shock, in 8.19.6.

8.19.3.2 Specimens.

8.19.3.2.1 The same three specimens shall be used for all three test series.

8.19.3.2.2 Each specimen tested shall be complete with power source.

8.19.3.3 Conditions.

8.19.3.3.1 The test chamber or cabinet shall be capable of maintaining the required conditions specified in 8.19.4, 8.19.5, and 8.19.6 throughout the envelope of air surrounding the specimen being tested.

8.19.3.3.2 The required conditions shall be continuously monitored.

8.19.3.4 Following each test procedure, the specimen shall be allowed to stabilize at ambient conditions prior to proceeding to the next test procedure.

8.19.4 Test Procedure 1.

8.19.4.1 Specimens shall be placed in the test apparatus that has been stabilized at 49°C, +3/−0°C (120°F, +5/−0°F).

8.19.4.2 After 6 hours, the temperature shall be raised to 71°C, +3/−0°C (160°F, +5/−0°F) within 1 hour and maintained for 4 hours.

8.19.4.3 The temperature shall then be decreased to 49°C, +3/−0°C (120°F, +5/−0°F) within 1 hour.

8.19.4.4 This cycle shall be repeated twice.

8.19.4.5 After the second cycle, the temperature shall be raised to 71°C, +3/−0°C (160°F, +5/−0°F) for 4 hours.

8.19.4.6 Specimens shall be removed following the specified conditioning, and testing shall begin within 30 seconds or removal from conditioning.

8.19.4.7 Specimens shall be operated according to the manufacturer's instructions to determine functionality as follows:

- (1) RF device as specified in Sections 6.2 through 6.7
- (2) RSM as specified in Section 6.9

8.19.4.8 The RF device shall transmit and a receiving RF device shall be used to determine pass or fail performance.

8.19.5 Test Procedure 2.

8.19.5.1 Specimens shall be placed and maintained in the test apparatus that has been stabilized at -20°C , $+0/-3^{\circ}\text{C}$ (-4°F , $+0/-5^{\circ}\text{F}$) for a minimum of 4 hours.

8.19.5.2 Removal.

8.19.5.2.1 Specimens shall be removed following the specified conditioning.

8.19.5.2.2 Testing shall begin within 30 seconds of removal from conditioning.

8.19.5.3 Specimens shall be operated according to the manufacturer's instructions to determine functionality as follows:

- (1) RF device as specified in Sections 6.2 through 6.7
- (2) RSM as specified in Section 6.9

8.19.5.4 The RF device shall transmit and a receiving RF device shall be used to determine pass or fail performance.

8.19.6 Test Procedure 3.

8.19.6.1 Hot/Cold Conditioning.

8.19.6.1.1 Specimens shall be conditioned for 4 hours in the test apparatus that has been stabilized at -20°C , $+0/-3^{\circ}\text{C}$ (-4°F , $+0/-5^{\circ}\text{F}$).

8.19.6.1.2 Specimens shall be removed from the cold condition.

8.19.6.1.3 Within 5 minutes, specimens shall be conditioned for 4 hours in another test apparatus that has been stabilized at 71°C , $+3/-0^{\circ}\text{C}$ (160°F , $+5/-0^{\circ}\text{F}$).

8.19.6.2 The cold-to-hot cycle shall be repeated twice.

8.19.6.3 Removal.

8.19.6.3.1 Specimens shall be removed following the specified conditioning.

8.19.6.3.2 Specimen testing shall begin within 30 seconds of removal from conditioning.

8.19.6.4 Specimens shall be operated according to the manufacturer's instructions to determine functionality as follows:

- (1) RF device as specified in Sections 6.2 through 6.7
- (2) RSM as specified in Section 6.9

8.19.6.5 The RF device shall transmit and a receiving RF device shall be used to determine pass or fail performance.

8.19.7 Report.

8.19.7.1 The functioning of the specimens shall be recorded and reported.

8.19.8 Interpretation.

8.19.8.1 Pass or fail performance shall be determined for each specimen.

8.19.8.2 Failure of one or more specimens shall constitute failing performance for this test.

8.20 Antenna VSWR Swept Frequency Test.

8.20.1 Application. This test method shall apply to all RF devices.

8.20.2 Samples.

8.20.2.1 Samples shall be complete devices.

8.20.2.2 Samples shall be conditioned as specified in 8.1.2.

8.20.3 Specimens. Specimens for testing shall be the RF device antenna.

8.20.4 Apparatus.

8.20.4.1 The manufacturer shall provide a fixture to mount the antenna to facilitate the swept frequency VSWR test.

8.20.4.2 The manufacturer shall provide an N-type female connector to connect the RF cable from the meter to the fixture.

8.20.5 Procedure.

8.20.5.1 Calibration.

8.20.5.1.1 The swept frequency VSWR meter shall be calibrated by connecting the meter to the fixture and applying the calibration loads to the antenna mounting point.

8.20.5.1.2 Adapters shall be permitted to connect the calibration load to the antenna mounting point.

8.20.5.1.3 The effect of adapters on the calibration shall be ignored.

8.20.5.2 The specimen's antenna shall be removed from the specimen and mounted in the fixture.

8.20.5.3 Configuration.

8.20.5.3.1 The swept frequency VSWR meter shall be configured for a start and stop frequency equal to the vendor-specified antenna bandwidth.

8.20.5.3.2 A minimum of 100 sample points shall be taken across the bandwidth.

8.20.5.4 VSWR Charts.

8.20.5.4.1 A baseline swept VSWR chart of the antenna shall be created before the RF device is subjected to any performance tests.

8.20.5.4.2 Subsequent swept VSWR charts shall be created after each performance test as specified.

8.20.5.4.3 These VSWR charts shall be compared to the baseline.

8.20.6 Report. The greatest change between the baseline and subsequent test curves shall be calculated, recorded, and reported.

8.20.7 Interpretation.

8.20.7.1 Pass or fail performance shall be determined for each specimen.

8.20.7.2 Failing performance of one or more specimens shall constitute failing performance for this test.