NFPA®

1982

Standard on Personal Alert Safety Systems (PASS)

2018

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NFPA® 1982

Standard on

Personal Alert Safety Systems (PASS)

2018 Edition

This edition of NFPA 1982, *Standard on Personal Alert Safety Systems (PASS)*, 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 November 10, 2017, with an effective date of November 30, 2017, and supersedes all previous editions.

This edition of NFPA 1982 was approved as an American National Standard on November 30, 2017.

Origin and Development of NFPA 1982

The Technical Committee on Protective Equipment for Fire Fighters began work on this standard in 1980 in answer to requests from the fire service to establish requirements for a device that would sound an audible signal for aid if a fire fighter became incapacitated while operating at an emergency. The International Association of Fire Fighters (IAFF) was instrumental in the developmental work that resulted in this standard. Developmental work was completed in the spring of 1982 and submitted to the NFPA for official adoption. The first edition was presented at the Annual Meeting in Kansas City, Missouri, and released on June 9, 1983.

Between the first and second editions, the name of the technical committee was changed to the Technical Committee on Fire Service Protective Clothing and Equipment, and the Subcommittee on Personal Alert Safety Systems (PASS) was organized to manage this document. The second edition was presented to the membership of the Association at the 1988 Annual Meeting in Los Angeles, California, and had an effective date of June 28, 1988.

For the third edition, the Subcommittee on PASS undertook a complete revision of its work, which was completed in December 1991. The document was passed on to the Technical Committee on Fire Service Protective Clothing and Equipment, presented to the membership of the Association at the 1993 Annual Meeting in Orlando, Florida, and was issued with an effective date of August 20, 1993.

In January 1995, the Standards Council reorganized the entire project for fire service protective clothing and equipment. The new project had a Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment and seven technical committees operating within the project. The former standing Subcommittee on PASS was combined with the Subcommittee on SCBA to form the new Technical Committee on Respiratory Protection and Personal Alarm Equipment, which took over the responsibility for NFPA 1982.

The fourth edition represented a complete revision of the third edition and included PASS that are integrated with SCBA and automatic activation of all PASS. It was presented to the membership of the Association at the 1998 Annual Meeting in Cincinnati, Ohio, and had an effective date of August 5, 1998.

In October 2002, the NFPA Standards Council established a new committee, the Technical Committee on Electronic Safety Equipment, within the project structure. This new committee was given the responsibility for addressing all electronics in equipment used by emergency responders and was assigned responsibility for NFPA 1982.

The fifth edition of NFPA 1982 was a complete revision of the fourth edition. During this revision cycle, the Committee received reports from the National Institute for Occupational Safety and Health (NIOSH) Division of Safety Research on its investigations of fire-fighter fatalities where there was evidence the PASS alarm signal failed to function or was not heard by other personnel in the

area, and in some instances that there was water ingress to the electronic components that diminished or canceled the alarm signal. The National Institute for Standards and Technology (NIST) Building and Fire Research Laboratory partnered with NIOSH to characterize the performance of PASS devices in the fire-fighting environment. NIST determined that exposure to high-temperature environments reduced the loudness of the alarm signal. That reduction in loudness can cause the alarm signal to become indistinguishable from background noise at an emergency scene. Initial laboratory testing by NIST highlighted that this sound reduction could begin to occur at temperatures as low as 149°C (300°F). All PASS devices that were evaluated experienced significant alarm signal degradation at temperatures between 149°C and 260°C (300°F and 500°F). As the PASS cooled, the alarm signal on most of the units returned to pre-exposure sound levels.

NIOSH and others also noted that water ingress did occur or could have occurred in several cases, causing the alarm signal to cease to function effectively, but that after the PASS electronics dried, the alarm signal would again function.

The Committee addressed these issues and others and developed changes to the requirements for the fifth edition. More significant changes were the following:

(1) New water immersion requirements and testing where PASS is exposed to 177°C (350°F) for 15 minutes and then to water submersion in 1.5 m (4.9 ft) also for 15 minutes for each of six cycles. PASS is then examined to determine no water ingress, that all PASS signals function properly, and that electronic data logging functions operate properly. PASS is then reimmersed in the test water for an additional 5 minutes with the power source compartment(s) open; after those 5 minutes, the PASS is removed from water and wiped dry, and the electronics compartment is opened and examined to determine no water ingress.
(2) Revised high-temperature resistance requirements and added new high-temperature functionality requirements and testing procedures where PASS is exposed to 260°C (500°F) for 5 minutes while mounted in a circulating hot air oven. The PASS alarm signal must function at or above the required 95 dBA sound level for the required duration of the signal, electronic data logging functions must operate properly, and no part of the PASS can show evidence of melting, dripping, or igniting.
(3) New tumble–vibration requirements and testing in which PASS is "tumbled" in a rotating drum for 3 hours. The PASS alarm signal must function at the required 95 dBA sound level, and electronic data logging functions must operate properly.
(4) New requirements to prevent muffling of the alarm signal where PASS is mounted on a test subject and evaluated in five positions (face down with arms extended, supine left, supine right, fetal right with knees drawn to chest, fetal left with knees drawn to chest), and the alarm signal must function at or above the required 95 dBA sound level in each of the positions.

The 2013 edition of NFPA 1982 was a complete revision of the fifth edition. During this revision cycle, the Technical Committee received reports from NIST on technical changes with respect to the testing of PASS.

The 2013 edition added the minimum requirements for radio frequency (RF) PASS devices that are capable of transmitting a distress alarm and receiving an evacuation alarm via an RF signal. New definitions in this edition included *RF PASS*, *base station*, *evacuation alarm*, *loss-of-signal alarm*, *RF interference*, and *RF transceiver*. In addition, the informational references in Annex B were updated to include NIST publications.

In Chapter 4, the test matrices for stand-alone, removable, and nonremovable integrated PASS were updated, and in Chapter 6, alarm signals were revised. In Chapter 8, several new test methods were added, including radio system tests for RF PASS, loss-of-signal alarms, and an RF interference test for optional RF PASS.

The 2018 edition of NFPA 1982 features referenced document edition updates, additions to Chapter 2 and Annex D, clarifications and editorial changes, and harmonization with NFPA 1801, *Standard on Thermal Imagers for the Fire Service*.

The Technical Committee has added a failure mode and effects analysis (FMEA) for PASS devices to identify and prioritize critical failures that could have a serious effect on the safety and reliability of a PASS in the expected operating environment. The FMEA also will help describe how the PASS system might fail.

Also added are changes to the PASS annunciator now driven by an alarm sequence of eight steps, changes to the frequency of sweep and tone, and the pre-alarm sound specification.

Revisions also were made to the low power source warning signal due to the introduction of rechargeable batteries to SCBA/PASS alarms, and the standard now requires that the battery must be discharged to the low battery trip point voltage or the low battery trip point capacity remaining percentage.

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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. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex D. 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 publications can be found in Chapter 2 and Annex D.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall specify minimum requirements for the design, performance, testing, and certification for all personal alert safety systems (PASS) for emergency services personnel.

1.1.2* This standard shall specify the requirements for all new PASS, including, but not limited to, stand-alone PASS, integrated PASS, and RF PASS.

1.1.3* This standard shall also specify the minimum requirements for the design, performance, testing, and certification of PASS or RF PASS devices certified to an earlier edition of this standard that incorporate parts, components, and/or software to meet this edition of the standard.

1.1.4 This standard shall not specify requirements for any accessories that could be attached to the PASS but that are not necessary for the PASS to meet the requirements of this standard.

1.1.5 This standard shall not be construed as addressing all the safety concerns associated with the use of compliant PASS. It shall be the responsibility of the persons and organizations that use compliant PASS to establish safety and health practices and to determine the applicability of regulatory limitations prior to use.

1.1.6 This standard shall not be construed as addressing all the safety concerns, if any, associated with the use of this standard by testing facilities. It shall be the responsibility of the persons and organizations that use this standard to conduct testing of PASS to establish safety and health practices and to determine the applicability of regulatory limitations prior to using this standard for any designing, manufacturing, and testing.

1.1.7 Nothing herein is intended to 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 PASS that are intended for use by emergency services personnel during emergency operations and that emit an audible signal to summon aid in the event the user becomes incapacitated or needs assistance.

1.2.1.1 This standard shall establish minimum requirements for optional RF PASS that are capable of transmitting an alarm signal and receiving an evacuation alarm via an RF signal.

1.2.1.2 This standard shall establish minimum requirements for the base station used in optional RF PASS for the receipt of an alarm signal and the transmission of an evacuation alarm via an RF signal.

1.2.2* Controlled laboratory tests used to determine compliance with the performance requirements of this standard shall not be deemed as establishing PASS performance levels for all situations to which fire-fighting or emergency services personnel can be exposed.

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

1.3 Application.

1.3.1 This standard shall apply to the design, performance, testing, and certification of PASS or RF PASS devices certified to an earlier edition of this standard that incorporate replacement parts, components, and/or software to be certified to this edition of the standard.

1.3.2* This standard shall not apply to any accessories that could be attached to the certified product before or after purchase but that are not necessary for the certified product to meet the requirements of this standard.

Δ **1.3.3** This standard shall not apply to the use of PASS, the requirements for which are specified in NFPA 1500.

1.4 Units.

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

1.4.2 Because the equivalent values in parentheses are approximate, they shall not be considered as the requirement.

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 1500, *Standard on Fire Department Occupational Safety and Health Program,* 2018 edition.

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

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services,* 2018 edition.

2.3 Other Publications.

Δ **2.3.1 ANSI Publications.** American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI/UL 913, *Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations,* sixth edition.

ANSI S1.4, *Specification for Sound Level Meters,* 1983, reaffirmed 2006.

ANSI/ASA S1.13, *Measurement of Sound Pressure Levels in Air,* 2005, reaffirmed 2010.

N **2.3.2 ASME Publications.** American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME B46.1, *Surface Texture (Surface Roughness, Waviness & Lay),* 2009.

ASME Y14.38, *Abbreviations and Acronyms for Use on Drawings and Related Documents,* 2007, reaffirmed 2013.

ASME Y14.5, *Dimensioning and Tolerancing,* 2009.

2.3.3 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.

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

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

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

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

IEC 61000-4-21, *Testing and measurement techniques — Reverberation chamber test methods,* 2011.

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.

2.3.5 U.S. Government Publications. U.S. Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

Title 47, Code of Federal Regulations, Subchapter A, General, Telecommunications, Chapter I, Federal Communications Commission, Part 15, Radio Frequency Devices.

2.3.6 Other Publications.

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

2.4 References for Extracts in Mandatory Sections.

NFPA 1801, *Standard on Thermal Imagers for the Fire Service,* 2018 edition.

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 equip-

ment, 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 Alarm Signal. An audible warning that is identifiable as an indication that an emergency services person is in need of assistance.

3.3.1.1 ***Evacuation Alarm.*** An alarm initiated by a base station, transmitted to an RF PASS via an RF signal. The evacuation alarm warns emergency services personnel to evacuate the premises.

Δ **3.3.1.2** ***Loss-of-Signal Alarm.*** A visual signal that is initiated automatically when the RF communication between a base station and RF PASS is lost

3.3.2 Certification Organization. An independent, third-party organization that determines product compliance with the requirements of this standard with a labeling/listing/follow-up program.

3.3.3 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.

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

3.3.5 Compliant Product(s). Clothing or equipment that is certified to the applicable NFPA standard.

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

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

3.3.8 Follow-Up 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.

3.3.9 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 the liability for the compliant product or provides the warranty for the compliant product.

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

3.3.11 Model. The collective term used to identify a group of 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.

3.3.12 PASS. Acronym for Personal Alert Safety Systems. See also 3.3.14, Personal Alert Safety Systems (PASS).

3.3.13 PASS Annunciator. The component designed to emit audible signals.

3.3.14 Personal Alert Safety Systems (PASS). A device that continually senses for lack of movement of the wearer and automatically activates the alarm signal, indicating the wearer is in need of assistance; can also be manually activated to trigger the alarm signal.

3.3.14.1 ***Integrated PASS.*** A removable or nonremovable PASS that is an integral part of another item or items of protective clothing, protective equipment, or both.

3.3.14.1.1 ***Nonremovable.*** An integrated PASS that is not removable and cannot be used independently of the item or items with which it is integrated.

3.3.14.1.2 ***Removable.*** An integrated PASS that is removable so that it can be used independently of the item or items with which it is integrated.

3.3.14.1.3 ***Stand-Alone PASS.*** A PASS that is not an integral part of any other item of protective clothing or protective equipment.

3.3.14.2 ***RF PASS.*** A PASS that contains an optional RF transceiver that enables the PASS to automatically transmit an alarm signal and receive evacuation alarms via RF signals; responds to an evacuation alarm with an audible and visual signal.

3.3.14.2.1 ***Base Station.*** An RF transceiver used in conjunction with an RF PASS that monitors for an alarm signal and emits a visual signal when this alarm is received. The base station is capable of sending an evacuation alarm to the RF PASS.

3.3.15 Pre-Alarm Signal. An audible warning that is identifiable as an indication that a PASS is about to sound the alarm signal.

3.3.16 Product Label. A marking provided by the manufacturer for each compliant product containing compliant statements, certification statements, manufacturer and model information, or similar data. The product label is not the certification organization's label, symbol, or identifying mark; however, the certification organization's label, symbol, or identifying mark is attached to or is part of the product label.

3.3.17 RF Interference. An unwanted radio-frequency signal that is present in the vicinity of an RF PASS system that could impede reception of an alarm signal or evacuation alarm.

3.3.18 RF Transceiver. A radio system capable of both transmitting and receiving a modulated radio-frequency (RF) signal that is then converted to an audio and/or data signal; used to transmit and receive signals such as the alarm signal and the evacuation alarm for RF PASS.

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

3.3.20 Sample. (1) The ensemble, element, component, or composite that is conditioned for testing. *(See also 3.3.21, Specimen.)* (2) 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.

3.3.21 Specimen. The conditioned ensemble, element, item, or component that is tested. Specimens are taken from samples. *(See also 3.3.20, Sample.)*

3.3.22 Surrogate Cylinder. A breathing air cylinder for testing only in which the mass of the breathing air is replaced by a substitute mass.

Chapter 4 Certification

4.1 General.

4.1.1 The certification process for PASS, as being compliant with NFPA 1982, shall include the requirements of Section 4.1, General; Section 4.2, Certification Program; Section 4.3, Inspection and Testing; Section 4.4, Recertification; Section 4.5, Manufacturers' Quality Assurance Program; Section 4.6, Hazards Involving Compliant Product; Section 4.7, Manufacturers' Investigation of Complaints and Returns; and Section 4.8, Manufacturers' Safety Alert and Product Recall Systems.

4.1.2 All PASS that are labeled as being compliant with this standard shall meet or exceed all applicable requirements specified in this standard and shall be certified. Manufacturers shall not claim compliance with a portion(s) or segment(s) of the requirements of this standard and shall not use the name or identification of this standard, NFPA 1982, in any statements about their respective products unless the product is certified to this standard.

Δ **4.1.3** All certification shall be performed by a certification organization that meets at least the personal protective equipment (PPE) requirements specified in Section 4.2, Certification Program, and that is accredited for PPE in accordance with ISO/IEC Guide 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services*. 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*.

4.1.4 All individual compliant PASS shall be labeled. All individual compliant PASS shall also have a product label or labels that meet the requirements specified in Section 5.1.

4.1.5 All compliant PASS shall be listed by the certification organization. The listing shall uniquely identify the certified product, for example, by style, model number, or part number.

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

4.1.7 The certification organization shall not certify any PASS to the 2013 edition of this standard on or after the NFPA effective date for the 2018 edition, which is November 30, 2017.

4.1.8 The certification organization shall not permit any manufacturer to label any PASS as compliant with the 2013 edition of this standard on or after November 30, 2018.

4.1.9 The certification organization shall require manufacturers to remove all certification labels and product labels indicating compliance with the 2013 edition of this standard from all PASS that are under the control of the manufacturer on or before November 30, 2018. The certification organization shall verify this action is taken.

4.2 Certification Program.

4.2.1* The certification organization shall not be owned or controlled by 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.

Δ **4.2.3** The certification organization shall be accredited for PPE in accordance with ISO/IEC Guide 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services*. 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 proper tests to determine product compliance.

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

4.2.6.2 The certification organization laboratory facilities shall follow good practice 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, Manufacturers' Quality Assurance Program.

4.2.7.1* The certification organization shall require the manufacturer to have a product recall system as specified in Section 4.8, Manufacturers' Safety Alert and Product Recall Systems, as part of the manufacturer's 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.

4.2.8.1 The certification organization and the manufacturer shall evaluate replacement parts, components, and software to determine any changes affecting the form, fit, or function of PASS or RF PASS devices certified to earlier editions of this standard to permit incorporation of replacement parts, components, or software, leading to certification of devices to this edition of the 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 sample 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 Sample product shall be evaluated by the certification organization to verify the product's continued compliance in order to assure 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, Hazards Involving Compliant Product, that address reports of situations in which a compliant product is subsequently found to be hazardous.

4.2.11 The certification organization's operating procedures shall provide a mechanism for the manufacturer to appeal decisions. The procedures shall include the presentation of information from both sides of a controversy to a designated appeals panel.

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

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 PPE.

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 PPE.

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 inspection to determine compliance with this standard shall be established by the certification organization and the manufacturer to ensure a reasonable and acceptable reliability at a reasonable and acceptable confidence level that products certified as being compliant with the standard are compliant.

4.3.5 Inspection 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 in Section 5.1, Product Labeling Requirements.

4.3.6 Inspection 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 5.1.4, to ensure that the symbols are clearly explained in the product's user information package.

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

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

4.3.9* Testing conducted by the certification organization in accordance with the testing requirements of Chapter 8, for determining product compliance with the applicable performance requirements specified in Chapter 7, shall be performed on whole and complete PASS. Where the PASS is an integral part of another item of protective clothing or protective equipment, that item with the PASS incorporated shall be tested as a whole, unless otherwise specified herein.

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4.3.10 PASS shall be tested for initial certification to this edition of NFPA 1982 and shall meet the performance requirements of the test series specified in the test matrix in Table 4.3.10(a) and Table 4.3.10(b) as applicable, for the type of PASS being certified.

4.3.10.1 Where there is more than one test for a single test specimen required by Table 4.3.10(a) or Table 4.3.10(b), the order of testing shall be from top to bottom of the test specimen column as shown in the table.

4.3.10.2 When testing removable integrated PASS, test specimens 1, 2, and 3, as identified in Table 4.3.10(a), shall be in the integrated PASS configuration.

Δ **4.3.10.3** When testing specimen PASS in accordance with Section 8.3, Electronic Temperature Stress Test; Section 8.4, Corrosion Resistance Test; Section 8.5, Heat and Immersion Leakage Test; Section 8.6, Case Integrity Test; Section 8.8, Impact Acceleration Resistance Test; and Section 8.13, Heat and Flame Test, one specimen PASS, instead of all three specimens tested in each test series, shall be selected to be used for evaluation of the requirements of 7.1.2. The one specimen PASS that is selected shall be chosen at random from each of the respective series of three specimens for each test.

4.3.11 Any change in the design, construction, or material of a compliant PASS shall necessitate new inspection and testing to verify compliance to all applicable requirements of this standard that the certification organization determines can be affected by such change. This recertification shall be conducted before labeling the modified PASS as being compliant with this standard.

4.3.12 The certification organization shall not allow any modifications, pretreatment, conditioning, or other such special processes of the PASS or any PASS component, prior to the

Δ **Table 4.3.10(a) Test Matrix for Stand-Alone PASS and Removable Integrated PASS**

Test Order	Specimens 1–3	Specimens 4–6	Specimens 7–9	Specimens 10–12	Specimens 13–15	Specimens 16–18	Specimens 19–21	Specimens 22–24
1	Sound pressure (Section 8.2), specimens 1–3	Shock sensitivity (Section 8.7), specimens 4–6	Electronic temperature stress — elevated (8.3.5), specimens 7–9	Water drainage (Section 8.11), specimens 10–12	Case integrity (Section 8.6), specimens 13–15	Vibration test (Section 8.9), specimens 16–18	Tumble vibration (Section 8.17), specimens 19–21	Signal frequencies (Sections 8.14 and 8.15), specimens 22–24
2	Alarm signal muffle (Section 8.18), specimens 1–3	Impact acceleration — ambient (Section 8.8), specimen 4	Electronic temperature stress — low (8.3.6), specimens 7–9	Corrosion (Section 8.4), specimens 10–12	Retention system (Section 8.10), specimens 13–15		Point-to-point RF attenuation test (Section 8.19), specimens 19–21	
3		Impact acceleration — cold (Section 8.8), specimen 5	Electronic temperature stress — shock (8.3.7), specimens 7–9	Product label durability (Section 8.16), specimens 10–12	High temperature functionality (Section 8.12), specimens 13–15		Loss-of-signal alarm test (Section 8.20), specimens 19–21	
4	Heat/flame test 1 (8.13.5.8), specimen 1	Impact acceleration — elevated (Section 8.8), specimen 6	Product label durability (Section 8.16), specimens 7–9				RF interference test (Section 8.21), specimens 19–21	
5	Heat/flame test 2 (8.13.5.9), specimen 2		Heat and immersion leakage (Section 8.5), specimens 7–9				RF Multipath Test (Section 8.22) specimens 19–21	
6	Heat/flame test 3 (8.13.5.10), specimen 3		Product label durability (Section 8.16), specimens 7–9				RF Multi-hop Test (Section 8.23) specimens 19–21	

Δ Table 4.3.10(b) Test Matrix for Nonremovable Integrated PASS

Test Order	Specimens 1–3	Specimens 4–6	Specimens 7–9	Specimens 10–12	Specimens 13–15	Specimens 16–18	Specimens 19–21
1	Sound pressure (Section 8.2), specimens 1–3	Shock sensitivity (Section 8.7), specimens 4–6	Electronic temperature stress — elevated (8.3.5), specimens 7–9	Water drainage (Section 8.11), specimens 10–12	Case integrity (Section 8.6), specimens 13–15	Tumble vibration (Section 8.17), specimens 16–18	Signal frequencies (Sections 8.14 and 8.15), specimens 19–21
2	Alarm signal muffle (Section 8.18), specimens 1–3	Vibration test (Section 8.9), specimens 4–6	Electronic temperature stress — low (8.3.6), specimens 7–9	Corrosion (Section 8.4), specimens 10–12	High temperature functionality (Section 8.12), specimens 13–15	Point-to-point RF attenuation test (Section 8.19), specimens 16–18	
3			Electronic temperature stress — shock (8.3.7, specimens 7–9	Product label durability (Section 8.16), specimens 10–12		Loss-of-signal alarm test (Section 8.20), specimens 16–18	
4	Heat/flame test 1 (8.13.5.8), specimen 1		Product label durability (Section 8.16), specimens 7–9			RF interference test (Section 8.21), specimens 16–18	
5	Heat/flame test 2 (8.13.5.9), specimen 2		Heat and immersion leakage (Section 8.5), specimens 7–9			RF Multipath Test (Section 8.22) specimens 16–18	
6	Heat/flame test 3 (8.13.5.10), specimen 3		Product label durability (Section 8.16), specimens 7–9			RF Multi-hop Test (Section 8.23) specimens 16–18	

product's submission for evaluation and testing by the certification organization. The certification organization shall accept, from the manufacturer for evaluation and testing for certification, only PASS or PASS components that are the same in every respect to the actual final product or component. Other than as specifically permitted herein, the certification organization shall not allow the substitution, repair, or modification of any PASS or any PASS component during testing.

Δ 4.3.13* All testing and inspection shall be performed utilizing the power source(s) specified on the PASS in accordance with 5.1.7(6).

4.4 Recertification.

4.4.1 After initial certification to this edition of NFPA 1982, compliant PASS shall be tested annually for recertification within 12 months from the previous certification or recertification.

4.4.2 Recertification shall occur each year of the 4 years following initial certification. If there is no revision to this edition of NFPA 1982 by the fifth year following initial certification, compliant PASS shall be required to undergo full certification testing as specified in 4.3.10 in the fifth year.

4.4.3 Unless otherwise indicated, only one test specimen shall be required for each test specified in Table 4.3.10(a) or Table 4.3.10(b), as applicable for the type of PASS being recertified.

4.4.4 Where there is more than one test for a single test specimen PASS required by Table 4.3.10(a) or Table 4.3.10(b), the order of testing shall be from top to bottom of the test specimen column as shown in the tables.

4.5 Manufacturers' Quality Assurance Program.

4.5.1 The manufacturer shall provide and operate a quality assurance program that meets the requirements of this section and that includes a product recall system as specified in 4.2.7.1, and Section 4.8, Manufacturers' Safety Alert and Product Recall Systems.

4.5.2 The operation of the quality assurance program shall evaluate and test compliant product production to the requirements of this standard to assure 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 for PPE.

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Δ 4.5.3.2 Registrars specified in 4.5.3.1 shall be accredited for PPE in accordance with ISO/IEC 17021-1, *Conformity assessment — Requirements for bodies providing audit and certification of management systems.*

Δ **4.5.3.3** Any new accreditations for registrars specified in 4.5.3.1 for PPE shall only be in accordance with ISO/IEC 17021-1, *Conformity assessment — Requirements for bodies providing audit and certification of management systems.*

4.5.4* Any entity that meets the definition of *manufacturer* specified in Section 3.3, General Definitions, and therefore is considered to be the "manufacturer" but does not manufacture or assemble the compliant product, shall meet the requirements specified in this 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 the documentation shall be provided to the manufacturer's ISO registrar and to the certification organization.

4.6 Hazards Involving Compliant Product.

4.6.1* The certification organization shall establish procedures to be followed where situation(s) are reported in which a compliant product is subsequently found to be hazardous. 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.

4.6.2* 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.

4.6.3 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 an imminently dangerous or dangerous condition.

4.6.4 Where a specific hazard is identified, the determination of the appropriate 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.

4.6.5 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.

4.6.6 The certification organization's investigation shall include, but not be limited to, the extent and scope of the problem as it might apply to other compliant product or compliant product components manufactured by other manufacturers or certified by other certification organizations.

4.6.7 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.

4.6.8 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 4.7, Manufacturers' Investigation of Complaints and Returns.

4.6.9 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.

4.6.10 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.

Δ **4.6.11*** Where the facts are conclusive and corrective action is indicated, the certification organization shall take one or more of the following corrective actions:

(1) Notification of parties authorized and responsible for issuing a safety alert when, in the opinion of the certification organization, such a notification is necessary to inform the users.
(2) Notification of parties authorized and responsible for issuing a product recall when, in the opinion of the certification organization, such a recall is necessary to protect the users.
(3) Removing the mark of certification from the product.
(4) Where a hazardous condition exists and it is not practical to implement 4.6.11(1), 4.6.11(2), or 4.6.11(3); or 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.

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

4.7 Manufacturers' Investigation of Complaints and Returns.

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

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

4.7.3 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 that is possibly subject to a safety alert or product recall, the manufacturer shall immediately contact the certification organization and provide all information about their review to assist the certification organization with their investigation.

4.8 Manufacturers' Safety Alert and Product Recall Systems.

4.8.1 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 it decides, or is directed by the certification organization, to either issue a safety alert or to conduct a product recall.

4.8.2 The manufacturers' safety alert and product recall system shall provide:

(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 a 1-week period 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 accurately and understandably 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 either repairing, or replacing, or compensating purchasers for returned product

Chapter 5 Labeling and Information

5.1 Product Labeling Requirements.

5.1.1 Each PASS shall have a product label(s) permanently and conspicuously attached. In all cases, the PASS shall bear at least one product label with the marking requirements specified in 5.1.5 through 5.1.8.

5.1.1.1 Where various components of PASS are not mounted or contained in a single location, case, or enclosure, additional product labels shall be permanently and conspicuously attached to major dispersed components.

5.1.1.2 The text of the product labels for dispersed PASS components shall be permitted to be limited to the marking requirements specified in 5.1.5 and 5.1.6.

5.1.2 Multiple label pieces shall be permitted in order to carry all statements and information required to be on the product label.

5.1.3 All worded portions of the required product label(s) shall be printed at least in English.

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

5.1.5* The certification organization's label, symbol, or identifying mark shall be attached to the product label or shall be part of the product label. The label, symbol, or identifying mark shall be at least 6 mm (¼ in.) in height and shall be placed in a conspicuous location.

5.1.6 One of the following statements, as applicable, shall be legibly printed on the product label(s) and placed in a conspicuous location. All letters shall be at least 2 mm (1/16 in.) in height.

N **5.1.6.1** For PASS devices without RF capability, the label shall read:

THIS PASS MEETS THE REQUIREMENTS OF NFPA 1982, STANDARD ON PERSONAL ALERT SAFETY SYSTEMS (PASS), 2018 EDITION. DO NOT REMOVE THIS LABEL.

N **5.1.6.2** For PASS devices with RF capability, the label shall read:

THIS RF PASS MEETS THE REQUIREMENTS OF NFPA 1982, STANDARD ON PERSONAL ALERT SAFETY SYSTEMS (PASS), 2018 EDITION. DO NOT REMOVE THIS LABEL.

N **5.1.6.3** For RF PASS with repeating capability, the label shall read:

THIS RF PASS (RPT) MEETS THE REQUIREMENTS OF NFPA 1982, STANDARD ON PERSONAL ALERT SAFETY SYSTEMS (PASS), 2018 EDITION. DO NOT REMOVE THIS LABEL.

N **5.1.6.4**

PASS or RF PASS devices certified to previous editions of this standard that have been upgraded to meet this edition shall have the following statement legibly printed. All letters shall be at least 2 mm (1/16 in.) in height. The label is not restricted to one line. The original NFPA required labeling shall not be removed or covered by the upgrade label.

UPGRADED TO NFPA 1982, 2018 EDITION.

5.1.7 At least the following information shall also be legibly printed on the product label(s) and placed on each PASS in a user-accessible location, and all letters shall be at least 2 mm (1/16 in.) in height:

(1) Manufacturer name, identification, or designation
(2) Country of manufacture
(3) Model name, number, or design
(4) Identification/lot/serial number
(5) Month and year of manufacture, not coded
(6) Recommended power source type and size if user replaceable

5.1.8 PASS also shall be labeled as certified at least to the requirements for Class I, Groups C and D; and Class II, Groups E, F, and G; Division 1 hazardous locations specified in ANSI/UL 913, *Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1 Hazardous (Classified) Locations.*

5.1.9 All product labels also shall meet the requirements specified in Section 7.13, Product Label Durability.

5.1.10 The base station component of an RF PASS system shall identify the maximum number of RF PASS alarm signals that the base station can process. This number shall be clearly printed on the product label.

5.1.11 The base station and RF PASS units shall contain the appropriate product label specified by FCC guidelines, if any, for the radio system technology used.

5.2 User Information.

5.2.1 The PASS manufacturer shall provide with each PASS at least the user information that is specified in 5.2.4.

5.2.2 The PASS manufacturer shall attach the required user information or packaging containing the user information to the PASS in such a manner that it is not possible to initially use the PASS without being aware of the information.

5.2.3 The required user information or packaging containing the user information shall be attached to the PASS so that a deliberate action is necessary to remove it. The PASS manufacturer shall provide notice that the user information is to be removed only by the end user.

5.2.4 The PASS manufacturer shall provide at least the following instructions and information with each PASS:

(1) Pre-use information as follows:
   (a) Safety considerations
   (b) Limitations of PASS
   (c) Marking recommendations and restrictions
   (d) Warranty information
(2) Preparation for use as follows:
   (a) Preferred mounting position and orientation for optimal performance
   (b) Training instructions
   (c) Recommended storage practices
(3) Inspection frequency and details
(4) Proper use
(5) Maintenance and cleaning as follows:
   (a) Cleaning instructions and precautions
   (b) Power source testing and replacement
   (c) Adjustments, if applicable
   (d) Maintenance criteria
   (e) Painting
   (f) Decontamination procedures
(6) Retirement criteria and considerations
(7) Procedure for reporting PASS problems to the manufacturer and to the certification organization

Chapter 6 Design Requirements

6.1 General Design Requirements for PASS.

6.1.1 PASS shall have at least the applicable design requirements specified in this section where inspected and evaluated by the certification organization as specified in Section 4.3, Inspection and Testing.

6.1.2 In all instances, the design of PASS shall provide for the safety and security of the functioning of the PASS.

6.1.2.1 PASS that is designed as a self-contained, independent device contained in a single case, housing, or enclosure and that is not an integral part or parts of any item or multiple items of protective clothing, protective equipment, or both shall be designated as "stand-alone PASS."

6.1.2.2 PASS that is designed with dispersed components as part or parts of any item or multiple items of protective clothing, protective equipment, or both and the dispersed components are not mounted, grouped, or contained in a single location nor in a single case, housing, or enclosure, but with multiple cases, housings, or enclosures, shall be designated as "integrated PASS."

6.1.2.3 Where integrated PASS is designed and intended to be readily removed from the item or multiple items of protective clothing, protective equipment, or both, so that it can also be used independently, such integrated PASS shall be designated as "removable integrated PASS."

6.1.2.4 Where integrated PASS is not designed and not intended to be readily removed from the item or multiple items of protective clothing, protective equipment, or both so that it cannot be used independently, such integrated PASS shall be designated as "nonremovable integrated PASS."

6.1.2.5 Where the PASS device is equipped with an RF PASS in addition to emitting an alarm signal, it shall also transmit and receive other alarm signals through the use of a modulated radio-frequency carrier. The RF PASS system shall consist of a wireless RF transceiver contained within or linked to the RF PASS, and a base station RF transceiver that might be self-contained or designed to operate in conjunction with a portable computer. The base station unit shall be capable of battery operation for up to 1 hour under alarm conditions. The use of repeaters is not precluded.

6.1.2.5.1 The base station shall be designed to emit a visual alarm when the alarm signal described in 6.4.3 is activated by the RF PASS unit, when the evacuation alarm is initiated, and/or when the loss-of-signal alarm is triggered.

6.1.2.5.2 Both the RF PASS unit and base station shall comply with FCC regulations for radio-frequency transmissions for the transmission format chosen by the manufacturer.

6.1.2.5.3 Antennas and/or other peripheral electronic components designed for use with RF PASS shall not interfere with or impede fire-fighting operations.

6.1.2.5.4 Software used in conjunction with RF PASS and base stations shall be updated as necessary within 6 months by the manufacturer for newly released versions of the computer operating system for which the software was designed.

6.1.3* PASS shall incorporate data logging in nonvolatile memory and, at a minimum, the following events shall be identified and recorded with the data log and shall also have a date and time stamp for each event in the data log:

(1) When the PASS is turned on
(2) When the PASS activates any alarm or pre-alarm
(3) When the PASS alarm is activated by the user
(4) When the PASS alarm was reset
(5) When the PASS was turned off
(6) When the PASS low power source warning signal activates

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

6.1.3.2 The data logging shall have a minimum capacity of logging 2000 events.

6.1.3.3 Data logging shall be permitted to be carried out via RF signals transmitted by an RF PASS and received by the base station.

6.1.4* Where PASS designated as stand-alone PASS or as integrated PASS are secured by a retention system in a wearing position, in accordance with the manufacturer's instructions, the retention system shall not affect the proper function of the mode selection device or devices specified in Section 6.2, Mode Selection Design Requirements for PASS, and shall not affect the performance of the PASS when tested to the performance requirements specified in Chapter 7.

6.1.5* PASS power source(s) shall be isolated from the operating components to prevent damage to the components.

6.1.6 All PASS hardware finishes shall be free of all rough spots, burrs, and sharp edges.

6.1.7 All sewing thread used in the construction of PASS shall be made of inherently flame-resistant fiber.

6.2 Mode Selection Design Requirements for PASS.

6.2.1 PASS shall allow for operation in at least three modes: (1) off, (2) alarm, (3) sensing.

6.2.2 The mode selection device(s) shall be designed to provide automatic activation from the off mode to the sensing mode without the user setting the mode selection device.

6.2.2.1 Such automatic activation shall include, but not be limited to, being linked to activation of SCBA, being linked to removal from storage or transportation positions, by pull-away tether to a fixed position, or by remote activation.

6.2.2.2 Such automatic activation shall be designed so that when PASS is automatically activated it shall be able to be manually switched from the sensing mode to the alarm mode with the mode selection device but shall not be able to be switched to the off mode until the automatic activation means is also intentionally deactivated.

6.2.2.3 Base station units for RF PASS shall indicate on a visual display the presence of all RF PASS units that are in sensing mode.

6.2.3 All mode selection devices shall be protected against accidental change of operation and impact damage.

6.2.4 All mode selection devices shall be rated for a service life of not fewer than 50,000 cycles.

6.2.5 All mode selection devices shall be capable of being switched to the alarm or sensing mode by a single gloved hand. The fingers of gloves utilized for this function test shall have a thickness of 2.5 mm to 4 mm ($\frac{3}{32}$ in. to $\frac{5}{32}$ in.).

6.2.6 Only one action shall be required to switch the mode selection device(s) from any mode to alarm mode.

6.2.7 When PASS is sounding the alarm signal, it shall require at least two separate and distinct manual actions to silence the alarm signal.

6.2.7.1 Any action to silence the alarm signal and the actual silencing of the alarm signal shall not permit PASS to remain in the off mode.

6.2.7.2 The silencing of the alarm signal shall automatically reset PASS to the sensing mode.

Δ **6.2.7.3** Base station units for RF PASS shall indicate on a visual display the presence of all RF PASS units that are in alarm mode.

6.2.8 PASS shall be provided with a light source capable of providing a visual indication of mode status as well as an audible source capable of providing an aural indication of a change in the mode selection when switching from off to sensing, off to alarm, and alarm to sensing.

6.2.8.1 Base station units for RF PASS shall utilize a different visual display to indicate sensing and alarm modes.

6.3 Motion Sensing Design Requirements for PASS.

6.3.1 PASS shall incorporate motion sensing that shall detect motion and lack of motion of the person on whom the PASS is deployed and cause the activation of the sequence that leads to the sounding of the alarm signal when lack of motion is detected for the specified time.

6.3.2 PASS shall sound the alarm signal specified in 6.4.3 when the PASS does not sense movement for 30 seconds, +5/–0 seconds.

6.3.2.1 The base station associated with RF PASS shall receive the alarm signal within 30 seconds +5/–0 seconds of its transmission by the RF PASS, unless RF communication has been lost.

6.3.3 The alarm signal shall be preceded by a pre-alarm signal as specified in 6.4.2 that shall sound for 10 seconds +3/–0 seconds before the sounding of the alarm signal.

6.3.4 PASS motion sensing shall function regardless of the angle of deployment of the PASS.

6.3.5 PASS shall be designed so that any failure of the motion sensing function shall cause the PASS to sound the alarm signal as specified in 6.4.3 within 30 seconds +5/–0 seconds of such failure. The PASS manufacturer shall submit a failure modes and effects analysis (FMEA) to the certification organization for verification of this requirement.

6.3.6 For RF PASS, the evacuation alarm shall be received within 30 seconds +5/–0 seconds of its transmission by the base station unless RF communication has been lost.

N **6.3.7 Failure Mode and Effects Analysis (FMEA) for Personal Alert Safety Systems.**

N **6.3.7.1*** An FMEA shall be applied throughout the development process.

N **6.3.7.2** The FMEA shall address PASS and shall identify and prioritize those critical failures that could have a serious effect on the safety and reliability of a PASS in the anticipated operating environments.

N **6.3.7.3** The FMEA shall tabulate potential failure modes and their effects on the performance of a PASS. The failure mode shall describe how the system might fail.

N **6.3.7.4*** The PASS manufacturer shall use the FMEA to address the reduction of risk of random and systematic failures of PASS by using as low as reasonably practical (ALARP) region activities, shown in Figure 6.3.7.4. The PASS manufacturer shall include the risk priority number (RPN) corresponding to the upper limit of the ALARP region in the FMEA report.

N **6.3.7.5** Where a PASS RPN as determined by the manufacturer is above the upper limit of the ALARP region as determined by the manufacturer, one or more of the practices specified in 6.3.7.5.1 shall be permitted.

N **6.3.7.5.1** Verification of the manufacturer's design and testing practices shall include documentation of at least temperature, vibration, and wetness exposure data, hours of operation, and management of change information.

N **6.3.7.6** The FMEA report shall be provided to the certification organization.

FIGURE 6.3.7.4 ALARP Region Activities. [1801: Figure 6.3.4]

6.4 Signal Design Requirements for PASS.

6.4.1 Operational Signal.

6.4.1.1 PASS shall emit an audible "operational signal" within 1 second of completing the required action to set PASS to the sensing mode, indicating to the user that the device is functioning properly.

6.4.1.2 When PASS is in the off mode and the power source is at or below the level specified in 6.4.4.1, the operational signal shall not sound when PASS is switched to the sensing mode.

6.4.2 Pre-Alarm Signal.

6.4.2.1 The PASS shall have at least an audible primary "pre-alarm signal." The audible primary pre-alarm signal shall be a distinct and different sound from the alarm signal.

6.4.2.2 PASS shall be permitted to incorporate a supplementary pre-alarm signal or signals in addition to the audible primary pre-alarm signal to enhance the ability of the user to detect and identify the pre-alarm status. Supplementary pre-alarm signals shall be variable in a continuous pattern or shall be recurrent.

6.4.2.2.1 The supplementary pre-alarm signal shall alert senses other than hearing.

6.4.2.2.2 When activated, the supplementary pre-alarm signal shall not diminish the performance of the audible primary pre-alarm signal below the requirements of this standard.

6.4.2.2.3 The design of the supplementary pre-alarm signal shall be such that failure of the supplementary pre-alarm signal shall not affect the activation or operation of the audible primary pre-alarm signal.

6.4.2.3 PASS shall sound the pre-alarm signal(s) 12 seconds +/−2 seconds prior to the sounding of the alarm signal.

6.4.2.4 During the pre-alarm signal(s) sounding, all other audible PASS signals, other than the alarm signal, shall be rendered inactive.

6.4.2.5 PASS shall be designed to have at least a motion-induced cancellation of functioning of the pre-alarm signal(s) prior to the sounding of the alarm signal.

6.4.2.6 Cancellation of the sounding of the audible primary pre-alarm signal and cancellation of functioning of the supplementary pre-alarm signal(s) shall not require the use of the user's hand(s).

6.4.2.7 PASS shall reset to the sensing mode upon cancellation of the pre-alarm signal.

6.4.2.8 Audible Primary Pre-Alarm Signal. The PASS annunciator shall be driven by a pre-alarm sequence consisting of the following three steps:

(1) Step 1: A Type-1 tone pair, repeated in sequence as follows with each tone duration being 500 ms ± 20 ms:
   (a) Tone 1..Tone 2..Tone 1..<silence 500 ms ± 20 ms>
   (b) Tone 1..Tone 2..Tone 1..<silence 500 ms ± 20 ms> immediately followed by Step 2.

(2) Step 2: A Type 2 tone pair, repeated in sequence as follows with each tone duration being 250 ms ± 10 ms:
   (a) Tone 3..Tone 4..Tone 3..<silence 250 ms ± 10 ms>
   (b) Tone 3..Tone 4..Tone 3..<silence 250 ms ± 10 ms>
   (c) Tone 3..Tone 4..Tone 3..<silence 250 ms ± 10 ms>
   (d) Tone 3..Tone 4..Tone 3..<silence 250 ms ± 10 ms> immediately followed by Step 3.

(3) Step 3: A Type 3 tone pair, repeated in sequence as follows with each tone duration being 125 ± 10 ms:
   (a) Tone 5..Tone 6..Tone 5..Tone 6..Tone 5..Tone 6..Tone 5..<silence 125 ms ± 10 ms>
   (b) Tone 5..Tone 6..Tone 5..Tone 6..Tone 5..Tone 6..Tone 5..<silence 125 ms ± 10 ms>
   (c) Tone 5..Tone 6..Tone 5..Tone 6..Tone 5..Tone 6..Tone 5..<silence 125 ms ± 10 ms>
   (d) Tone 5..Tone 6..Tone 5..Tone 6..Tone 5..Tone 6..Tone 5..<silence 125 ms ± 10 ms>

6.4.2.8.1 The total duration of the three steps shall comply with the time window for the pre-alarm specified in 6.3.3.

6.4.2.8.2 Tone pair definitions: The frequency of all tones shall be between 1000 Hz and 4000 Hz, with the second tone of each pair (Tone 2, Tone 4, and Tone 6) being 250 Hz + 250/−50 Hz higher than the first tone (Tone 1, Tone 3, and Tone 5) of the pair. It shall be permitted for each step's tone pair to be the same two tones or for them to rise to higher tones. If rising tone pairs are deployed, the frequency gap between Tone 2 and Tone 3 and between Tone 4 and Tone 5 shall be 250 Hz + 250/−50 Hz.

6.4.3 Alarm Signal.

6.4.3.1 PASS shall sound the alarm signal when switched to the alarm signal mode.

6.4.3.2 While in the motion sensing mode, PASS shall sound the alarm signal when activated by the motion sensing component when motion is not detected for 30 seconds.

6.4.3.2.1 For RF PASS, while in the sensing mode, the PASS shall sound an audible evacuation or other alarm within 30 seconds of the evacuation or other alarm being sent by the base station, unless the RF PASS is in alarm mode or the unit is out of range. Upon resetting the alarm condition, the RF PASS shall sound the evacuation or other alarm within 30 seconds. While the RF PASS is in alarm mode, no other audible alarms shall override or impede the alarm signal. For RF PASS with integrated repeating capability, the alarm shall be received within 30 seconds after two repeater hops, as specified by Section 8.23, Multi-hop RF Test.

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6.4.3.3 When activated by the motion sensor, the alarm signal shall be preceded by the pre-alarm signal, which shall sound 10 seconds +3/−0 seconds before the sounding of the alarm signal.

6.4.3.4 During the alarm signal sounding, all other audible PASS signals shall be rendered inactive.

6.4.3.4.1 For RF PASS, during the alarm signal sounding, all other audible PASS signals shall be rendered inactive.

6.4.3.5 The alarm signal shall have a duration of at least 1 hour at the PASS.

6.4.3.5.1 For RF PASS, the alarm signal shall have a duration of at least 1 hour at the base station.

6.4.3.6 The alarm signal, once activated, shall not be deactivated by the motion detector.

6.4.3.7 Any action to silence the alarm signal and the actual silencing of the alarm signal shall not permit the PASS to remain in the off mode.

6.4.3.8 The silencing of the alarm signal shall automatically reset the PASS to the sensing mode.

6.4.3.9 The PASS annunciator shall be driven by an alarm sequence consisting of the following eight steps:

(1) A Type 1 sweep
(2) A silent interval of 300 ms ± 100 ms
(3) A Type 2 sweep, repeated a total of 4 times with a silent interval of 10 ms ± 5 ms between each sweep
(4) A silent interval of 300 ms ± 100 ms
(5) A Type 1 warble
(6) A Type 2 warble
(7) A Type 1 warble
(8) A silent interval of 600 ms ± 100 ms

6.4.3.9.1 Following Step 8, the alarm sound shall repeat beginning immediately with Step 1.

6.4.3.9.2 Type 1 Sweep. The Type 1 sweep is a 1 second ± 50 ms frequency sweep with a minimum of 100 increasing frequency steps. The start frequency and end frequency shall be in the range of 2000 Hz to 4000 Hz and the end frequency must be a minimum of 500 Hz greater than the start frequency.

6.4.3.9.3 Type 2 Sweep. The Type 2 sweep is a 250 ms ± 12.5 ms frequency sweep with a minimum of 25 increasing frequency steps. The start frequency and end frequency shall be in the range of 2000 Hz to 4000 Hz and the end frequency must be a minimum of 500 Hz greater than the start frequency.

6.4.3.9.4 Type 1 Warble. The Type 1 warble is a 400 ms ± 20 ms sound that alternates between Tone A and Tone B every 10 ms ± 5 ms.

N **6.4.3.9.5 Type 2 Warble.** The Type 2 warble is a 200 ms ± 10 ms sound that alternates between Tone B and Tone C every 10 ms ± 5 ms.

N **6.4.3.9.6** Tones A, B, and C shall be between 2000 Hz and 4000 Hz.

N **6.4.3.9.6.1 Tone A.** Tone A shall be a frequency between 2300 Hz and 4000 Hz.

N **6.4.3.9.6.2 Tone B.** Tone B shall be a frequency 100 Hz to 200 Hz below Tone A.

N **6.4.3.9.6.3 Tone C.** Tone C shall be a frequency 200 Hz to 300 Hz below Tone B.

6.4.4 Low Power Source Warning Signal.

6.4.4.1 While in the sensing mode, PASS shall emit a recurrent audible low power source warning signal when the power source voltage or power source percent capacity remaining is depleted to the level that will maintain the alarm signal level at a minimum of 92 dBA for a minimum of 1 hour.

6.4.4.2 The power source shall be discharged at a rate that is equal to the average current draw, ±10 percent of the same model PASS, while in the alarm mode. The rate shall be determined by measurement by the certification organization.

6.4.4.3 The low power source warning signal sound shall be distinct and different from the pre-alarm signal(s) and the alarm signal.

6.4.4.4 The low power source warning signal shall have an interval of not greater than 30 seconds.

6.4.4.5 While in the off mode and with the power source voltage or power source percent remaining at or below the level specified in 6.4.4.1, the system that causes the activation of the low power source warning signal shall cancel the operational signal so that it shall not sound when the PASS is switched to the sensing mode.

6.4.5 Loss-of-Signal Alarm (RF PASS).

6.4.5.1 For RF PASS, when loss of RF communication is detected, the base station shall emit a recurrent visual loss-of-signal alarm and the RF PASS unit shall emit a recurrent visual loss-of-signal alarm within 60 seconds of loss of RF communication. The visual alarm shall recur at a period of no more than 20 seconds. Loss of communication might be due to, but not be limited to, the portable unit being out of range or the presence of an RF interferer.

6.4.5.2 The loss-of-signal alarm shall consist of a visual alarm, distinct from the remote distress alarm and the evacuation signal.

6.4.5.3 The base station and the RF PASS shall monitor for loss of RF communication periodically when the RF PASS is in sensing mode at a period not to exceed 60 seconds.

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Chapter 7 Performance Requirements

7.1 Sound Pressure Levels.

7.1.1 Audible Primary Pre-Alarm Signal.

7.1.1.1 PASS shall be tested for the sound pressure level of the audible primary pre-alarm signal as specified in Section 8.2, Sound Pressure Level Tests. The sound pressure level of the Type 1 tone pair shall be a minimum of 60 dBA. The sound pressure level of the Type 2 tone pair shall be a minimum of 75 dBA and a minimum of 3 dBA greater than the Type 1 tone pair. The sound pressure level of the Type 3 tone pair shall be a minimum of 90 dBA and shall be a minimum of 3 dBA greater than the Type 2 tone pair.

7.1.1.2* PASS shall be tested for primary pre-alarm signal frequency as specified in Section 8.14, Signal Frequency Test, shall have at least an audible signal, and shall have the primary pre-alarm as specified in 6.4.2.8.

7.1.2 PASS Alarm Signal.

7.1.2.1 PASS shall be tested for the sound pressure level of the alarm signal as specified in Section 8.2, Sound Pressure Level Tests, and shall not have the alarm signal, once activated, be deactivated by the motion detector; shall have the alarm signal sound pressure level not be less than 92 dBA; and shall have PASS function properly as specified in 6.4.3.

7.1.2.2 PASS shall be tested for frequency content as specified in Section 8.15, Signal Frequency Test, and shall have the alarm signals as specified in 6.4.3.9.

7.1.3 PASS Low Power Warning Signal. PASS shall be tested for the sound pressure level of the *low power source warning signal* as specified in Section 8.2, Sound Pressure Level Tests, and shall have a sound pressure level between 75 dBA and 95 dBA; shall have the low power source warning signal continue

to sound for not less than 1 hour; and shall have the PASS function properly as specified in 6.4.4.

Δ **7.2 Electronic Temperature Stress.** PASS shall be tested for resistance to electronic temperature stress as specified in Section 8.3, Electronic Temperature Stress Test, and shall be evaluated for proper functioning of signals as specified in 6.4.2.3 and 6.4.3.2, shall meet the proper alarm signal sound pressure level as specified in 7.1.2.1, and shall have the data logging functions specified in 6.1.3(1) through 6.1.3(6) operating properly.

Δ **7.3 Corrosion Resistance.** PASS shall be tested for resistance to corrosion as specified in Section 8.4, Corrosion Resistance Test, and shall be evaluated for proper functioning of signals as specified in 6.4.2.3 and 6.4.3.2, shall meet the proper alarm signal sound pressure level as specified in 7.1.2.1, and shall have the data logging functions specified in 6.1.3(1) through 6.1.3(6) operating properly.

7.4 Immersion Leakage Resistance.

Δ **7.4.1** PASS shall be tested for resistance to leakage as specified in Section 8.5, Heat and Immersion Leakage Test, and for 8.5.5, Test Procedure 1, PASS shall be evaluated for proper functioning of signals as specified in 6.4.2.3 and 6.4.3.2, shall meet the proper alarm signal sound pressure level as specified in 7.1.2.1, shall have no water in its power source compartment(s), and shall have the data logging functions specified in 6.1.3(1) through 6.1.3(6) operating properly.

7.4.2 PASS shall be tested for resistance to leakage as specified in Section 8.5, Heat and Immersion Leakage Test; and for 8.5.6, Test Procedure 2, PASS shall have no water in the electronics compartment(s).

Δ **7.5 Case Integrity.** PASS cases, housings, or enclosures shall be tested for integrity as specified in Section 8.6, Case Integrity Test; shall be evaluated for proper functioning of signals as specified in 6.4.2.3 and 6.4.3.2; shall meet the proper alarm signal sound pressure level as specified in 7.1.2.1; shall support the test weight without affecting case integrity or causing visible damage; and shall have the data logging functions specified in 6.1.3(1) through 6.1.3(6) operating properly.

7.6 Intrinsic Safety. PASS shall be certified for intrinsic safety as specified in ANSI/UL 913, *Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1 Hazardous (Classified) Locations*, and shall meet the requirements for Class I, Groups C and D, and Class II, Groups E, F, and G, Division 1 hazardous locations.

7.7 Shock Sensitivity. PASS shall be tested for signal cancellation sensitivity as specified in Section 8.7, Shock Sensitivity Test, and the pre-alarm signal shall not cancel.

7.8 Impact and Vibration Resistance.

Δ **7.8.1** PASS shall be tested for resistance to impact as specified in Section 8.8, Impact Acceleration Resistance Test, and shall be evaluated for proper functioning of signals as specified in 6.4.2.3 and 6.4.3.2; shall meet the proper alarm signal sound pressure level as specified in 7.1.2.1; and shall have the data logging functions specified in 6.1.3(1) through 6.1.3(6) operating properly.

Δ **7.8.2** PASS shall be tested for resistance to vibration as specified in Section 8.9, Vibration Resistance Test, and shall be evaluated for proper functioning of signals as specified in 6.4.2.3 and 6.4.3.2; shall meet the proper alarm signal sound pressure level as specified in 7.1.2.1; and shall have the data logging functions specified in 6.1.3(1) through 6.1.3(6) operating properly.

Δ **7.8.3** PASS shall be tested for resistance to vibration as specified in Section 8.17, Tumble–Vibration Test, and shall be evaluated for proper functioning of signals as specified in 6.4.2.3 and 6.4.3.2; shall meet the proper alarm signal sound pressure level as specified in 7.1.2.1; and shall have the data logging functions specified in 6.1.3(1) through 6.1.3(6) operating properly.

7.9 Retention System. PASS shall be tested for durability of the retention system as specified in Section 8.10, Retention System Test, and the retention system shall withstand the applied force without separating.

7.10 Water Drainage. PASS shall be tested for water drainage as specified in Section 8.11, Water Drainage Test, and the alarm signal sound pressure level shall be at least 92 dBA.

Δ **7.11 Heat Resistance.** PASS shall be tested for resistance to heat as specified in Section 8.12, High Temperature Functionality Test, and shall not melt, drip, or ignite.

N **7.11.1** PASS shall be evaluated for proper functioning of signals as specified in 6.4.2.3 and 6.4.3.2.

N **7.11.2** The sound pressure level shall not be less than 92 dBA.

N **7.11.3** The data logging functions specified in 6.1.3(1) through 6.1.3(5)shall operate properly.

7.12 Heat and Flame Resistance.

Δ **7.12.1** PASS shall be tested for resistance to heat and flame as specified in Section 8.13, Heat and Flame Test, Test Procedure 1, and shall not have the afterflame exceed 2.2 seconds; shall have nothing fall off the PASS; shall not have the PASS fall from its mounted position; and the PASS shall function as follows:

(1) The alarm signal shall sound and continue to sound as specified in 6.4.3.
(2) The alarm signal shall meet the sound pressure levels as specified 7.1.2.1.
(3) At least two separate and distinct manual actions shall be required to change the mode selection device from alarm to sensing in order to silence the alarm as specified in 6.2.7.
(4) The data logging functions specified in 6.1.3(1) through 6.1.3(6) shall operate properly.

Δ **7.12.2** PASS shall be tested for resistance to heat and flame as specified in Section 8.13, Heat and Flame Test, Test Procedure 2, and shall not have the afterflame exceed 2.2 seconds; shall have nothing fall off the PASS; shall not have the PASS fall from its mounted position; and the PASS shall function as follows:

(1) PASS shall emit the operational signal as specified in 6.4.1.
(2) PASS shall cycle from sensing to pre-alarm as specified in Section 6.3, Motion Sensing Design Requirements for PASS.
(3) The primary pre-alarm signal shall sound as specified in 6.4.2.

(4) PASS shall cycle from pre-alarm to alarm as specified in Section 6.3, Motion Sensing Design Requirements for PASS.
(5) The alarm signal shall sound as specified in 6.4.3.
(6) At least two separate and distinct manual actions shall be required to change the mode selection device from alarm to sensing in order to silence the alarm as specified in 6.2.7.
(7) The primary pre-alarm signal sound pressure level shall be as specified in 7.1.1.1, and supplementary pre-alarm signals shall function as designed.
(8) The alarm signal sound pressure level shall be as specified in 7.1.2.1.
(9) The data logging functions specified in 6.1.3 through 6.1.3(6) shall operate properly.

Δ **7.12.3** PASS shall be tested for resistance to heat and flame as specified in Section 8.13, Heat and Flame Test, Test Procedure 3, and shall not have the afterflame exceed 2.2 seconds, shall have nothing fall off the PASS; shall not have the PASS fall from its mounted position; and the PASS shall function as follows:

(1) PASS shall emit the operational signal as specified in 6.4.1.
(2) The mode selection device shall be capable of being switched from sensing to alarm as specified in 6.2.5 and 6.2.6.
(3) The alarm signal shall sound as specified in 6.4.3.
(4) At least two separate and distinct manual actions shall be required to change the mode selection device from alarm to sensing in order to silence the alarm as specified in 6.2.7.
(5) The primary pre-alarm signal sound pressure level shall be as specified in 7.1.1.1, and supplementary pre-alarm signals shall function as designed.
(6) The alarm signal sound pressure level shall be as specified in 7.1.2.1.
(7) The data logging functions specified in 6.1.3(1) through 6.1.3(6) shall operate properly.

7.13 Product Label Durability. PASS with product labels attached shall be tested for durability and legibility as specified in Section 8.16, Product Label Durability Test, and the product labels shall remain attached to the PASS and shall be legible to the unaided eye.

Δ **7.14 Alarm Signal Muffle Test.** PASS shall be tested for resistance to sound pressure level deadening or muffling as specified in Section 8.18, PASS Alarm Signal Muffle Test, and the sound pressure level shall not be less than 92 dBA.

7.15* Radio System Tests — Point-to-Point RF Attenuation Test. RF PASS shall be tested for reliable wireless transmission and reception of alarm signals under a fixed amount of path loss (attenuation) as specified in Section 8.19, Radio System Tests for RF PASS — Point-to-Point RF Attenuation Test.

Δ **7.15.1** The base station shall automatically emit a visual alarm in response to an alarm signal received from the RF PASS within 30 seconds of alarm activation under the radio channel conditions specified in Section 8.19, Radio System Tests for RF PASS — Point-to-Point RF Attenuation Test.

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N **7.15.2** The RF PASS shall automatically emit an audible alarm within 30 seconds of evacuation alarm transmission by the base station under the radio channel conditions specified in Section 8.19, Radio System Tests for RF PASS — Point-to-Point RF Attenuation Test.

7.16 Radio System Tests — Loss-of-Signal Alarm Test. RF PASS shall be tested for initiation of a visual alarm signal when RF communication is lost as specified in Section 8.20, Radio System Tests for Optional RF PASS — Loss-of-Signal Alarm Test.

Δ **7.16.1** The base station shall automatically initiate the loss-of-signal alarm in response to loss of RF communication with the RF PASS within 60 seconds under the radio channel conditions specified in Section 8.20, Radio System Tests for Optional RF PASS — Loss-of-Signal Alarm Test.

N **7.16.2** The RF PASS shall automatically initiate the loss-of-signal alarm within 60 seconds of loss of RF communication with the base station under the radio channel conditions specified in Section 8.20, Radio System Test for Optional RF PASS — Loss-of-Signal Alarm Test.

7.17 Radio System Tests — RF Interference Test. RF PASS shall be tested for wireless transmission and reception of alarm signals under a fixed amount of external in-band RF interference as specified in Section 8.21, Radio System Tests for RF PASS — RF Interference Test.

7.17.1 The base station shall automatically emit a visual alarm in response to an alarm signal received from the RF PASS within 30 seconds of alarm activation under the radio channel conditions specified in Section 8.21, Radio System Tests for RF PASS — RF Interference Test.

7.17.2 The RF PASS shall automatically emit an audible alarm within 30 seconds of evacuation alarm transmission by the base station under the radio channel conditions specified in Section 8.21, Radio System Tests For RF PASS — RF Interference Test.

N **7.18 Radio System Tests — Multipath Test.** RF PASS shall be tested for reliable wireless transmission and reception of alarm signals under a statistical condition of multipath reflections as specified in Section 8.22, Radio System Tests for RF PASS — Multipath Test.

N **7.18.1** The base station shall automatically emit an audible alarm in response to an alarm signal received from the RF PASS within the time specified in 6.3.2.1 of alarm activation under the radio channel conditions specified in Section 8.22, Radio System Tests for RF PASS — Multipath Test. The RF PASS shall automatically emit an audible alarm within the time specified in 6.3.6 of evacuation alarm transmission by the base station under the radio channel conditions specified in Section 8.22, Radio System Tests for RF PASS — Multipath Test.

N **7.18.2** The multipath test shall be conducted to determine whether the RF PASS system will operate in an RF environment having multipath reflections as characterized in a reverberation chamber.

N **7.19 Radio System Tests for RF PASS — Multi-hop RF Test.** RF PASS with repeating capability shall be tested for reliable wireless transmission and reception of alarm signals under a fixed amount of path loss (attenuation) and through two repeaters as specified in Section 8.23, Radio System Tests for RF PASS — Multi-hop RF Test.

N **7.19.1** The RF PASS shall automatically emit an audible alarm within the time specified in 6.3.2.1 of alarm activation under

the radio channel conditions specified in Section 8.23, Radio System Tests for RF PASS — Multi-hop RF Test.

N **7.19.2** The Multi-hop test shall be conducted to determine whether the RF PASS system will operate in an RF environment having multipath reflections as characterized in a reverberation chamber as specified in 8.22.4.4.

Chapter 8 Test Methods

8.1 Sample Preparation.

8.1.1 Application.

8.1.1.1 The sample preparation procedures contained in this section shall apply to each test method in this chapter, as specifically referenced in the sample preparation section of each test method.

8.1.1.2 Only the specific sample preparation procedure or procedures referenced in the sample preparation section of each test method shall be applied to that test method.

8.1.2 Room Temperature Conditioning Procedure.

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

8.1.2.2 Samples shall be tested within 5 minutes after removal from conditioning.

8.1.3 Cold Temperature Conditioning Procedure.

8.1.3.1 Specimens shall be exposed to a temperature of –20°C +0/–3°C (–4°F +0/–5°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°C (160°F +2/–0°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 Sound Pressure Level Tests.

8.2.1 Application.

8.2.1.1 This test method shall apply to all PASS.

8.2.1.2 Modifications to this test method for testing pre-alarm signals shall be as specified in 8.2.9.

8.2.1.3 Modifications to this test method for testing alarm signals shall be as specified in 8.2.8.

8.2.1.4 Modifications to this test method for testing low power source warning signals shall be as specified in 8.2.10.

8.2.2 Samples.

8.2.2.1 Samples shall be complete PASS.

8.2.2.2 Samples shall be conditioned as specified in 8.1.2.

8.2.3 Specimens.

8.2.3.1 Specimens for testing shall be complete PASS.

8.2.3.2 A minimum of three specimens shall be tested.

8.2.4 Apparatus.

8.2.4.1 Where the audio test mannequin is specified, the test mannequin shall be a Central Display, Inc., Model MA32 medium-size mannequin or equivalent as shown in Figure 8.2.4.1.

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8.2.4.2 The test chamber shall be as specified in ANSI/ASA S1.13, *Methods for Measurement of Sound Pressure Levels in Air*.

N **8.2.4.3** The sound level meter shall meet the requirements of ANSI S1.4, *Specification for Sound Level Meters*, Type 1.

8.2.5 Procedure.

8.2.5.1 Specimens shall be tested for sound pressure levels of the signals in accordance with ANSI/ASA S1.13, *Methods for Measurement of Sound Pressure Levels in Air*.

8.2.5.2 The laboratory measurement defined in ANSI/ASA S1.13, *Methods for Measurement of Sound Pressure Levels in Air,* shall be used for these tests.

8.2.5.3 All sound pressure level measurements shall be made with the sound level meter set to A-weighting with a fast response time (LAF). 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.

8.2.6 Report.

8.2.6.1 The alarm signal sound pressure level after testing as specified in 8.2.8 shall be measured, recorded, and reported.

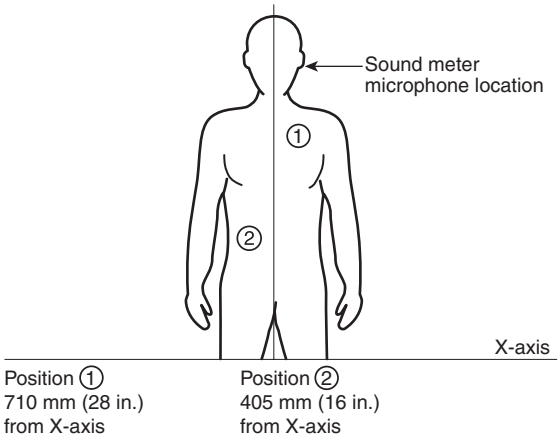
8.2.6.2 The pre-alarm signal sound pressure level after testing as specified in 8.2.9 shall be measured, recorded, and reported.

8.2.6.3 The low power source warning signal sound pressure level after testing as specified in 8.2.10 shall be measured, recorded, and reported.

8.2.7 Interpretation.

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

8.2.7.2 One or more specimens failing any portion of this test shall constitute failing performance.



N **FIGURE 8.2.4.1 Audio Test Mannequin.**

8.2.8 Specific Requirements for Testing Alarm Signals.

8.2.8.1 The sound pressure level for the alarm signal shall be measured in a spherical radius at a distance of 1 m +2.5 /−0 cm (3.3 ft +1/−0 in.) in from the specimen's annunciator.

N **8.2.8.2** The specimen shall be mounted on the audio test mannequin in the preferred mounting position and orientation for optimal performance as specified by the manufacturer.

Δ **8.2.8.3** Before starting the test, the specimen's power source shall be discharged to the voltage level or percent capacity remaining value at which the PASS first emits the low power source warning signal specified in 6.4.4.

8.2.8.4 The power source voltage shall be discharged at a rate that is equal to the average current draw, ±10 percent, of the same model PASS while in the operational condition that uses maximum current. The rate shall be determined by measurement by the certification organization.

8.2.8.5 The sound pressure level for the alarm signal shall be measured at 60 minutes +1/−0 minutes after the start of the test. Five measurements, each for a minimum duration of 6 seconds, shall be taken. The maximum sound pressure value shall be recorded for each measurement. The lowest of the five measurements shall be discarded and the remaining four shall be the sound pressure values.

Δ **8.2.8.6** The sound pressure values for the PASS alarm signal shall be recorded, evaluated, and reported to determine pass or fail performance.

8.2.8.7 For testing purposes only, manufacturers shall be permitted to reconfigure a PASS device sample to allow external test equipment to access the digital signal being delivered to the sound mechanism/transducer element.

8.2.9 Specific Requirements for Testing Pre-Alarm Signals.

8.2.9.1 The specimen shall be mounted on the audio test mannequin in the preferred mounting position and orientation for optimal performance as specified by the manufacturer.

Δ **8.2.9.2** Before the test is started, the specimen's power source shall be discharged to the voltage level or percent capacity remaining value at which the PASS first emits the low power source warning signal specified in 6.4.4.

8.2.9.3 Power sources shall be discharged at a rate that is equal to the average current draw, ±10 percent, of the same model PASS while in the operating condition that uses maximum current. The rate shall be determined by measurement by the certification organization.

8.2.9.4 The sound pressure level for the pre-alarm signal shall be measured in a spherical radius at a distance of 1 m +2.5/−0 cm (3.3 ft +1/−0 in.) from the specimen's annunciator for the duration of the pre-alarm.

8.2.9.5 The pre-alarm signal sound pressure level shall be recorded, evaluated, and reported for the entire duration to determine pass or fail performance.

8.2.10 Specific Requirements for Testing Low Power Source Warning Signal.

8.2.10.1 Specimens shall be mounted on the audio test mannequin in the preferred mounting position and orientation for optimal performance as specified by the PASS manufacturer.

8.2.10.2 Before the test is started, the specimen's power source shall be discharged to the voltage level or percent capacity remaining value at which the specimen first emits the low power source warning signal specified in 6.4.4.

8.2.10.3 The power source shall be discharged at a rate that is equal to the average current draw, ±10 percent, of the same model PASS, while in the operational condition that uses maximum current. The rate shall be determined by measurement by the certification organization.

8.2.10.4 The sound pressure level for the low power source warning signal shall be measured at 60 minutes +1/−0 minutes after the start of the test. Five measurements, each for a minimum duration of 6 seconds, shall be taken. The maximum sound pressure value shall be recorded for each measurement. The lowest of the five measurements shall be discarded and the remaining four shall be the sound pressure values.

8.2.10.5 The low power source warning signal sound pressure level shall be recorded, evaluated, and reported for the entire duration to determine pass or fail performance.

8.3 Electronic Temperature Stress Test.

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

8.3.2 Samples.

8.3.2.1 Samples shall be complete PASS.

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 PASS.

8.3.3.2 A minimum of three specimens shall be tested.

8.3.4 Procedure.

8.3.4.1 Each specimen shall be subjected to a series of three temperature stress tests identified as 8.3.5, Test Procedure 1, for elevated temperature, 8.3.6, Test Procedure 2, for low operating temperature, and 8.3.7, Test Procedure 3, for temperature shock.

8.3.4.2 The same three specimens shall be used for all three test series. Each specimen tested shall be complete with power source.

8.3.4.3 The test chamber or cabinet shall be capable of maintaining the required conditions specified in 8.3.5, 8.3.6, and 8.3.7 throughout the envelope of air surrounding the specimen being tested, and these conditions shall be continuously monitored.

8.3.4.4 Following each test procedure, the specimen shall be allowed to stabilize at ambient conditions prior to proceeding to the next test procedure.

8.3.5 Test Procedure 1.

8.3.5.1 Specimens shall be placed in the test apparatus that has been stabilized at 49°C +3/−0°C (120°F +5/−0°F).

8.3.5.2 After 6 hours, the temperature shall be raised within 1 hour to 71°C +3/−0°C (160°F +5/−0°F) and maintained for 4 hours.

8.3.5.3 The temperature shall then be decreased within 1 hour to 49°C +3/−0°C (120°F +5/−0°F).

8.3.5.4 This cycle shall be repeated twice.

8.3.5.5 After the second cycle, the temperature shall be raised to 71°C +3/–0°C (160°F +5/–0°F) for 4 hours.

8.3.5.6 Specimens shall be removed following the specified conditioning, and testing shall begin within 30 seconds of removal from conditioning.

8.3.5.7 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning as specified in 6.4.2.3 and 6.4.3.2.

8.3.5.8 The alarm signal sound pressure level shall be measured as specified in 7.1.2 to determine pass or fail performance.

8.3.5.9 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning for data logging as specified in 6.1.3 to determine pass or fail performance.

8.3.6 Test Procedure 2.

8.3.6.1 Specimens shall be placed in the test apparatus that has been stabilized at –20°C +0/–3°C (–4°F +0/–5°F) and maintained for a minimum of 4 hours.

8.3.6.2 Specimens shall be removed following the specified conditioning, and testing shall begin within 30 seconds of removal from conditioning.

8.3.6.3 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning as specified in 6.4.2.3 and 6.4.3.2.

8.3.6.4 The alarm signal sound pressure level shall be measured as specified in 7.1.2 to determine pass or fail performance.

8.3.6.5 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning for data logging as specified in 6.1.3 to determine pass or fail performance.

8.3.7 Test Procedure 3.

Δ **8.3.7.1** Specimens shall be placed in the test apparatus that has been stabilized at –20°C +0/–3°C (–4°F +0/–5°F) cold condition for 4 hours.

8.3.7.2 Specimens shall be removed from the cold condition and shall be placed within 5 minutes into another test apparatus that has been stabilized at 71°C +3/–0°C (160°F +5/–0°F) hot condition for 4 hours.

8.3.7.3 The cold-to-hot cycle shall be repeated twice.

8.3.7.4 Specimens shall be removed following the specified conditioning, and testing shall begin within 30 seconds of removal from conditioning.

8.3.7.5 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning as specified in 6.4.2.3 and 6.4.3.2.

8.3.7.6 The alarm signal sound pressure level shall be measured as specified in 7.1.2 to determine pass or fail performance.

8.3.7.7 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning for data logging as specified in 6.1.3 to determine pass or fail performance.

8.3.8 Report.

8.3.8.1 The specimen alarm signal sound pressure level shall be measured, recorded, and reported.

8.3.8.2 The functioning of the specimens shall be recorded and reported.

8.3.9 Interpretation.

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

8.3.9.2 One or more specimens failing this test shall constitute failing performance.

8.4 Corrosion Resistance Test.

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

8.4.2 Samples.

8.4.2.1 Samples shall be complete PASS.

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 PASS.

8.4.3.2 A minimum of three specimens shall be tested.

8.4.4 Procedure.

8.4.4.1 Specimens shall be tested in accordance with ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*, the salt spray shall be 5 percent saline solution, and the test exposure shall be for 48 hours +30/–0 minutes.

8.4.4.2 The chamber shall be stabilized at a temperature of 35°C +3/–0°C (95°F +5/–0°F).

8.4.4.3 Specimens shall be placed in the chamber as if worn by a user, in a wearing position specified by the manufacturer.

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

8.4.4.5 Following the conditioning period, specimens shall be tested within 30 seconds of removal from conditioning.

8.4.4.6 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning as specified in 6.4.2.3 and 6.4.3.2.

8.4.4.7 The alarm signal sound pressure level shall be measured as specified in 7.1.2 to determine pass or fail performance.

8.4.4.8 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning for data logging as specified in 6.1.3 to determine pass or fail performance.

8.4.5 Report.

8.4.5.1 The specimen alarm signal sound pressure level shall be measured, recorded, and reported.

8.4.5.2 The functioning of the specimens shall be recorded and reported.

8.4.6 Interpretation.

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

8.4.6.2 One or more specimens failing this test shall constitute failing performance.

8.5 Heat and Immersion Leakage Test.

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

8.5.2 Samples.

8.5.2.1 Samples shall be complete PASS.

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 PASS.

8.5.3.2 A minimum of three specimens shall be tested.

8.5.4 Apparatus.

8.5.4.1 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.

8.5.4.1.1 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 21°C (70°F) at 1 atmosphere measured at the center point of the oven.

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

8.5.4.2 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.

8.5.4.2.1 The water container shall maintain the PASS at that depth.

8.5.4.2.2 The water temperature shall be 18°C ± 10°C (64°F ± 18°F).

8.5.5 Test Procedure 1.

8.5.5.1 Specimens shall be placed in the test oven that has been preheated to 177°C +5/–0°C (350°F +10/–0°F). Test exposure time of 15 minutes shall begin.

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

8.5.5.3 Specimens shall be subject to 8.5.5.1 and 8.5.5.2 for six complete cycles.

8.5.5.4 After the sixth cycle, the power source compartment of the specimens shall be opened and shall be inspected for water leakage to determine pass or fail performance. Where the PASS does not fail this portion of the test, the power source shall be replaced.

8.5.5.5 After the sixth cycle, the specimens shall be operated according to the manufacturer's instructions to determine the proper functioning as specified in Section 6.4, Signal Design Requirements for PASS.

8.5.5.6 After the sixth cycle, the specimens' alarm signal sound pressure level shall be measured as specified in 7.1.2.1 to determine pass or fail performance.

8.5.5.7 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning for data logging as specified in 6.1.3 to determine pass or fail performance.

8.5.6 Test Procedure 2.

8.5.6.1 Following test procedure 1, the specimens shall be reimmersed in the test water container for an additional 5 minutes +30/–0 seconds. The power source compartment(s) shall be open, and the power source shall not be installed.

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

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

8.5.7 Report.

8.5.7.1 For test procedure 1, the specimen alarm signal sound pressure level shall be measured, recorded, and reported.

8.5.7.2 For test procedure 1, the functioning of the specimens shall be recorded and reported.

8.5.7.3 Following each test procedure, any water leakage shall be reported and recorded.

8.5.8 Interpretation.

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

8.5.8.2 One or more specimens failing any portion of this test shall constitute failing performance.

8.6 Case Integrity Test.

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

8.6.2 Samples.

8.6.2.1 Samples shall be complete PASS.

8.6.2.2 Samples shall be conditioned as specified in 8.1.2.

8.6.3 Specimens.

8.6.3.1 Specimens for testing shall be complete PASS.

8.6.3.2 A minimum of three specimens for PASS that meet the criteria specified in 6.1.2.1 shall be tested.

8.6.3.3 A minimum of three specimens shall be tested for each containment case, housing, and enclosure for PASS that meet the criteria specified in 6.1.2.2, 6.1.2.3, or 6.1.2.4.

8.6.4 Procedure.

8.6.4.1 Specimens shall be subjected to a test weight of 200 kg +2/–0 kg (442 lb +4.4/–0 lb).

8.6.4.2 The test weight shall be placed on each surface of the specimen case, housing, or enclosure.

8.6.4.3 The test weight shall be placed so as to avoid impact loading.

8.6.4.4 The test weight shall remain on each surface of the specimen case for 1 minute +15/–0 seconds.

8.6.4.5 After removal of the test weight, each surface of the specimen case, housing, and enclosure shall be examined for damage.

8.6.4.6 Signal testing shall begin within 30 seconds following the final inspection of the case, housing, and enclosure.

8.6.4.7 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning as specified in 6.4.2.3 and 6.4.3.2.

8.6.4.8 The specimens' alarm signal sound pressure level shall be measured as specified in 7.1.2 to determine pass or fail performance.

8.6.4.9 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning for data logging as specified in 6.1.3 to determine pass or fail performance.

8.6.5 Report.

8.6.5.1 The specimen alarm signal sound pressure level shall be measured, recorded, and reported.

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

8.6.5.3 Any visible damage to the specimen case shall be 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 One or more specimens failing this test shall constitute failing performance.

8.7 Shock Sensitivity Test.

8.7.1 Application. This test method shall apply to all PASS.

8.7.2 Samples.

8.7.2.1 Samples shall be complete PASS.

8.7.2.2 Samples shall be conditioned as specified in 8.1.2.

8.7.3 Specimens.

8.7.3.1 Specimens for testing shall be complete PASS.

8.7.3.2 A minimum of three specimens shall be tested.

8.7.4 Apparatus.

8.7.4.1 A granite surface place with minimum dimensions of 305 mm width × 305 mm length × 75 mm thickness (12 in. × 12 in. × 3 in.) shall be used as the test surface.

8.7.4.2 A 10 mm (3/8 in.) I.D. × 150 mm (6 in.) long tube shall be used as a guide for the ball drop.

8.7.4.3 A stainless steel test ball measuring 8 mm (5/16 in.) O.D. shall be used.

8.7.5 Procedure.

8.7.5.1 Specimens shall be subjected to one test series conducted on each test orientation as specified in Figure 8.7.5.1. A single test series shall consist of the test ball being dropped three times.

8.7.5.2 Specimens shall be placed in direct contact on the granite test surface and secured in such a manner to prevent movement of the specimen during the test. The method of securing the specimen shall not interfere with the surface being tested.

8.7.5.3 Specimens shall be placed in the sensing mode. The testing shall be conducted during the sounding of the pre-alarm signal.

8.7.5.4 The guide tube shall be positioned in a vertical orientation over the center of the surface of the specimen, with the long axis perpendicular within ±2 degrees. The bottom of the tube shall be within 3 mm (1/8 in.) of the surface of the specimen but shall not touch the specimen.

8.7.5.5 The stainless steel test ball shall be held at the top of the tube, then dropped through the tube and allowed to fall on the surface of the specimen.

8.7.5.6 The sounding of the specimen pre-alarm signal shall be monitored to determine pass or fail performance.

8.7.6 Report.

8.7.6.1 The sounding of the pre-alarm signal during testing shall be recorded and reported.

8.7.6.2 Any cancellation of the pre-alarm signal during testing shall be recorded and reported.

8.7.7 Interpretation.

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

8.7.7.2 Cancellation of the pre-alarm signal as a result of the ball drop shall constitute failure.

8.7.7.3 One or more specimens failing any portion of this test shall constitute failing performance.

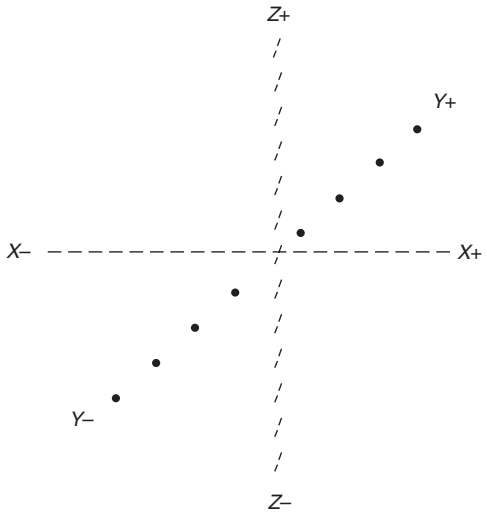


FIGURE 8.7.5.1 Test Orientation.

8.8 Impact Acceleration Resistance Test.

8.8.1 Application.

8.8.1.1 This test method shall apply to stand-alone and removable integrated PASS.

8.8.1.2 This test method shall not apply to nonremovable integrated PASS.

8.8.2 Samples.

8.8.2.1 Samples shall be complete PASS.

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 PASS.

8.8.3.2 A minimum of three specimens shall be tested.

8.8.3.3 Specimens of removable integrated PASS shall have the PASS removed from the integrated attachment so that the PASS alone is tested.

8.8.4 Procedure.

8.8.4.1 Three specimens shall be subjected to a series of impact–acceleration tests.

8.8.4.1.1 One specimen shall be conditioned as specified in 8.1.2.

8.8.4.1.2 One specimen shall be conditioned as specified in 8.1.3.

8.8.4.1.3 One specimen shall be conditioned as specified in 8.1.4.

8.8.4.2 Each specimen tested shall be complete with power supply.

8.8.4.3 After conditioning, specimens shall be turned to the on position. Testing shall begin within 30 seconds of removal from conditioning.

8.8.4.4 For each conditioning, the specimens shall be dropped a total of eight times from a distance of 3 m +0.1/−0 m (118 in. +4/−0 in.) onto a concrete surface so that impact is on each face, on one corner, and one edge of the specimen. The specimens shall not be permitted to bounce a second time.

8.8.4.5 Following each drop, the specimen shall remain motionless and shall sound the pre-alarm signal and the alarm signal from the sensing mode to evaluate proper functioning as specified in Section 6.3, Motion Sensing Design Requirements for PASS, for determining pass or fail performance, after which the alarm signal shall be stopped and the specimen reset to sensing mode for the next drop.

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

8.8.4.7 Following the entire single series of drops, the specimen's alarm signal testing shall begin within 30 seconds.

8.8.4.8 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning as specified in 6.4.2.3 and 6.4.3.2.

8.8.4.9 The alarm signal sound pressure level shall be measured as specified in 7.1.2 to determine pass or fail performance.

8.8.4.10 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning for data logging as specified in 6.1.3 to determine pass or fail performance.

8.8.5 Report.

8.8.5.1 The specimen alarm signal sound pressure level shall be measured, recorded, and reported.

8.8.5.2 The functioning of the specimens shall be recorded and reported.

8.8.6 Interpretation.

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

8.8.6.2 One or more specimens failing this test shall constitute failing performance.

8.9 Vibration Resistance Test.

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

8.9.2 Samples.

8.9.2.1 Samples shall be complete PASS.

8.9.2.2 Samples shall be conditioned as specified in 8.1.2.

8.9.3 Specimens.

8.9.3.1 Specimens for testing shall be complete PASS.

8.9.3.2 A minimum of three specimens shall be tested.

8.9.3.3 Integrated PASS shall be tested with the PASS in the integrated configuration.

8.9.4 Apparatus.

8.9.4.1 Specimens shall be tested on a typical package tester within the compartments specified in 8.9.4.2.

8.9.4.2 Compartments shall be configured as specified in Figure 8.9.4.2(a) and Figure 8.9.4.2(b).

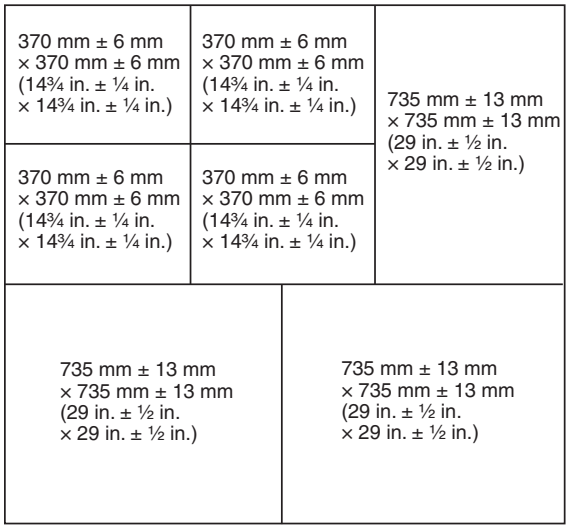


FIGURE 8.9.4.2(a) Vibration Table Compartments: Top View (Not to scale).

8.9.4.3 The sides and the base of the compartments shall be constructed of nominal 6 mm (¼ in.) stainless steel, and the top of the compartments shall remain open.

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

8.9.4.5 The large compartments shall be utilized for integrated PASS.

8.9.4.6 The small compartments shall be utilized for stand-alone PASS.

8.9.5 Procedure.

8.9.5.1 The integrated PASS or the stand-alone PASS shall be placed unrestrained in the compartments specified in 8.9.4.5 or 8.9.4.6 as applicable, and all adjustments, where present, shall be fully extended.

8.9.5.2 No tie-downs shall be allowed to be made to the specimens.

8.9.5.3 The basic movement of the bed of the test table shall be a 25 mm (1 in.) orbital path, such as can be obtained on a standard package tester operating in synchronous mode at 250 rpm ± 5 rpm.

8.9.5.4 The test duration shall be 3 hours +5/–0 minutes.

8.9.5.5 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning as specified in 6.4.2.3 and 6.4.3.2.

8.9.5.6 The alarm signal sound pressure level shall be measured as specified in 7.1.2 to determine pass or fail performance.

8.9.5.7 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning for data logging as specified in 6.1.3 to determine pass or fail performance.

8.9.6 Report.

8.9.6.1 The specimen alarm signal sound pressure level shall be measured, recorded, and reported.

8.9.6.2 The functioning of the specimens shall be 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 One or more specimens failing this test shall constitute failing performance.

<table>
<tr><td>370 mm ± 6 mm
× 610 mm
± 13 mm
(14¾ in. ± ¼ in.
× 24 in. ± ½ in.)</td><td>370 mm ± 6 mm
× 610 mm
± 13 mm
(14¾ in. ± ¼ in.
× 24 in. ± ½ in.)</td><td>735 mm ± 13 mm
× 610 mm ± 13 mm
(29 in. ± ½ in.
× 24 in. ± ½ in.)</td></tr>
<tr><td colspan="3">Vibration table surface</td></tr>
</table>

FIGURE 8.9.4.2(b) Vibration Table Compartments: Side View (Not to scale).

8.10 Retention System Test.

8.10.1 Application.

8.10.1.1 This test method shall apply to stand-alone and removable integrated PASS with a retention system.

8.10.1.2 This test method shall not apply to nonremovable integrated PASS.

8.10.2 Samples.

8.10.2.1 Samples shall be complete PASS.

8.10.2.2 Samples shall be conditioned as specified in 8.1.2.

8.10.3 Specimens.

8.10.3.1 Specimens for testing shall be complete PASS.

8.10.3.2 A minimum of three specimens shall be tested.

8.10.4 Procedure.

8.10.4.1* Prior to testing, specimens shall have the retention system attachment method cycled 500 times.

8.10.4.2 Specimens shall be placed in a test stand capable of applying a load to the retention system.

8.10.4.3 A base load of 45 N +3/–0 N (10 lbf +0.7/–0 lbf) shall be applied to the retention system.

8.10.4.4 A force shall then be steadily applied from the base load of 45 N (10 lbf) at a rate between 9 N/sec (2 lbf/sec) and 45 N/sec (10 lbf/sec). The force shall be applied perpendicular to the plane of the specimen as it is intended to be worn, in accordance with the manufacturer's instructions.

8.10.4.5 The force shall be applied until 445 N +9/–0 N (100 lbf +2/–0 lbf) is attained, and then the force shall be released.

8.10.4.6 Specimens shall then be inspected for retention system separation.

8.10.5 Report. Any separation of the retention system shall be recorded and reported.

8.10.6 Interpretation.

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

8.10.6.2 One or more specimens failing this test shall constitute failing performance.

8.11 Water Drainage Test.

8.11.1 Application. This test method shall apply to all PASS.

8.11.2 Samples.

8.11.2.1 Samples shall be complete PASS.

8.11.2.2 Samples shall be conditioned as specified in 8.1.2.

8.11.3 Specimens.

8.11.3.1 Specimens for testing shall be complete PASS.

8.11.3.2 A minimum of three specimens shall be tested.

8.11.4 Procedure.

8.11.4.1 Specimens shall be subjected to three water drainage tests.

8.11.4.1.1 The first test shall have the specimens positioned with the annunciator oriented in the position it is intended to be worn, in accordance with the manufacturer's instructions.

8.11.4.1.2 The second test shall have the specimens positioned with the annunciator oriented horizontally and facing up.

8.11.4.1.3 A third test shall have the specimen positioned where the annunciator is oriented in a position that will retain the greatest volume of water.

8.11.4.2 Water shall be introduced into all openings, indentations, and grilles of the specimens until water overflows from each such opening, indentation, and grille.

8.11.4.3 The filling method shall ensure that no air bubbles remain in any of the openings, indentations, and grilles.

8.11.4.4 Specimens shall then be placed in the alarm mode and allowed to sound the alarm signal for at least 65 seconds without the specimen being moved.

8.11.4.5 The alarm signal sound pressure level shall be measured as specified in 7.1.2 for the duration of the test.

8.11.4.6 The alarm signal sound pressure level shall be measured and recorded at the 60 second +5/–0 seconds, mark to determine pass or fail performance.

8.11.5 Report. The specimen alarm signal sound pressure level shall be measured, recorded, and reported.

8.11.6 Interpretation.

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

8.11.6.2 One or more specimens failing this test shall constitute failing performance.

8.12 High Temperature Functionality Test.

8.12.1 Application. This test method shall apply to all PASS.

8.12.2 Samples.

8.12.2.1 Samples shall be complete PASS.

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 PASS.

8.12.3.2 A minimum of three specimens shall be tested.

8.12.3.3 Integrated PASS shall be tested with the PASS in the integrated configuration.

8.12.4 Apparatus.

8.12.4.1 The thermal exposure 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*. The test oven shall be capable of maintaining temperatures up to 260°C +6/–0°C (500°F +10/–0°F) and shall be capable of maintaining the required conditions specified in 8.12.5.1, and these conditions shall be continuously monitored.

8.12.4.2 A test fixture shall be constructed using an aramid belt that is at least 50 mm (2 in.) wide and fastened to mounting posts spaced 305 mm +25/–0 mm (12 in. +1/–0 in.) apart. The test fixture shall be designed to allow the specimens to be attached to the belt by the retention system according to the PASS manufacturer's instructions.

8.12.4.3 An alternative text fixture shall be designed to allow an integrated PASS to be attached in the same configuration as a PASS integrated with SCBA mounting assembly attaches to the PASS.

8.12.4.4 Integrated PASS, other than SCBA integrated PASS, shall be tested in the "as designed" configuration and shall not be altered, separated, or cut apart from what it is integrated with.

8.12.4.5 The test fixtures shall be designed such that with the specimen attached, no portion of the specimen shall touch any oven surface. The test fixtures shall also not degrade the oven recovery time.

8.12.4.6 The sound test chamber shall be as specified in ANSI/ASA S1.13, *Methods for Measurement of Sound Pressure Levels in Air*.

8.12.5 Procedure.

8.12.5.1 The thermal exposure test temperature shall be set to 260°C +6/–0°C (500°F +10/–0°F). The oven shall be allowed to stabilize at the test temperature for a minimum of 30 minutes.

8.12.5.2 Specimens shall be attached to a test fixture in the "as worn" position.

8.12.5.3 Specimens shall be set to the sensing mode.

8.12.5.4 The test fixture with the specimen attached shall be placed in the test oven perpendicular to the airflow of the oven.

8.12.5.5 There shall be no obstructions between the specimen and the airflow. The test fixture shall position the specimen equidistant from all interior oven surfaces.

8.12.5.6 The test oven door shall not remain open more than 15 seconds. The air circulation shall be shut off while the door is open and turned on when the door is closed.

8.12.5.7 The total test oven recovery time shall not exceed 60 seconds. The thermocouple reading shall remain at 260°C +5/–0°C (500°F +10/–0°F) for the duration of the test.

8.12.5.8 Specimens, mounted as specified, shall be exposed in the test oven for 5 minutes +15/–0 seconds. The test exposure time shall begin when the test thermocouple recovers to 260°C +5/–0°C (500°F +10/–0°F).

8.12.5.9 Provisions shall be made to prevent the PASS device from going from sensing mode to alarm mode for the duration of the thermal exposure.

8.12.5.10 After the specified thermal exposure period, the specimen shall be removed from the thermal exposure test oven and within 30 seconds placed in the sound test chamber specified in 8.12.4.6.

8.12.5.11 The specimen shall remain motionless and be allowed to cycle from sensing mode to alarm mode. When the PASS cycles into the alarm mode, within 30 seconds the sound pressure value for the alarm signal shall be measured in a spherical radius at a distance of 1 m +2.5/–0 cm (3.3 ft +1/–0 in.) from the specimen's annunciator.

8.12.5.12 Following the sound pressure level measurement, the specimen shall be operated according to the manufacturer's instructions to determine the proper functioning as specified in 6.4.2.3 and 6.4.3.2 to determine pass or fail performance.

8.12.5.13 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning for data logging as specified in 6.1.3 to determine pass or fail performance.

8.12.5.14 Specimens shall be examined for melting, dripping, or ignition to determine pass or fail performance.

8.12.6 Report.

8.12.6.1 The alarm signal sound pressure level measured after exposure to high temperature environment shall be recorded and reported.

8.12.6.2 The functioning of the specimens shall be recorded and reported.

8.12.7 Interpretation.

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

8.12.7.2 Failing performance of one or more specimens shall constitute failing performance for this test.

8.13 Heat and Flame Test.

8.13.1 Application. This test method shall apply to all PASS.

8.13.2 Samples.

8.13.2.1 Samples shall be complete PASS.

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 PASS.

8.13.3.2 A minimum of three specimens shall be tested.

8.13.4 Apparatus.

8.13.4.1 A calibration mannequin meeting the requirements specified in Figure 8.13.4.1 shall be provided.

8.13.4.2 A heat and flame test mannequin meeting the requirements specified in Figure 8.13.4.2 shall be provided.

8.13.4.3* Both the calibration mannequin specified in 8.13.4.1 and the heat and flame test mannequin specified in 8.13.4.2 shall have a protective covering.

8.13.4.3.1 The protective covering shall be a weld blanket made of fireproof silica cloth of a minimum weight of 18 oz/sq yd.

8.13.4.3.2 The protective covering shall be designed and constructed to provide coverage over the surface of the mannequin.

8.13.4.3.3 Where additional insulation is needed to protect the mannequin electronics, an additional thermal liner underlayer shall be permitted.

8.13.4.4 The complete protective covering shall be discarded and shall not be used where the damage to any portion indicates the covering can no longer provide thermal protection for the test mannequin.

Δ **8.13.4.5** The test headform shall be covered with an undyed aramid hood for protection of the headform during testing. The protective hood shall meet the structural fire-fighting protective hood requirements specified in NFPA 1971.

8.13.4.6 The heat and flame test apparatus shall be as specified in Figure 8.13.4.6(a) and Figure 8.13.4.6(b).

8.13.4.7 The test oven shall be a horizontal forced circulating air oven with an internal velocity of 61 m/min, ±15 m/min (200 linear ft/min, ±49 linear ft/min). The test oven shall have minimum dimensions of 915 mm depth × 915 mm width × 1220 mm height (36 in. depth × 36 in. width × 48 in. height).

8.13.5 Procedure.

8.13.5.1 For calibration prior to the heat and flame test, the calibration mannequin specified in Figure 8.13.4.1 shall be exposed to direct flame contact for 10 seconds using the heat and flame test apparatus.

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

8.13.5.1.2 The average mean of all peak temperature readings shall be no higher than 950°C (1742°F).

8.13.5.2 The test oven recovery time, after the door is closed, shall not exceed 1 minute.

8.13.5.3 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, SCBA strap, or other means, on the outside or over the mannequin protective clothing.

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

8.13.5.3.2 For integrated PASS, the specimens shall be mounted on the test mannequin in accordance with the PASS manufacturer's instructions to simulate the correct wearing position.

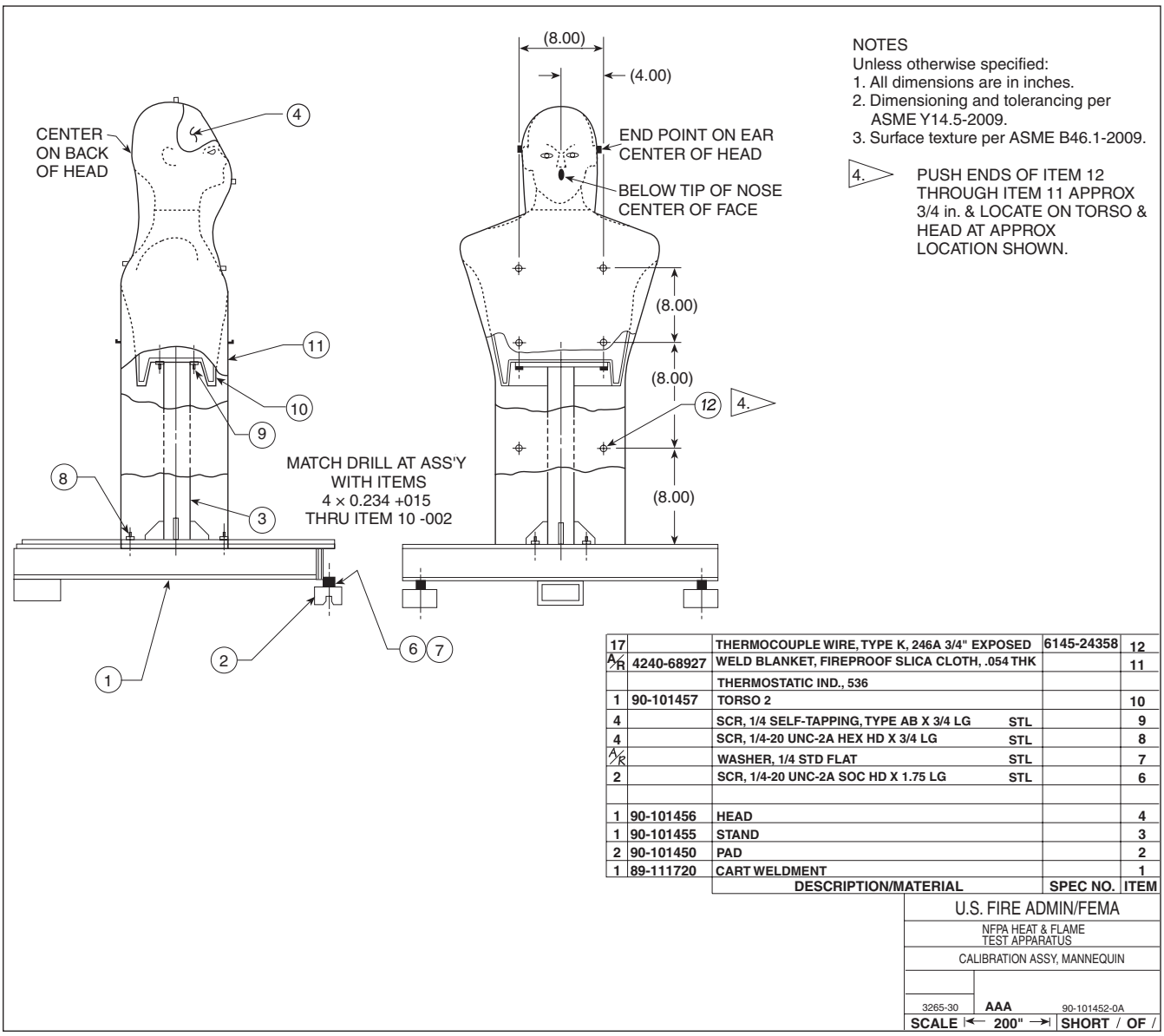
8.13.5.4 Specimens shall be subjected to three different series of the heat and flame test identified in this section as test procedure 1, test procedure 2, and test procedure 3. Different specimens shall be used for each of the three test series.

8.13.5.5 For all three test procedures, specimens mounted on the test mannequin shall first be placed in the test oven, which has been preheated to 95°C ± 2°C (203°F ± 4°F) for 15 minutes +15/–0 seconds. The test exposure time of 15 minutes shall begin after the door is closed and the oven temperature recovers to 95°C (203°F).

8.13.5.6 At the completion of the 15-minute +15/–0 seconds exposure, the oven door shall be opened and the specimens, mounted on the test mannequin, shall be moved out of the oven and into the center of the burner array.

8.13.5.7 The specimens shall then be exposed to direct flame contact for 10 seconds +0.25 /–0 seconds. This exposure shall begin within 20 seconds of removal of the specimen from the test oven.

Δ **8.13.5.8** For test procedure 1, the specimen mode selection device shall be set in the alarm mode and then exposed to the flame and drop sequences. Specimens shall be observed for the



17		THERMOCOUPLE WIRE, TYPE K, 246A 3/4" EXPOSED	6145-24358	12
A/R	4240-68927	WELD BLANKET, FIREPROOF SLICA CLOTH, .054 THK		11
		THERMOSTATIC IND., 536		
1	90-101457	TORSO 2		10
4		SCR, 1/4 SELF-TAPPING, TYPE AB X 3/4 LG STL		9
4		SCR, 1/4-20 UNC-2A HEX HD X 3/4 LG STL		8
A/R		WASHER, 1/4 STD FLAT STL		7
2		SCR, 1/4-20 UNC-2A SOC HD X 1.75 LG STL		6
1	90-101456	HEAD		4
1	90-101455	STAND		3
2	90-101450	PAD		2
1	89-111720	CART WELDMENT		1
		DESCRIPTION/MATERIAL	SPEC NO.	ITEM

U.S. FIRE ADMIN/FEMA
NFPA HEAT & FLAME TEST APPARATUS
CALIBRATION ASSY, MANNEQUIN
3265-30 AAA 90-101452-0A
SCALE ← 200" → SHORT / OF /

Δ FIGURE 8.13.4.1 Calibration Mannequin.

sounding of the alarm signal to determine pass or fail performance as specified in 7.12.1(1).

Δ 8.13.5.9 For test procedure 2, the specimen mode selection device shall be set in the sensing mode and then exposed to the flame and drop sequences. Specimens shall be observed for the sounding of the operational signal to determine pass or fail performance as specified in 7.12.2(1).

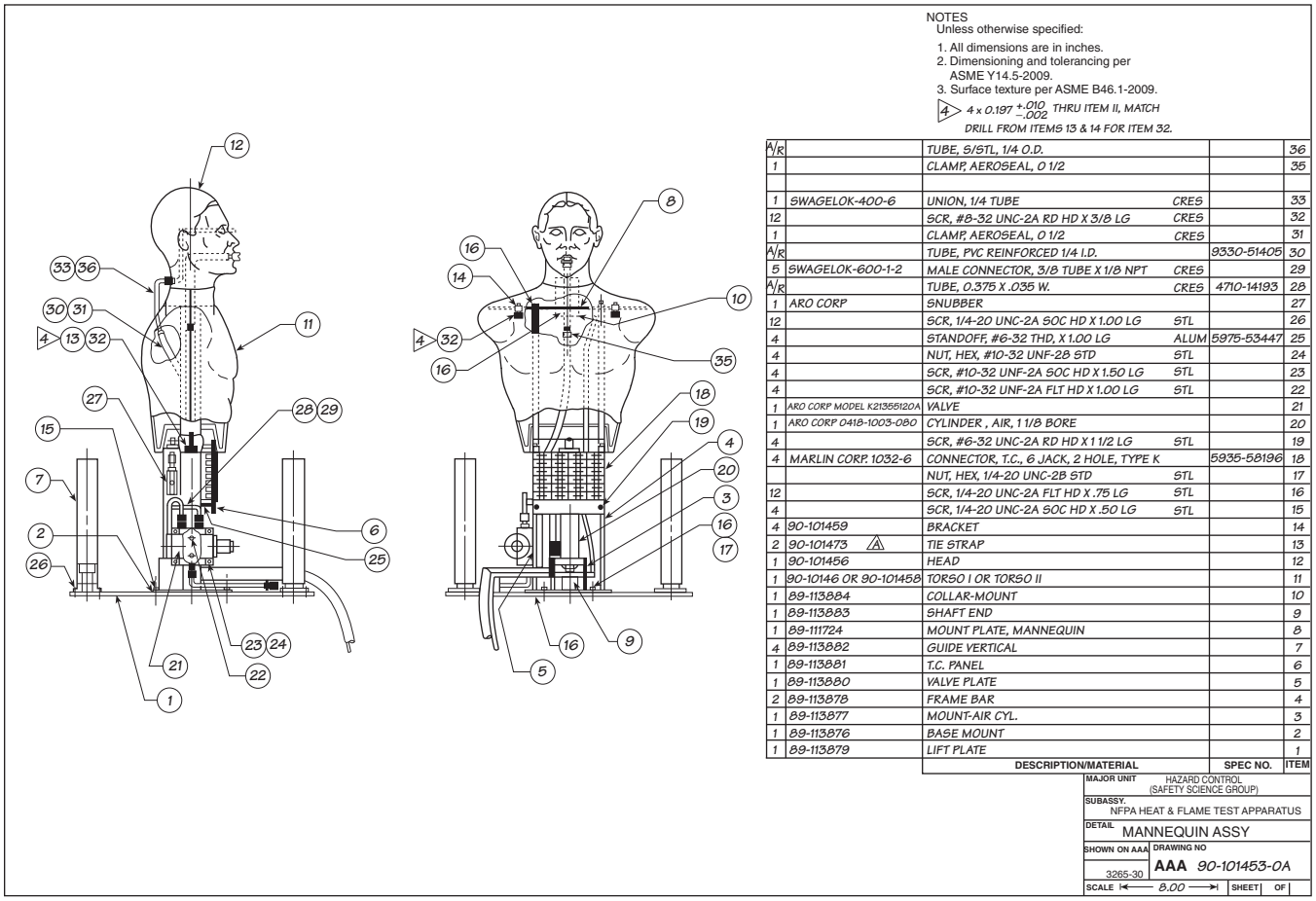
Δ 8.13.5.10 For test procedure 3, the specimen mode selection device shall be set in the sensing mode and then exposed to the flame and drop sequences. Specimens shall be observed for the sounding of the operational signal to determine pass or fail performance as specified in 7.12.3(1).

8.13.5.11 After the mode selection device has been set to the applicable setting for test procedure 1, test procedure 2, or test procedure 3, as indicated in 8.13.5.8, 8.13.5.9, or 8.13.5.10, respectively, the specimens in all three test procedures shall then be exposed to direct flame contact for 10 seconds +0.25 / –0 seconds. The exposure shall begin within 20 seconds of removal of the specimens from the test oven.

8.13.5.12 For all three test procedures, specimens shall be observed for any afterflame, and the afterflame duration shall be recorded to determine pass or fail performance as specified in 7.12.1, 7.12.2, and 7.12.3.

Δ 8.13.5.13 For test procedure 1, specimens shall be observed for the continued sounding of the alarm signal to determine pass or fail performance as specified in 7.12.1(1).

8.13.5.14 For all three test procedures, within 20 seconds of completion of the direct flame exposure, specimens mounted on the test mannequin shall be raised 150 mm +6/–0 mm (6 in. +0.25/–0 in.) and dropped freely.



Δ FIGURE 8.13.4.2 Heat and Flame Test Mannequin.

8.13.5.15 For all three test procedures, specimens shall be observed to determine pass or fail performance and that nothing has fallen off the PASS and that the PASS has not fallen from its mounted position.

Δ 8.13.5.16 Specimens shall be operated according to the manufacturer's instructions to determine the proper functioning for data logging as specified in 6.1.3 to determine pass or fail performance as specified in 7.12.1(4), 7.12.2(9), and 7.12.3(7).

Δ 8.13.5.17 For test procedure 1, following the drop sequence, specimens shall be observed for the continued sounding of the alarm signal to determine pass or fail performance as specified in 7.12.1(1).

8.13.5.17.1 The specimen mode selection device then shall be set to off.

Δ 8.13.5.17.2 Specimens shall be observed for the proper functioning of the mode selection device to determine pass or fail performance as specified in 7.12.1(3).

8.13.5.18 For test procedure 2, following the flame and drop sequences, specimens shall remain motionless and allowed to cycle to the pre-alarm signal and then to the alarm signal.

8.13.5.18.1 Following the sounding of the alarm signal, the mode selection device shall be set to off.

Δ 8.13.5.18.2 Specimens shall be observed for the proper cycling to determine pass or fail performance as specified in 7.12.2(2) and 7.12.2(4).

Δ 8.13.5.18.3 Specimens shall be observed for the activation and operation of the primary pre-alarm signal and the alarm signal to determine pass or fail performance as specified in 7.12.2(3) and 7.12.2(8).

8.13.5.18.4 Supplementary pre-alarm signal(s), where provided, shall be evaluated for proper operation.

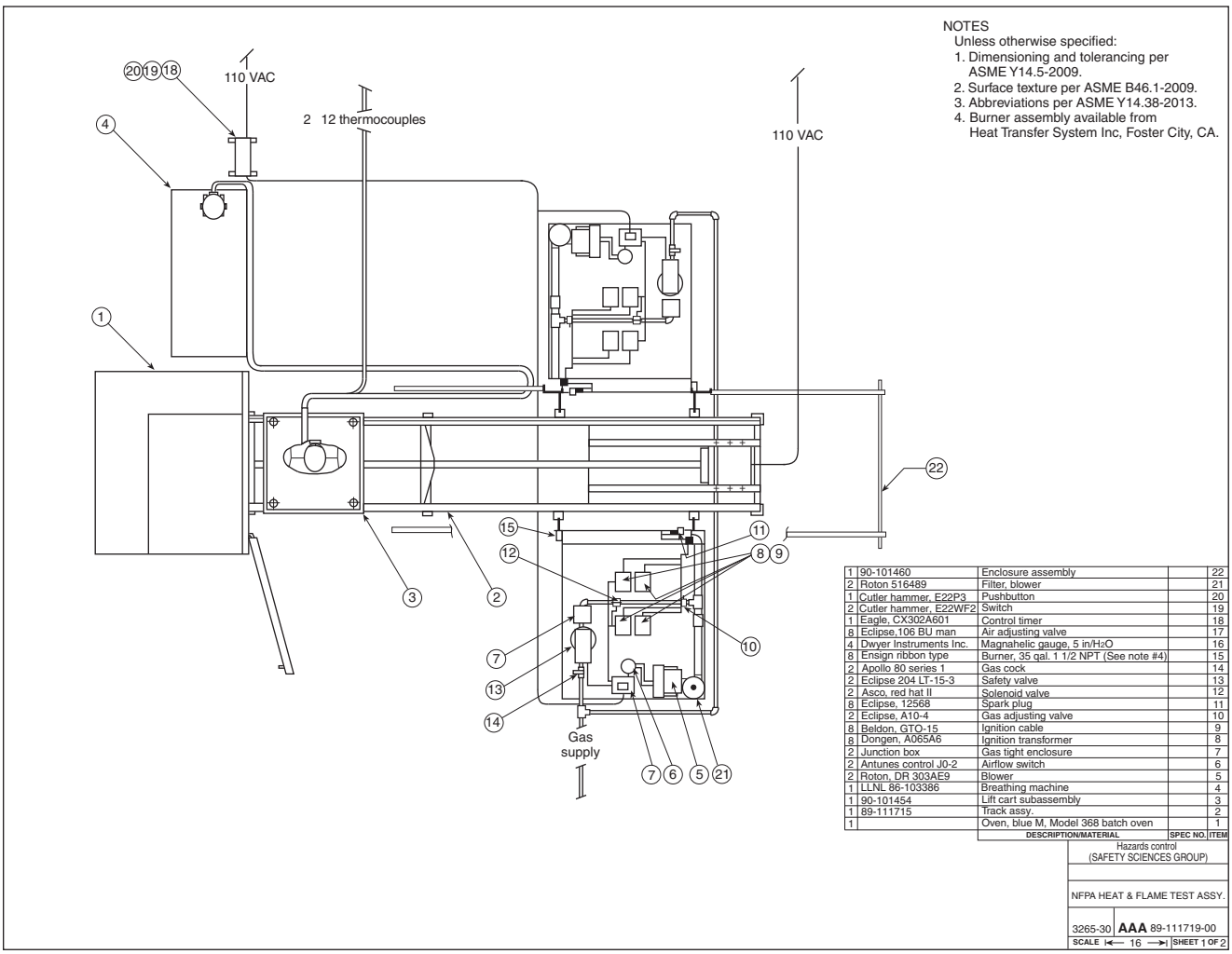
Δ 8.13.5.18.5 Specimens shall be observed for the proper functioning of the mode selection device to determine pass or fail performance as specified in 7.12.2(6).

8.13.5.19 For test procedure 3, following the flame and drop sequences, the specimen mode selection device shall be set to alarm.

8.13.5.19.1 Where specimens begin to operate the pre-alarm signal(s) prior to being set to alarm, the specimen shall be jarred to cancel the pre-alarm signal(s) before setting to alarm.

8.13.5.19.2 Following the sounding of the alarm signal, the mode selection device shall be set to off.

Δ 8.13.5.19.3 Specimens shall be observed for the proper functioning of the mode selection device while switching to alarm to determine pass or fail performance as specified in 7.12.3(2).



Δ FIGURE 8.13.4.6(a) Heat and Flame Test Apparatus: Top View.

Δ 8.13.5.19.4 Specimens shall be observed for the sounding of the alarm signal to determine pass or fail performance as specified in 7.12.3(3).

Δ 8.13.5.19.5 Specimens shall be observed to determine the proper functioning of the mode selection device while switching to off to determine pass or fail performance as specified in 7.12.3(4).

8.13.5.20 For all three test procedures, specimens shall be operated according to the manufacturer's instructions to determine the proper functioning as specified in 6.4.2.3 and 6.4.3.2.

8.13.5.21 The alarm signal sound pressure level shall be measured as specified in 7.1.2.1 to determine pass or fail performance.

8.13.6 Report.

8.13.6.1 Observations of any afterflame shall be recorded and reported for each specimen.

8.13.6.2 Observations of the functioning of the mode selection while the specimen is being activated shall be evaluated, recorded, and reported for each specimen.

8.13.6.3 Observations of the sounding of the operational signal shall be evaluated, recorded, and reported for each specimen.

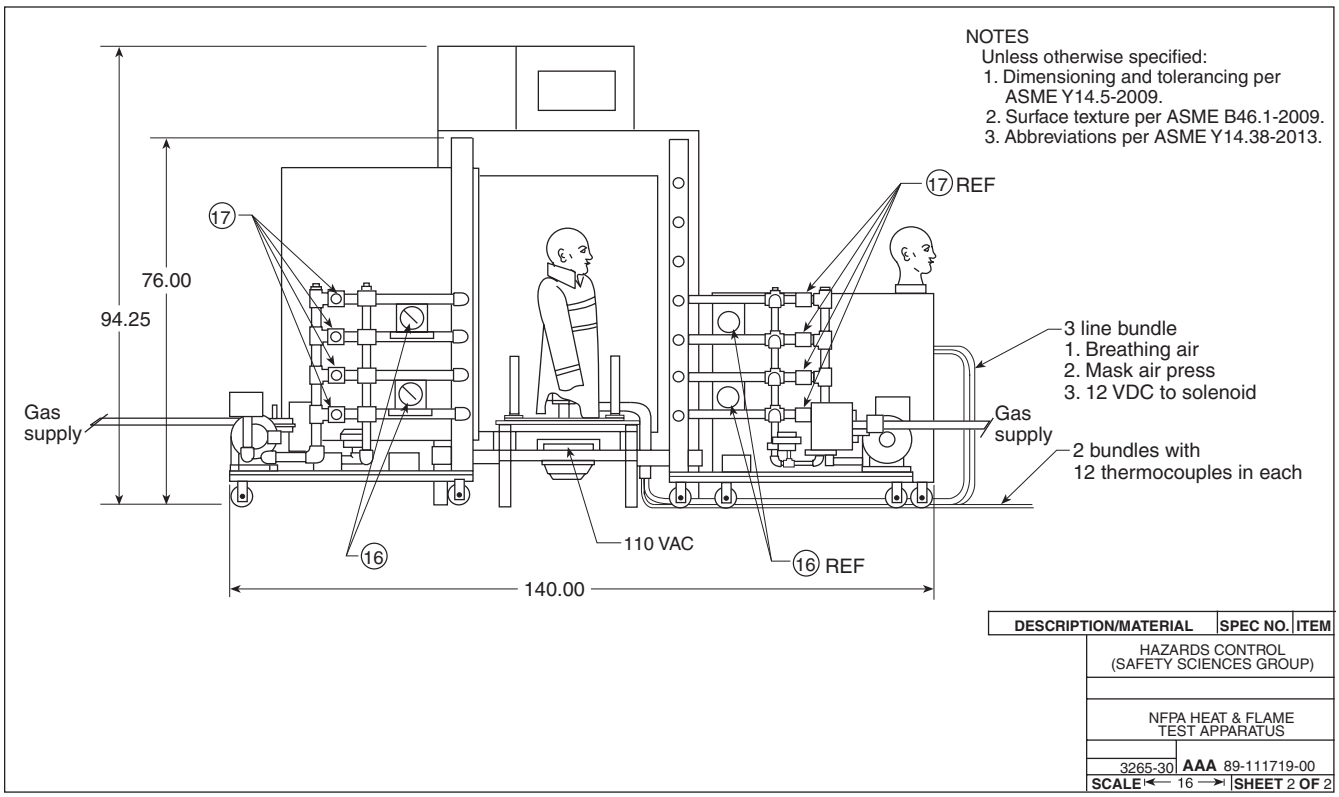
8.13.6.4 Observations of the functioning of the mode selection device while being switched to the sensing mode shall be evaluated, recorded, and reported for each specimen.

8.13.6.5 Observations of the activation and sounding of the primary pre-alarm signal shall be evaluated, recorded, and reported for each specimen.

8.13.6.6 Observations of the activation and sounding of any supplementary pre-alarm signal(s), where provided, shall be evaluated, recorded, and reported for each specimen.

8.13.6.7 Observations of the functioning of the mode selection device while switching to alarm shall be evaluated, recorded, and reported for each specimen.

8.13.6.8 Observations of the sounding of the alarm signal and the continued sounding of the alarm signal shall be evaluated, recorded, and reported for each specimen.



Δ FIGURE 8.13.4.6(b) Heat and Flame Test Apparatus: Side View.

8.13.6.9 Observations of the functioning of the mode selection device while switching to off shall be evaluated, recorded, and reported for each specimen.

8.13.6.10 Observations of the functioning of the data logging shall be evaluated, recorded, and reported for each specimen.

8.13.6.11 The specimen alarm signal sound pressure level shall be measured, recorded, and reported.

8.13.7 Interpretation.

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

8.13.7.2 One or more specimens failing this test or a portion of this test shall constitute failing performance.

8.14 Signal Frequency Test.

8.14.1 Application. This test shall apply to the pre-alarm signals of all PASS.

8.14.2 Samples.

8.14.2.1 Samples shall be complete PASS.

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 PASS.

8.14.3.2 A minimum of three specimens shall be tested.

8.14.4 Apparatus.

8.14.4.1 All testing shall be conducted in a laboratory grade semi-anechoic room.

8.14.4.2 A frequency analyzer set to measure in either $^1/_{12}$ octave or narrow band connected to a microphone shall be used to measure the frequencies of the audible primary pre-alarm signal.

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8.14.5 Procedure.

8.14.5.1 Specimens shall be oriented in the wearing position with the annunciator positioned 1 m ± 25 mm (39 in. ± 1 in.) from the microphone in the semi-anechoic room.

Δ 8.14.5.2 The pre-alarm signal shall be activated, and the signal frequency shall be measured.

8.14.5.3 A new primary frequency shall have a valley of at least 3 dB between the two frequencies being measured.

8.14.6 Report.

8.14.6.1 The audible primary pre-alarm signal frequencies shall be recorded and reported.

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8.14.7 Interpretation.

Δ 8.14.7.1 Pass or fail performance shall be determined for each specimen for the pre-alarm signal, verified that it meets the requirements of 6.4.2.8, and reported.

8.14.7.2 One or more specimens failing this test shall constitute failing performance.

8.15 Signal Frequency Test.

8.15.1 Application. This test shall apply to the alarm signals of all PASS.

8.15.2 Samples.

8.15.2.1 Samples shall be complete PASS with suitable modifications to provide access to the digital pulse wave that controls the driver circuit for the audible annunciator.

Δ **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 PASS.

8.15.3.2 A minimum of three specimens shall be tested.

8.15.4 Apparatus. A sampling digital oscilloscope or time-interval counter connected to the digital pulse wave shall be used to measure the frequencies of the alarm signal. The sampling digital oscilloscope or time-interval counter shall have a minimum time resolution of 50 nanoseconds.

8.15.5 Procedure. The alarm signal shall be activated, and the signal frequencies shall be measured. Frequency measurements shall be based on the period of individual cycles of the digital pulse wave.

8.15.6 Report.

8.15.6.1 The alarm signal frequencies shall be recorded and reported.

8.15.6.2 The alarm signal shall be recorded at a minimum time resolution of 50 nanoseconds, verified that it meets the requirements of 6.4.3.9, and reported.

8.15.7 Interpretation.

8.15.7.1 Pass or fail performance shall be determined for each specimen for the alarm signals.

8.15.7.2 One or more specimens failing this test shall constitute failing performance.

8.16 Product Label Durability Test.

8.16.1 Application. This test method shall apply to all PASS product labels.

8.16.2 Samples.

8.16.2.1 Samples shall be complete PASS with all product labels attached.

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 PASS with all product labels attached.

8.16.3.2 A minimum of three specimens shall be tested.

8.16.3.3 At least three specimens shall be subjected to all three test procedures.

8.16.4 Apparatus.

8.16.4.1 A test chamber or cabinet shall be provided and shall be capable of maintaining the required conditions specified in 8.16.5, 8.16.6, and 8.16.7 throughout the envelope of air surrounding the specimen being tested.

8.16.4.2 The conditions in the chamber or cabinet shall be continuously monitored.

8.16.5 Test Procedure 1.

8.16.5.1 Specimens shall be subjected to the elevated temperature environmental conditioning specified in 8.3.5.1 through 8.3.5.5, excluding 8.3.5.6 through 8.3.5.9.

8.16.5.2 Specimens shall be removed following the specified conditioning, and evaluation shall begin within 30 seconds of removal from conditioning.

8.16.5.3 The product labels shall be permitted to be wiped clean with an untreated cloth prior to being examined.

8.16.5.4 Specimen product labels shall be examined at a distance of 305 mm +25/–0 mm (12 in. +1/–0 in.) by the unaided eye with 20/20 vision or with vision corrected to 20/20.

8.16.6 Test Procedure 2.

8.16.6.1 Specimens shall be subjected to the low-temperature environmental conditioning specified in 8.3.6.1, excluding 8.3.6.2 through 8.3.6.5.

8.16.6.2 Specimens shall be removed following the specified conditioning, and evaluation shall begin within 30 seconds of removal from conditioning.

8.16.6.3 The product labels shall be permitted to be wiped clean with an untreated cloth prior to being examined.

8.16.6.4 Specimen product labels shall be examined at a distance of 305 mm +25/–0 mm (12 in. +1/–0 in.) by the unaided eye with 20/20 vision or with vision corrected to 20/20.

8.16.7 Test Procedure 3.

8.16.7.1 Specimens shall be subjected to the temperature shock environmental conditioning specified in 8.3.7.1 through 8.3.7.4 and excluding 8.3.7.5 through 8.3.7.7.

8.16.7.2 Specimens shall be removed following the specified conditioning, and evaluation shall begin within 30 seconds of removal from conditioning.

8.16.7.3 The product labels shall be permitted to be wiped clean with an untreated cloth prior to being examined.

8.16.7.4 Specimen product labels shall be examined at a distance of 305 mm +25/–0 mm (12 in. +1/–0 in.) by the unaided eye with 20/20 vision or with vision corrected to 20/20.

8.16.8 Report. The legibility of each specimen product label shall be recorded and reported.

8.16.9 Interpretation.

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

8.16.9.2 Any one specimen failing the test shall constitute failing performance.

8.17 Tumble–Vibration Test.

8.17.1 Application. This test method shall apply to all PASS.

8.17.2 Samples.

8.17.2.1 Samples shall be complete PASS.

8.17.2.2 Samples shall be conditioned as specified in 8.1.2.

8.17.2.3 Integrated PASS, other then SCBA integrated PASS, shall be tested in the "as designed" configuration and shall not be altered, separated, or cut apart from what it is integrated with.

8.17.3 Specimens.

8.17.3.1 Specimens for testing shall be complete PASS.

8.17.3.2 A minimum of three specimens shall be tested.

8.17.4 Apparatus. The tumble test apparatus shall be as specified in Figure 8.17.4.

8.17.5 Procedure.

8.17.5.1 The test specimens shall be placed unrestrained in the tumbling apparatus. Only one specimen shall be tested at a time.

8.17.5.2 The tumbling apparatus shall be run at a speed of 15 rpm ± 1 rpm.

8.17.5.3 The test shall be run for a duration of 3 hours +5/−0 minutes.

8.17.5.4 Specimens shall be operated according to the manufacturer's instruction to determine the proper functioning as specified in 7.1.3 to determine pass or fail performance.

8.17.5.5 Upon completion of the test duration, specimens shall be operated according to the manufacturer's instructions to determine the proper functioning for data logging as specified in 6.1.3 to determine pass or fail performance.

8.17.5.6 The alarm signal sound pressure level shall be measured as specified in 7.1.3 to determine pass or fail performance.

8.17.6 Report.

8.17.6.1 The specimen alarm signal sound pressure level shall be measured, recorded, and reported.

8.17.6.2 The functioning of the specimens shall be recorded and reported.

8.17.7 Interpretation.

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

8.17.7.2 Any one specimen failing the test shall constitute failing performance.

8.18 PASS Alarm Signal Muffle Test.

8.18.1 Application. This test method shall apply to all PASS.

8.18.2 Samples.

8.18.2.1 Samples for testing shall be complete PASS.

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 PASS.

8.18.3.2 At least three specimens shall be tested.

8.18.4 Apparatus.

8.18.4.1 The test chamber shall be as specified in ANSI/ASA S1.13, *Methods for Measurement of Sound Pressure Levels in Air*.

8.18.4.2 Testing shall be conducted in a test chamber that absorbs a minimum of 90 percent of all sound from 500 Hz to 5000 Hz.

Δ **8.18.4.3** Test subjects shall wear a structural fire-fighting protective ensemble that includes the coat, trousers, helmet, hood, gloves, and footwear that are certified as compliant with NFPA 1971.

Δ **8.18.4.4** Test subjects shall also wear an SCBA that is certified as compliant with NFPA 1981.

8.18.5 Procedure.

8.18.5.1 Specimens shall be tested at an ambient temperature of 22°C ± 3°C (72°F ± 5°F) and RH of 50 percent ± 25 percent.

8.18.5.2 Specimens shall be tested for sound pressure levels of the primary alarm signals in accordance with ANSI/ASA S1.13, *Methods for Measurement of Sound Pressure Levels in Air*.

8.18.5.3 All sound pressure level measurements shall be made with the sound level meter set to A-weighting with a fast response time (LAF). The maximum-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. The test subject shall don the following:

(1) The protective ensemble specified in 8.18.4.3
(2) The specimen PASS per the manufacturers' instructions

8.18.5.4 The test subject shall assume each of the following five testing positions, shall place the specimen PASS into the alarm mode, and shall remain in each position, unmoving, until the sound pressure levels have been measured and recorded:

(1) Face down with arms fully extended out to the sides
(2) Supine left as far as possible, arms down along sides
(3) Supine right as far as possible, arms down along sides
(4) Fetal, knees drawn to chest as far as possible, arms around legs, and lying on right side
(5) Fetal, knees drawn to chest as far as possible, arms around legs, and lying on left side

8.18.5.5 The sound pressure value for the alarm signal shall be measured in a spherical radius at a distance of 1 m +2.5/−0 cm (3.3 ft +1/−0 in.) from the specimen's annunciator.

8.18.6 Report. The alarm signal sound pressure levels shall be measured, recorded, and reported.

8.18.7 Interpretation.

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

8.18.7.2 One or more specimens failing any portion of this test shall constitute failing performance.

8.19 Radio System Tests for RF PASS — Point-to-Point RF Attenuation Test.

8.19.1 Application. This test method shall apply to all RF PASS systems.

8.19.1.1 The RF PASS shall be tested in conjunction with the model of base station with which it is intended to be deployed. If a portable computer is utilized in the base station, radio system tests shall be conducted using the manufacturer's supplied portable computer. The portable computer, if used, shall be placed into the test chamber with the base station.

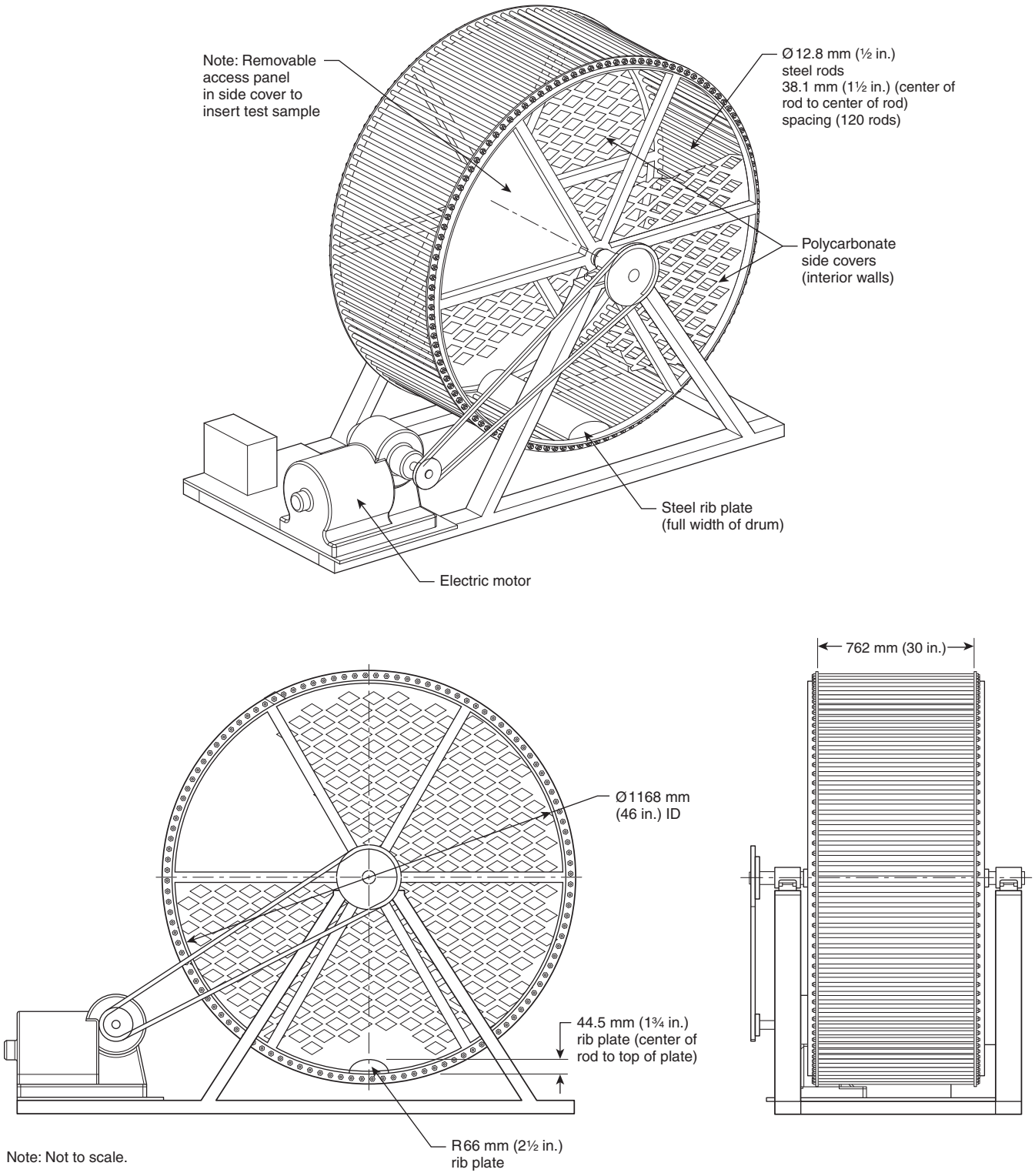


FIGURE 8.17.4 Tumble Test Apparatus.

8.19.1.2 The base station, base station computer, and any other electronic equipment associated with the RF PASS system shall operate on battery power for the duration of the RF system tests.

8.19.2 Samples.

8.19.2.1 Samples shall be complete RF PASS systems.

8.19.2.2 Samples shall be conditioned as specified in 8.1.2.

8.19.3 Specimens

8.19.3.1 Specimens for testing shall be complete RF PASS consisting of an RF PASS and the base station designed for use with it, provided by the manufacturer.

8.19.3.2 A single RF PASS and a single base station shall be used in each test. Three different sets of units (portable + base station) shall be tested.

8.19.3.3 All point-to-point RF attenuation tests shall be conducted using specimens 19–21 in Table 4.3.10(a) if the specimens are stand-alone or removable integrated PASS and specimens 16–18 in Table 4.3.10(b) if the specimens are nonremovable integrated PASS.

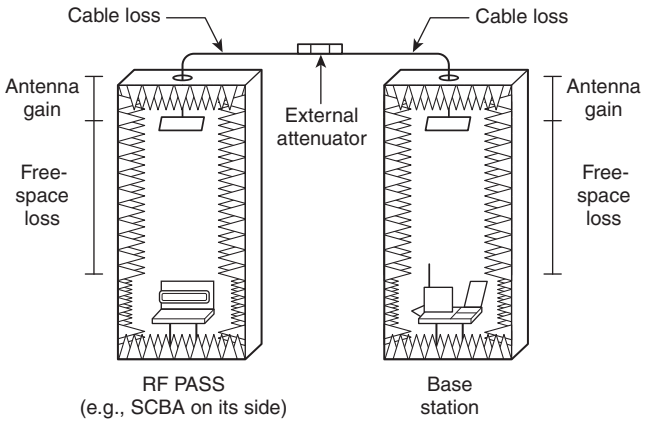
8.19.4 Test Apparatus

Δ **8.19.4.1*** The point-to-point RF attenuation test shall be conducted as shown in Figure 8.19.4.1 in the following two configurations:

(1) With the base station acting as the receiver and the RF PASS transmitting an alarm signal
(2) With the RF PASS acting as a receiver and the base station transmitting an evacuation alarm

8.19.4.2 For both configurations, the total attenuation (including cables, connectors, free-space path loss, antenna loss, and external added attenuation) between the base station and the RF PASS shall correspond to 100 dB ± 3 dB. The total attenuation shall be calculated using the methods described in 8.19.5.2.

8.19.4.3 The point-to-point RF attenuation test shall be conducted with no added radio interference.



Δ **FIGURE 8.19.4.1 Apparatus Used for Point-to-Point RF Attenuation Test.**

8.19.4.4 Anechoic Chambers.

Δ **8.19.4.4.1*** Overall usable interior height of an anechoic chamber shall be no less than 40 in. (102 cm) between the antenna and tabletop or 55 in. These specifications shall not preclude the use of a larger anechoic chamber, including one large enough to contain operation personnel if the RF isolation conditions in 8.19.4.4.2 and field uniformity conditions in 8.19.5.2.1 are satisfied.

8.19.4.4.2 Each chamber shall provide at least 100 dB shielding from the test platform tabletop to the outside of the chamber at the frequency of operation of the RF PASS, with the bulkhead ports specified in 8.19.4.4.8 in place. This will RF isolate the device and base station from each other.

8.19.4.4.3 The chambers shall provide RF attenuation of a minimum of 25 dB normal incidence, at the frequency of operation of the RF PASS, provided by RF absorbing material. Performance specifications provided by the manufacturer shall satisfy this requirement.

8.19.4.4.4 Minimum door size shall be 18 in. (46 cm) × 12 in. (30.5 cm).

8.19.4.4.5 The width and depth of the chambers shall be large enough to allow insertion, placement, and rotation of complete SCBAs. Usable space shall be a minimum of 24 in. (61 cm) width × 24 in. (61 cm) depth × 10 in. (30.5 cm) height at the height of the table. Usable interior width and depth shall be permitted to be smaller at other heights within the chamber.

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8.19.4.4.6 Each chamber shall include a nonconducting antenna mount that shall ensure the usable interior height specified in 8.19.4.4.1.

8.19.4.4.7 Each chamber shall include a nonconducting table top a minimum 12 in. (30.5 cm) square, 15 in. (38 cm) high.

8.19.4.4.8 Each chamber shall include a side bulkhead located on the right side of the chamber when facing it, no higher than 18 in. (46 cm) from the bottom of the chamber onto which one type N or SMA bulkhead adapter is connected.

8.19.4.5 Antennas.

8.19.4.5.1 Circularly polarized patch antennas shall be used to minimize the dependence of the test on the orientation within the chamber of the RF PASS and base station.

8.19.4.5.2 Four antennas are required for the path loss calibration step; two shall be used during the test.

8.19.4.5.3 Cables that are connected to the antennas shall be no longer than 24 in. (61 cm) to minimize errors in estimating the antenna gain during the calibration step, unless a three-antenna calibration is used to determine the antenna gain, in which case the cable shall be the same as that used during the three-antenna calibration.

8.19.4.6 Cables.

8.19.4.6.1 Cables shall be high-quality shielded coaxial cables with type N or SMA connectors.

8.19.4.6.2 If cables are permanently left in place at the top of each chamber to make changing antennas easier, these cables shall be accounted for in the path loss calibration step.

8.19.4.6.3 Appropriate torque wrenches for the cable connectors shall be used to torque cable connectors to manufacturer's specifications.

8.19.4.7 Test Equipment.

8.19.4.7.1 The following test equipment shall be utilized in the point-to-point attenuation test:

(1) A three-axis field probe with optical fiber cabling to characterize the field uniformity of the chamber/antenna combination
(2) A spectrum analyzer to calibrate the path loss
(3) A variable attenuator (or combination of fixed and variable) to set the path loss
(4) A signal generator capable of generating a continuous-wave signal in each frequency of operation of the RF PASS
(5) An external power amplifier designed to work in the frequency of operation of the RF PASS

8.19.5 Procedure.

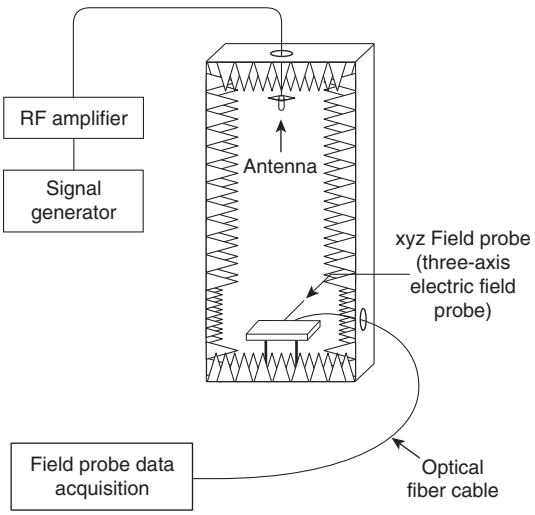
8.19.5.1 Procedure for Field Uniformity Calibration.

8.19.5.1.1 Each anechoic chamber shall be calibrated individually, using the same antenna and interior coaxial cables that shall be used during the RF PASS test. The configuration shall be as shown in Figure 8.19.5.1.1.

8.19.5.1.2 The antenna used for the RF PASS test shall be mounted to the antenna mount specified in 8.19.4.4.6. A coaxial cable shall connect the antenna to the interior bulkhead adapter of the chamber.

8.19.5.1.3 A coaxial cable shall connect the exterior side of the bulkhead adapter of the chamber to a signal generator. The signal generator shall be set to the frequency of operation of the RF PASS. The power level setting shall provide a reading on the field probe.

8.19.5.1.4 The field probe shall be connected to its receiver through a chamber bulkhead.



Δ FIGURE 8.19.5.1.1 Configuration for Testing the Electric Field Uniformity Using a Signal Generator and a Three-Axis Electric Field Probe.

8.19.5.1.5 The total electric field shall be sequentially measured and recorded at the 25 points specified in Figure 8.19.5.1.5.

Δ 8.19.5.1.6* The power level at each of the 25 points shall be calculated relative to the minimum total power measured at one of the 25 points. The minimum total power, *P*, shall be determined by calculating the total power at each of the measurement points, and then selecting the minimum value of those calculations as follows:

N **[8.19.5.1.6a]**

$$P_k^i(dB)_{relative} = 20 \times \log_{10}\left(\frac{E_k^i}{\text{minimum}\left(E_{total}^i\right)}\right)$$

where:
i = 1, 2, 3 ... 25 (the measured points),
k = x, y, z, or "*total*," and

N **[8.19.5.1.6b]**

$$E_{total}^i = \sqrt[2]{\left(E_x^i\right)^2 + \left(E_y^i\right)^2 + \left(E_z^i\right)^2}$$

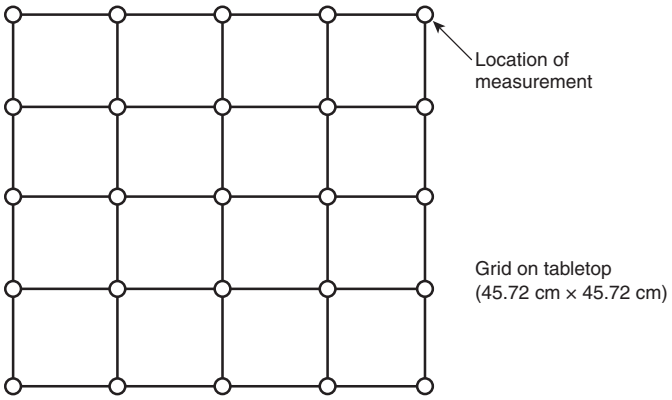
8.19.5.1.7 Seventy five percent of the measured points in 8.19.5.1.5 shall not exceed the minimum measured total power results by more than 3 dB.

8.19.5.2 Procedure for Configuring Chambers with the Target Attenuation. This procedure shall be carried out for each set of chambers, antennas, and cables.

8.19.5.2.1 The chambers shall be configured as shown in Figure 8.19.5.2.1.

8.19.5.2.2 Two calibration antennas, as shown in Figure 8.19.5.2.1, shall be inserted into the test chambers on the same tabletops where the RF PASS components shall be placed during the attenuation test. The gain of these antennas shall be obtained from the manufacturer's specifications or by use of a technique such as a three-antenna method.

8.19.5.2.3 One calibration antenna shall be connected to the signal generator, and the other to the spectrum analyzer through bulkhead adapters in the body of the test chambers.



Δ FIGURE 8.19.5.1.5 The Measurement Pattern for Checking the Electric Field Uniformity on the Table Surface.

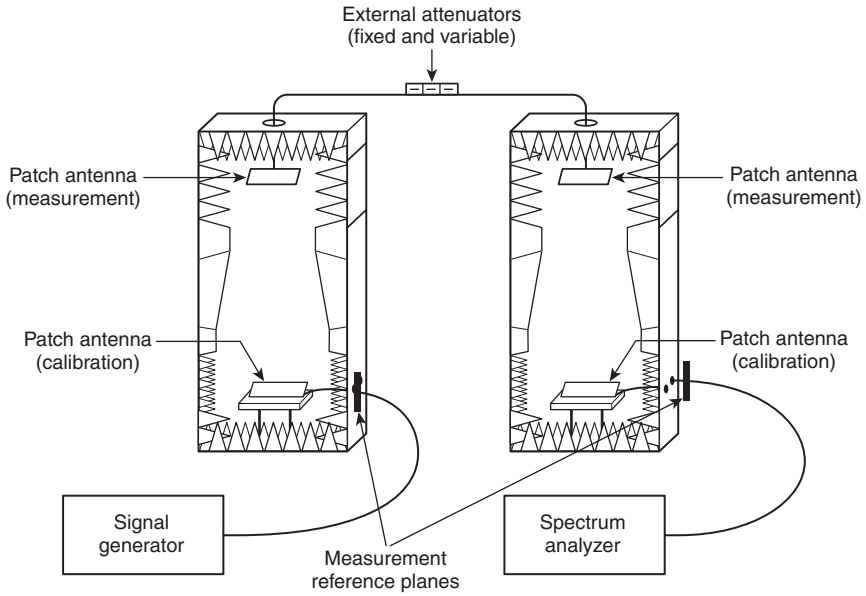


FIGURE 8.19.5.2.1 Configuration for Calibration of Target Path Loss, Consisting of the Summation (in dB) of the Various Fixed Elements in the Propagation Path, Plus the External Attenuators. (In the calibration step, the external attenuator is adjusted until the target path loss is obtained.)

The cables connecting the antennas to the bulkhead adapters shall be of a length that limits power loss to less than 2 dB.

8.19.5.2.4 The power loss in the cables connecting the signal generator and spectrum analyzer to the bulkheads of the chambers shall be determined through measurement.

8.19.5.2.5 The system path loss shall be measured between the two measurement reference planes specified in Figure 8.19.5.2.1 with the external attenuator set to 0 dB. The power loss between the measurement reference planes shall be a positive quantity that is measured and recorded as "measured path loss, 0 dB." Measurements shall be collected over the frequency of operation of the RF PASS system that is being tested. The resolution bandwidth of the spectrum analyzer shall be less than or equal to 1 kHz.

8.19.5.2.6 The calibrated path loss, 0 dB shall be calculated as measured path loss, 0 dB + gain of calibration antennas, where gain of calibration antennas is the sum of the specified gain of each calibration antenna in decibels.

8.19.5.2.7 The external attenuator to achieve the total attenuation from table to table shall be calculated as total attenuation — calibrated path loss, 0 dB, where total attenuation is 100 dB ± 3 dB for the point-to-point RF attenuation test.

8.19.5.3 Procedure for Point-to-Point RF Attenuation Test.

8.19.5.3.1 Alarm Signal Test. The test shall be conducted with the base station acting as the receiver and the RF PASS transmitting an alarm signal upon initiation of the alarm signal.

8.19.5.3.1.1 The total attenuation, including cables, connectors, free-space path loss, antenna loss, and external added attenuation, between the base station and the RF PASS shall correspond to 100 dB ± 3 dB using the calibration procedure specified in 8.19.5.2.

8.19.5.3.1.2 A wireless link shall be established between the base station and the RF PASS before closing the chambers' doors.

Δ **8.19.5.3.1.3** The alarm signal test shall be conducted twice.

N **(A)** The RF PASS system shall be tested with the RF PASS perpendicular to the surface of the tabletop and the base station antenna parallel to the surface of the tabletop.

N **(B)** The RF PASS system shall be tested with the RF PASS parallel to the surface of the tabletop and the base station antenna parallel to the surface of the tabletop.

8.19.5.3.1.4 For each test, the chamber doors shall be closed and the duration of time between the initiation of the alarm signal until the reception of the alarm signal shall be recorded.

8.19.5.3.2 Evacuation Alarm Test. The test shall be conducted with the RF PASS acting as a receiver and the base station transmitting an evacuation alarm.

8.19.5.3.2.1 The total attenuation, including cables, connectors, free-space path loss, antenna loss, and external added attenuation, between the base station and the RF PASS shall correspond to 100 dB ± 3 dB using the calibration procedure specified in 8.19.5.2.

8.19.5.3.2.2 A wireless link shall be established between the base station and RF PASS before closing the chambers' doors.

8.19.5.3.2.3 The RF PASS shall be kept in motion so that the motion-sensing device shall not trigger the alarm signal. A mechanism to move the RF PASS shall be permitted to be used. Any mechanism employed to move the RF PASS shall not disturb the field uniformity of the chamber more than 3 dB as specified in 8.19.5.1.

Δ **8.19.5.3.2.4** The evacuation alarm test shall be conducted twice.

N **(A)** The RF PASS system shall be tested with the RF PASS placed perpendicular to the surface of the tabletop and the base station antenna placed parallel to the surface of the tabletop.

N **(B)** The RF PASS system shall be tested with the RF PASS placed parallel to the surface of the tabletop and the base station antenna placed parallel to the surface of the tabletop.

8.19.5.3.2.5 For each test, the chamber doors shall be closed and the evacuation alarm shall be initiated. A mechanism to initiate the evacuation alarm shall be permitted to be used. Any mechanism employed to initiate the evacuation alarm shall not disturb the field uniformity of the chamber by more than 3 dB as specified in 8.19.5.1.

8.19.5.3.2.6 For each test, the duration of time between the initiation of the evacuation alarm and the reception of the alarm RF PASS shall be recorded.

8.19.6 Report.

8.19.6.1 All quantities shall be reported to the nearest decibel.

8.19.6.2 The operator shall record and report the results of all the tests and test parameters specified in 8.19.5, including the values of:

(1) Total attenuation associated with the test environment
(2) Maximum difference in field uniformity within an area covering the center 30 cm × 30 cm of the test chamber, as measured in 8.19.5.1
(3) Value of measured path loss when the external attenuator is set to 0 dB denoted as calibrated path loss, 0 dB, in 8.19.5.2.6
(4) Value of external attenuators used
(5) Frequency of operation (the minimum and maximum operating frequencies utilized)

8.19.7 Interpretation.

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

8.19.7.2 One or more specimens failing this test shall constitute failing performance.

8.20 Radio System Tests for Optional RF PASS — Loss-of-Signal Alarm Test.

8.20.1 Application. This test method shall apply to all optional RF PASS systems.

8.20.2 Samples.

8.20.2.1 Samples shall be complete RF PASS systems.

8.20.2.2 Samples shall be conditioned as specified in 8.1.2.

8.20.3 Specimens.

8.20.3.1 Specimens for testing shall be complete RF PASS consisting of an RF PASS and the base station designed for use with it, provided by the manufacturer.

8.20.3.2 A single RF PASS and a single base station shall be used in each test. Three different sets of units (portable + base station) shall be tested.

Δ **8.20.3.3** The RF PASS shall be tested in conjunction with the model of base station with which it is intended to be deployed.

N **8.20.3.3.1** If a portable computer is utilized in the base station, radio system tests shall be conducted using the manufacturer's supplied portable computer.

N **8.20.3.3.1.1** The radiating element of the base station (i.e., the antenna) shall be placed into the test chamber.

N **8.20.3.3.2** If the base station is placed outside the test chamber, a coaxial cable shall connect the antenna to the base station through either a bulkhead connector or through the bulkhead feed-through.

N **8.20.3.3.3** If the base station is placed inside the test chamber, the base station shall connect to the host computer using a shielded data cable via the bulkhead feed-through.

8.20.3.4 The base station, base station computer, and any other electronic equipment associated with the RF PASS system shall operate on battery power for the duration of the RF system tests.

8.20.3.5 The loss-of-signal alarm test shall be conducted using specimens 19–21 in Table 4.3.10(a) if the specimens are standalone or removable integrated PASS and specimens 16–18 in Table 4.3.10(b) if the specimens are nonremovable integrated PASS.

8.20.4 Test Apparatus.

8.20.4.1 The test apparatus described in 8.19.4 for the point-to-point RF attenuation test shall be used.

8.20.5 Procedure.

8.20.5.1* The loss-of-signal alarm test shall be conducted with the RF PASS placed in one test chamber and the base station placed in a second chamber.

8.20.5.2 The path loss used in the loss-of-signal alarm test shall be implemented by disconnecting the coaxial cables that were connected to the attenuator in the point-to-point RF attenuation test. These cables shall be as specified in Figure 8.19.4.1.

8.20.5.3 The orientation of the RF PASS and the base station is not critical.

8.20.5.4 An RF link shall be established between the RF PASS and base station with the doors to the test chambers open. When the link has been established, the doors shall be closed.

Δ **8.20.5.5** Upon closing the second door, the duration until the loss-of-signal alarm from each of the RF PASS and the base station shall be noted.

8.20.6 Report. The operator shall note the results of the three tests specified in 8.20.5.5, including the duration before the loss-of-signal alarm sounds at the RF PASS and base station, and the frequency of operation.

8.20.7 Interpretation.

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

8.20.7.2 One or more specimens failing this test shall constitute failing performance.

8.21 Radio System Tests for RF PASS — RF Interference Test.

8.21.1 Application. This test method shall apply to all RF PASS systems that operate using unlicensed frequencies in the 902–928 MHz and 2.400–2.4835 GHz ISM bands. RF PASS

systems operating with a licensed frequency shall be exempt from the requirements of this test.

8.21.1.1 The RF PASS shall be tested in conjunction with the model of base station with which it is intended to be deployed. If a portable computer is utilized in the base station, radio system tests shall be conducted using the manufacturer's supplied portable computer. The portable computer, if used, shall be placed into the test chamber with the base station.

8.21.1.2 The base station, base station computer, and any other electronic equipment associated with the RF PASS system shall operate on battery power for the duration of the RF interference test.

8.21.1.3 The total attenuation, including cables, connectors, free-space path loss, antenna loss, and external added attenuation, between the base station and the RF PASS shall correspond to 100 dB ± 3 dB using the method described in 8.19.5.2.

8.21.1.4 The RF interference test shall be conducted with the base station acting as the receiver and the RF PASS transmitting an alarm signal in the presence of RF interference.

8.21.1.5 The RF interference test does not preclude the use of repeaters in the field.

8.21.2 Samples.

8.21.2.1 Samples shall be complete RF PASS systems.

8.21.2.2 Samples shall be conditioned as specified in 8.1.2.

8.21.3 Specimens.

8.21.3.1 Specimens for testing shall be complete RF PASS consisting of an RF PASS and the base station designed for use with it, provided by the manufacturer.

8.21.3.2 A single RF PASS and a single base station that have passed the point-to-point RF attenuation test described in Section 8.19 and the loss-of-signal alarm test described in Section 8.20 shall be tested.

8.21.3.3 All RF interference tests shall be conducted using Specimens 19–21 in Table 4.3.10(a) if the specimens are standalone or removable integrated PASS and specimens 16–18 in Table 4.3.10(b) if the specimens are nonremovable integrated PASS.

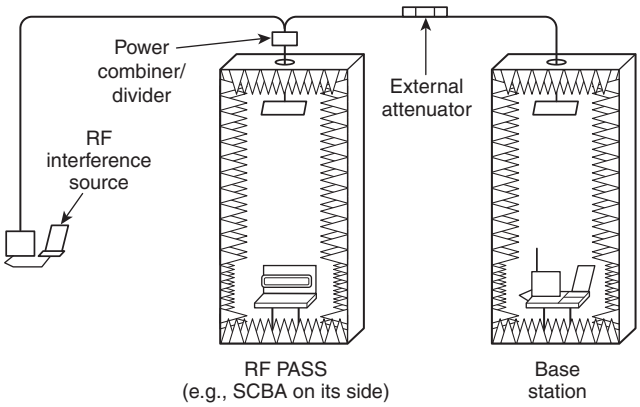
8.21.4 Test Apparatus.

8.21.4.1 The RF interference test shall be conducted with apparatus that meets the guidelines in 8.21.2 through 8.21.4.4, as illustrated in Figure 8.21.4.1.

8.21.4.2 Test Chambers. The two test chambers shall be configured as shown in Figure 8.19.4.1. The anechoic chambers, antennas, and cables used in the RF Interference Test are the same as those described in 8.19.4.

8.21.4.3 Power Combiner. A power combiner shall be used to combine the signal from the base station with the interfering signal, as shown in Figure 8.21.4.1. The power combiner shall have two input ports and one output port, shall use Type N or SMA connectors, and shall have a minimum isolation between the input ports of 20 dB.

Δ **8.21.4.4 Interferer.** A programmable signal generator or a commercial wireless device capable of emitting the common wireless protocols specified in Table 8.21.4.4 shall be used. The signal generator or the commercial wireless device shall be programmed to provide the parameters specified in Table 8.21.4.4 for the frequency of operation of the RF PASS system.



Δ **FIGURE 8.21.4.1 Apparatus Used for RF Interference Test. Two anechoic chambers provide shielding between the RF PASS and the base station. The chambers are linked by a known amount of attenuation, representing a specified path loss. An interfering RF signal is introduced into the test chambers by use of a power combiner.**

8.21.4.4.1 The 900 MHz interferer shall be a programmable signal generator or a wireless development board controlled by a computer as illustrated in Figure 8.21.4.4.1. The interferer shall be capable of producing the equivalent channel usage requirements in Table 8.21.4.4. The interferer shall hop over 51 channels in the 902 MHz to 928 MHz band, at a hop duration of 40 ms ± 2 ms. The interferer shall utilize an RF data rate of 38 kB/sec ± 2 kB/sec and a serial data rate of 38 kB/sec ± 2 kB/sec. Data are transmitted with filtered non-return-to-zero (NRZ) encoding modulated onto a carrier with binary frequency shift keying (FSK).

8.21.4.4.2 The 2.4 GHz interferer shall consist of a programmable signal generator or two wireless access points as illustrated in Figure 8.21.4.4.1, capable of producing the equivalent channel usage requirement as specified in Table 8.21.4.4. The two access points shall be connected to the input ports of a power combiner with no less than 20 dB of isolation between the input ports. The output of the power combiner shall be connected to the input of the power combiner on the test chamber containing the RF PASS. The programmable signal generator or wireless access points shall be set to establish a 1 MB/sec wireless distribution or bridging channel between two access points. A computer connected to the Ethernet port on one of the access points continuously sends an "echo request" to the Ethernet interface of the other access point with a packet size of 28 kB/sec, using the internet control message protocol (ICMP). The receiving access point shall reply with an "echo response."

8.21.4.4.3 The physical distance between the transmit antenna and the center of the testing platform supporting the PASS shall be 1.25 m ± 0.1 m.

8.21.4.4.4 The interference signal path loss in dB shall be calculated as cable losses plus power combiner insertion losses plus external attenuator losses minus interference signal amplification minus antenna gain in the test chamber. The value

Δ Table 8.21.4.4 Definition of Interference Sources for RF Interference Test

Frequency Range	Transmission Format or Modulation Scheme	Subcarrier or Channel Bandwidth	Output Power and FCC Part	Channel Usage by Interference Source
902 MHz–928 MHz	Direct sequence spread spectrum (DSSS) or frequency hopping spread spectrum (FHSS)	100 kHz subcarrier	1 W peak power (30 dBm) into antenna (w/ max 6 dBi gain), 47 CFR, FCC Part 15.247*	25% over the 30 second test interval; 25% ± 10% within any 5 second subinterval
2.4 GHz–2.472 GHz	Direct sequence spread spectrum (DSSS) or frequency hopping spread spectrum (FHSS)	22 MHz (IEEE 802.11 channels)	63 mW peak power (18 dBm) into antenna, 47 CFR, FCC Part 15 *(See example 2 for determination of correction factor.)*	25% over the 30 second test interval; 25% ± 10% within any 5 second subinterval

shall be 0 dB ± 2 dB, the interference shall be either attenuated or amplified so that the calculated value equals 0 dB ± 2 dB.

8.21.5 Procedure.

8.21.5.1 Prior to conducting the RF interference test, each anechoic chamber shall be characterized using the techniques described in 8.19.5.1.

8.21.5.2 The total attenuation, including cables, connectors, free-space path loss, antenna loss, power combiner, and external added attenuation, between the base station and the RF PASS shall correspond to 100 dB ± 3 dB. The total attenuation shall be calculated using the calibration procedure described in 8.19.5.2.

8.21.5.3 The signal from the RF interferer shall be coupled into the test chamber in which the RF PASS is located. Coupling shall be through a coaxial cable to a two-input power combiner having a minimum of 20 dB isolation between input ports. The other input port of the power combiner shall be connected to the coaxial cable that connects the base station test chamber to the RF PASS test chamber, as specified in 8.19.5.2.

8.21.5.4 A wireless link shall be established between the base station and device before closing the chambers' doors.

8.21.5.5 The chamber doors shall be closed.

8.21.5.6 The interferer shall be turned on.

8.21.5.7 The duration until the reception of the alarm signal shall be recorded.

8.21.5.8 The RF PASS system shall be tested with the RF PASS placed in two orientations (vertically and horizontally) and the base station placed in one orientation (horizontally).

8.21.6 Report.

8.21.6.1 All quantities shall be reported to the nearest decibel.

8.21.6.2 The operator shall record and report the results of all tests and test parameters specified in 8.21.5 including the values of:

(1) Total attenuation associated with the test environment
(2) Maximum difference in field uniformity within an area covering the center 30 cm × 30 cm of the test chamber, as specified in 8.19.5.1
(3) Calibrated path loss, 0 dB specified in 8.19.5.2.6
(4) External attenuators used
(5) Frequency of operation (the minimum and maximum operating frequencies utilized by the RF PASS system under test)
(6) Model, typical loss and isolation of power combiner, from manufacturer's specifications
(7) Model of the interferer
(8) Interferer parameters, as specified in Table 8.21.4.4
(9) Interference signal path loss, as specified in 8.21.4.4.4

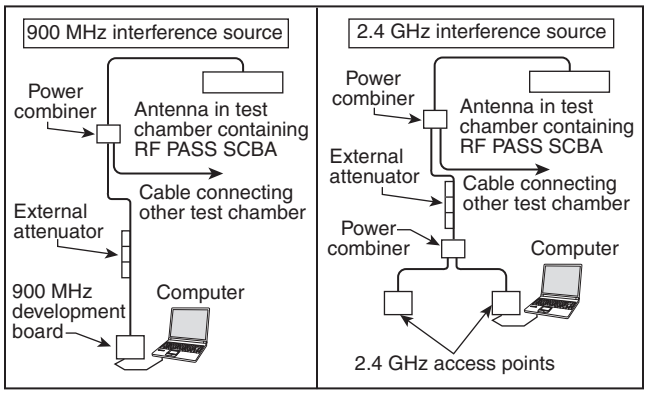
8.21.7 Interpretation.

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

8.21.7.2 One or more specimens failing this test shall constitute failing performance.

***N* 8.22 Radio System Tests for RF PASS — Multipath Test.**

***N* 8.22.1 Application.** This test method shall apply to all RF PASS systems.



Δ FIGURE 8.21.4.4.1 Apparatus Used for Creating the 900 MHz and 2.46 GHz Band Interference.

N **8.22.1.1** The RF PASS shall be tested in conjunction with the model of base station with which it is intended to be deployed. If a portable computer is utilized in the base station, radio system tests shall be conducted using the manufacturer's supplied portable computer. The portable computer, if used, shall be placed into the test chamber with the base station.

N **8.22.1.2** The base station, base station computer, and any other electronic equipment associated with the RF PASS system shall operate on battery power for the duration of the RF system tests.

N **8.22.2 Samples.**

N **8.22.2.1** Samples shall be complete RF PASS systems.

N **8.22.2.2** Samples shall be conditioned as specified in 8.1.2.

N **8.22.3 Specimens.**

N **8.22.3.1** Specimens for testing shall be complete RF PASS systems consisting of an RF PASS and the base station designed for use with it, provided by the manufacturer.

N **8.22.3.2** A single RF PASS and a single base station shall be used in each test. Three different sets of units (portable base station) shall be tested.

N **8.22.3.3** All multipath tests shall be conducted using specimens 19–21 in Table 4.3.10(a) if the specimens are stand-alone or removable integrated PASS and specimens 16–18 in Table 4.3.10(b) if the specimens are non-removable integrated PASS.

N **8.22.4 Test Apparatus.**

N **8.22.4.1** The multipath test shall be conducted as shown in Figure 8.22.4.1 in the following two configurations:

(1) With the base station acting as the receiver and the RF PASS transmitting an alarm signal
(2) With the RF PASS acting as a receiver and the base station transmitting an evacuation alarm

N **8.22.4.2** For both configurations, the total attenuation (including cables, connectors, free-space path loss, antenna loss, and external added attenuation) between the base station and the RF PASS shall correspond to 100 dB ± 3 dB. The total attenuation shall be calculated using the method specified in 8.22.5.3.

N **8.22.4.3* Anechoic Chamber.** This test chamber shall be configured as the base station chamber shown in Figure 8.19.4.1.

N **8.22.4.4 Reverberation Chamber.**

N **8.22.4.4.1** Overall usable interior dimensions of the reverberation chamber shall be such that the distance between the antenna and the DUT is a minimum of one-half the free space wavelength, and the distance between the DUT and any chamber wall surface is a minimum of one-half the free space wavelength. The free space wavelength shall be computed at the lowest intended frequency of DUT operation. These specifications shall not preclude the use of a larger reverberation chamber.

N **8.22.4.4.2** To isolate the device and base station from each other, the reverberation chamber shall provide at least 100 dB shielding from the test platform tabletop to the outside of the chamber at the frequency of operation of the RF PASS, with the bulkhead ports specified in 8.19.4.4.8 in place.

N **8.22.4.4.3** The reverberation chamber shall meet specifications as specified in IEC 61000-4-21, *Testing and measurement techniques — Reverberation chamber test methods.* Performance specifications provided by the manufacturer shall satisfy this requirement.

N **8.22.4.4.4** Minimum reverberation chamber door size shall be 18 in. (46 cm) × 12 in. (30.5 cm).

N **8.22.4.4.5** The width and depth of the reverberation chamber shall be large enough to allow insertion, placement, and rotation of complete SCBAs. Usable space shall be a minimum of 24 in. (61 cm) width × 24 in. (61 cm) depth × 10 in. (30.5 cm) height at the height of the table. Usable interior width and depth shall be permitted to be smaller at other heights within the chamber.

N **8.22.4.4.6** The reverberation chamber shall include a nonconducting antenna mount that shall ensure the usable interior height specified in 8.22.4.4.1.

N **8.22.4.4.7** The reverberation chamber shall include a nonconducting tabletop with minimum dimensions of 12 in. (30.5 cm) square, 15 in. (38 cm) high.

N **8.22.4.5 Antennas.** The antennas shall be as specified in 8.19.4.5.

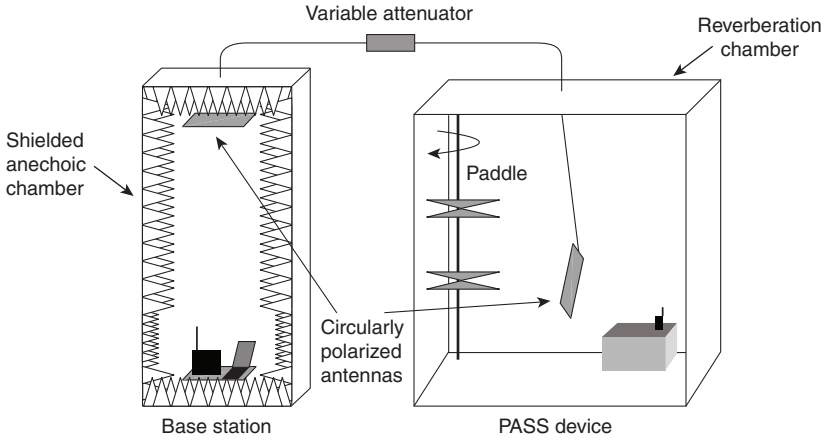


FIGURE 8.22.4.1 Setup for the Multipath Test.

N **8.22.4.6 Cables.** The cables shall be as specified in 8.19.4.6.

N **8.22.4.7 Test Equipment.** The test equipment shall be as specified in 8.19.4.7.

N **8.22.5 Procedure.**

N **8.22.5.1 Procedure for Field Uniformity Calibration in Anechoic Chamber.** The procedure specified in 8.19.5.1 shall be followed to calibrate the field uniformity in the anechoic chamber.

N **8.22.5.2 Procedure for Field Calibration in Reverberation Chamber.** The procedure specified in IEC 61000-4-21, clause 8, and IEC 61000-4-21, annex B, shall be followed to calibrate the field uniformity and verify the loading in the reverberation chamber. The field uniformity shall be ±3 dB standard deviation for frequencies above 400 MHz.

N **8.22.5.3 Procedure for Configuring Chambers with Target Attenuation.** This procedure shall be carried out for each set of chambers, antennas, and cables. An average value shall be obtained using independent tuner paddle locations as specified in 8.22.5.3.2.

N **8.22.5.3.1** The chambers shall be configured as shown in Figure 8.22.5.3.1.

N **8.22.5.3.2** The procedure specified in 8.19.5.2 shall be followed to obtain a sample value for the final average. The paddle shall be stationary in the reverberation chamber for each sample measurement. The paddle shall be moved to a unique location for each sample measurement. One hundred (100) samples shall be obtained and averaged to determine the system path loss.

N **8.22.5.3.3** The procedure specified in 8.22.5.3.2 shall be used to obtain a total attenuation value of 100 dB ± 3 dB for the multipath test.

N **8.22.5.4 Procedure for Multipath Test.**

N **8.22.5.4.1 Alarm Signal Test.** The test shall be conducted with the base station acting as the receiver and the RF PASS transmitting an alarm signal upon initiation of the alarm signal.

N **8.22.5.4.1.1** The total attenuation, including cables, connectors, free-space path loss, antenna loss, and external added attenuation, between the base station and the RF PASS shall correspond to 100 dB ± 3 dB using the calibration procedure specified in 8.22.5.3.

N **8.22.5.4.1.2** A wireless link shall be established between the base station and the RF PASS before closing the chambers' doors.

N **8.22.5.4.1.3** The alarm signal test shall be conducted twice, once in the configuration specified in 8.22.5.4.1.3(A) and once in the configuration specified in 8.22.5.4.1.3(B).

N **(A)** The RF PASS system shall be tested with the RF PASS perpendicular to the surface of the tabletop and the base station antenna parallel to the surface of the tabletop.

N **(B)** The RF PASS system shall be tested with the RF PASS parallel to the surface of the tabletop and the base station antenna parallel to the surface of the tabletop.

N **8.22.5.4.1.4** The paddle in the reverberation chamber shall continuously spin at 3 RPM.

N **8.22.5.4.1.5** For each test, the chamber doors shall be closed and the duration of time between the initiation of the alarm signal and the reception of the alarm signal shall be recorded.

N **8.22.5.4.2 Evacuation Alarm Test.** The test shall be conducted with the RF PASS acting as a receiver and the base station transmitting an evacuation alarm.

N **8.22.5.4.2.1** The total attenuation, including cables, connectors, free-space path loss, antenna loss, and external added attenuation, between the base station and the RF PASS shall correspond to 100 dB ± 3 dB using the calibration procedure specified in 8.22.5.2.

N **8.22.5.4.2.2** A wireless link shall be established between the base station and RF PASS before closing the chambers' doors.

N **8.22.5.4.2.3** The RF PASS shall be kept in motion so that the motion-sensing device shall not trigger the alarm signal. A mechanism to move the RF PASS shall be permitted to be used. Any mechanism employed to move the RF PASS shall not disturb the field uniformity of the anechoic chamber more than 3 dB as specified in 8.22.5.1.

N **8.22.5.4.2.4** The evacuation alarm test shall be conducted twice, once in the configuration specified in 8.22.5.4.2.4(A) and once in the configuration specified in 8.22.5.4.2.4(B).

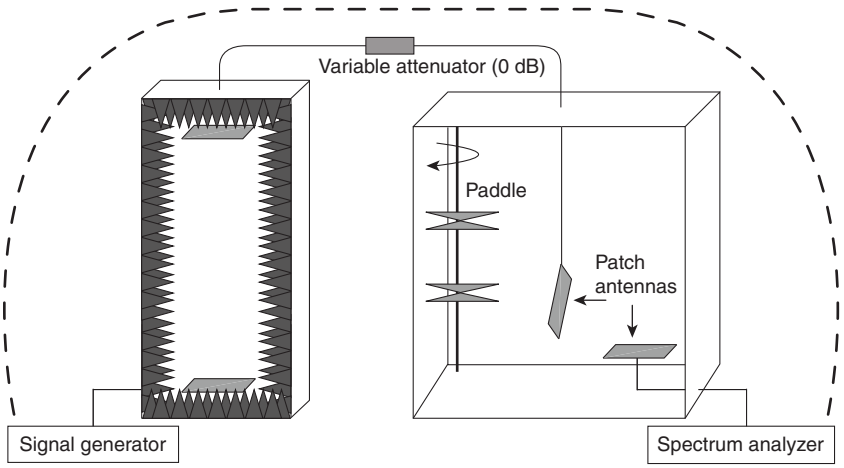


FIGURE 8.22.5.3.1 Configuration for Calibration of System Path Loss.

N **(A)** The RF PASS system shall be tested with the RF PASS placed perpendicular to the surface of the tabletop and the base station antenna placed parallel to the surface of the tabletop.

N **(B)** The RF PASS system shall be tested with the RF PASS placed parallel to the surface of the tabletop and the base station antenna placed parallel to the surface of the tabletop.

N **8.22.5.4.2.5** The paddle in the reverberation chamber shall continuously spin at 3 RPM.

N **8.22.5.4.2.6** For each test, the chamber doors shall be closed and the evacuation alarm shall be initiated. A mechanism to initiate the evacuation alarm shall be permitted to be used. Any mechanism employed to initiate the evacuation alarm shall not disturb the field uniformity of the anechoic chamber by more than 3 dB as specified in 8.22.5.1.

N **8.22.5.4.2.7** For each test, the duration of time between the initiation of the evacuation alarm and the reception of the alarm RF PASS shall be recorded.

N **8.22.6 Report.**

N **8.22.6.1** All quantities shall be reported to the nearest decibel.

N **8.22.6.2** The operator shall record and report the results of all the tests and test parameters specified in 8.22.5, including the values of the following:

(1) Total attenuation associated with the test environment
(2) Maximum difference in field uniformity within an area covering the center 30 cm × 30 cm (12 in. × 12 in.) of the anechoic chamber, as measured in 8.22.5.1
(3) Value of reverberation chamber loss, including the number of samples upon which the estimated loss is based
(4) Value of measured path loss when the external attenuator is set to 0 dB denoted as calibrated path loss, 0 dB, in 8.22.5.3
(5) Value of external attenuators used
(6) Frequency of operation (the minimum and maximum operating frequencies utilized)

N **8.22.7 Interpretation.**

N **8.22.7.1** Pass or fail performance shall be determined for each specimen.

N **8.22.7.2** One or more specimens failing this test shall constitute failing performance.

N **8.23 Radio System Tests for RF PASS — Multi-hop RF Test.**

N **8.23.1 Application.** This test method shall apply to all RF PASS with integrated repeating capability.

N **8.23.2 Samples.**

N **8.23.2.1** Samples shall be complete RF PASS with integrated repeating capability.

N **8.23.2.2** Samples shall be conditioned as specified in 8.1.2.

N **8.23.3 Specimens.**

N **8.23.3.1** Specimens for testing shall be complete RF PASS consisting of three RF PASS devices capable of relaying an RF PASS signal and a base station designed for use with them, provided by the manufacturer.

N **8.23.3.2** Two of the three RF PASS devices shall serve as repeater units capable of relaying an RF PASS signal, and one shall originate or terminate the alarm signal.

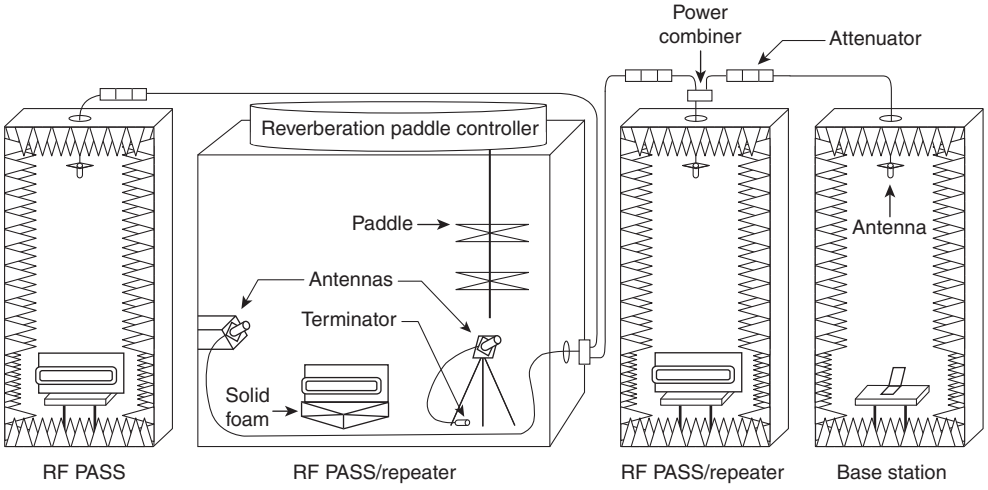
N **8.23.3.3** All multi-hop RF tests shall be conducted using specimens 19–21 in Table 4.3.10(a) if the specimens are stand-alone or removable integrated PASS and specimens 16–18 in Table 4.3.10(b) if the specimens are non-removable integrated PASS.

N **8.23.4 Test Apparatus.**

N **8.23.4.1** The multi-hop RF test shall be conducted as shown in Figure 8.23.4.1 in the following two configurations:

(1) With the base station acting as the receiver and the RF PASS under test transmitting an alarm signal
(2) With the RF PASS under test acting as a receiver and the base station transmitting an evacuation alarm

N **8.23.4.2** For both configurations, the total attenuation (including cables, connectors, free-space path loss, antenna loss, and external added attenuation) between two anechoic chambers shall correspond to 100 dB. The total attenuation



Δ **FIGURE 8.23.4.1 Apparatus Used for Multi-hop RF Test.**

between the anechoic and reverberation chamber shall correspond to 80 dB.

N **8.23.4.3 Anechoic Chambers.** The anechoic chambers shall be as specified in 8.19.4.4.

N **8.23.4.4 Reverberation Chamber.** The reverberation chamber shall be as specified in 8.22.4.4.

N **8.23.4.5 Antennas.**

N **8.23.4.5.1** Circularly polarized antennas shall be used to minimize the dependence of the test on the orientation within the chamber of the RF PASS under test and base station.

N **8.23.4.5.2** Five circularly polarized antennas and one linearly polarized horn antenna shall be used during the calibration steps. Five circularly polarized antennas shall be used during the test.

N **8.23.4.5.3** Cables permanently connected to any antenna shall be no longer than 24 in. (61 cm) to minimize errors in estimating the antennas gain during the calibration step, unless a three-antenna calibration is used to determine the antenna gain, in which case the cable shall be the same as that used during the three-antenna calibration.

N **8.23.4.6 Cables.** The cables shall be as specified in 8.19.4.6.

N **8.23.4.7** Test Equipment. The test equipment shall be as specified in 8.19.4.7.

N **8.23.5 Procedure.**

N **8.23.5.1 Procedure for Field Uniformity Calibration in Anechoic Chamber.** The procedure for field uniformity calibration shall be as specified in 8.19.5.1.

N **8.23.5.2 Procedure for Field Calibration in Reverberation Chamber.** The procedure for field calibration in the reverberation chamber shall be as specified in 8.22.5.2.

N **8.23.5.3 Procedure for Configuring one Anechoic Chamber Connected to one Reverberation Chamber with Target Attenuation.** This procedure shall be carried out for the connection between an anechoic chamber and a reverberation chamber, antennas, and cables.

N **8.23.5.3.1** The chambers shall be configured as shown in Figure 8.23.5.3.1.

N **8.23.5.3.2** Two circularly polarized antennas shall be inserted into the reverberation chamber as shown in Figure 8.23.5.3.1. One dual ridged horn antenna as shown in Figure 8.23.5.3.1 shall be inserted into the anechoic chamber on the same tabletops where the RF PASS components shall be placed during the attenuation test. The gain of these antennas shall be obtained from the manufacturer's specifications or by use of a technique such as a three-antenna method.

N **8.23.5.3.3** One calibration antenna shall be connected to the signal generator, and the other to the spectrum analyzer through bulkhead adapters in the body of the test chambers. The cables connecting the antennas to the bulkhead adapters shall be of a length that limits power loss to less than 2 dB.

N **8.23.5.3.4** The power loss in the cables connecting the signal generator and spectrum analyzer to the bulkheads of the chambers shall be determined through measurement.

N **8.23.5.3.5** The reverberation chamber paddle shall be on and operating at 0.2 RPM and path loss measurements shall be collected every 3 seconds.

N **8.23.5.3.6** The path loss measurements shall be averaged. This value shall be regarded as the total path loss between the tabletop of the anechoic chamber and the reverberation chamber.

N **8.23.5.3.7** The system path loss shall be measured between the reference plane within the anechoic chamber and the reverberation chamber specified in Figure 8.23.5.3.1 with the external attenuator set to 0 dB. The power loss between the measurement reference planes shall be a positive quantity that is measured and recorded as "measured path loss, 0 dB." Measurements shall be collected over the frequency of operation of the RF PASS under test. The resolution bandwidth of the spectrum analyzer shall be less than or equal to 1 kHz.

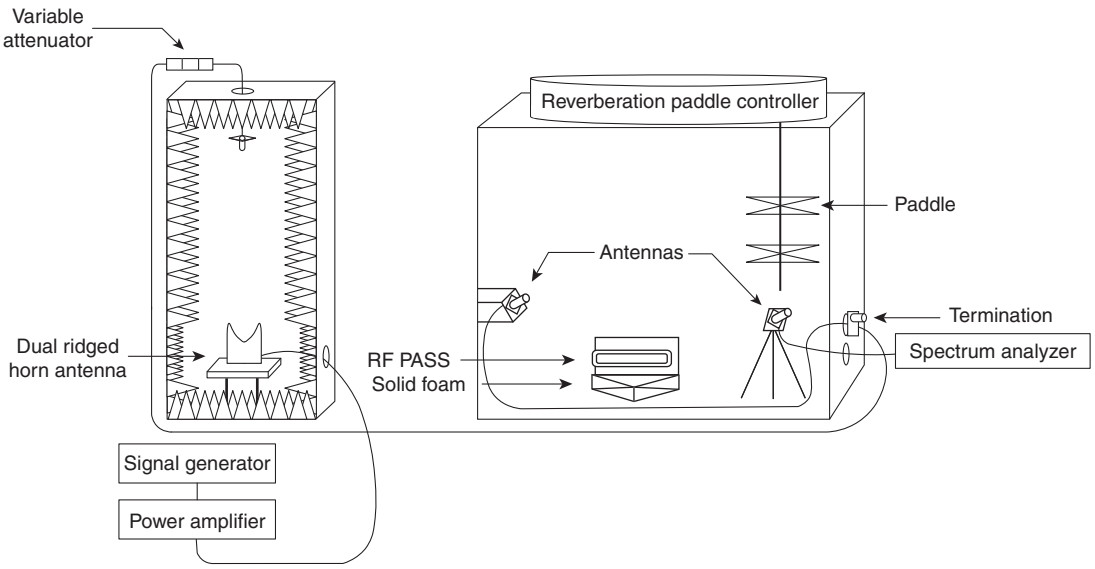


FIGURE 8.23.5.3.1 Configuration for Calibration of Target Path Loss Between Anechoic Chamber and Reverberation Chamber.

N **8.23.5.3.8** The calibrated path loss, 0 dB shall be calculated as measured path loss, 0 dB gain of calibration antennas, where gain of calibration antennas is the sum of the specified gain of each calibration antenna in decibels.

N **8.23.5.3.9** The external attenuator to achieve the total attenuation from table to table shall be calculated as total attenuation — calibrated path loss, 0 dB, where total attenuation is 80 dB between the anechoic chamber and reverberation chamber for the multi-hop RF test.

N **8.23.5.4 Procedure for Configuring one Reverberation Chamber Connected to one Anechoic Chamber with Target Attenuation.** This procedure shall be carried out for the connection between reverberation chamber and anechoic chamber, antennas, and cables.

N **8.23.5.4.1** The chambers shall be configured as shown in Figure 8.23.5.4.1.

N **8.23.5.4.2** Two circularly polarized antennas shall be inserted into the reverberation chamber as shown in Figure 8.23.5.3.1. One dual ridged horn antenna as shown in Figure 8.23.5.4.1 shall be inserted into the anechoic chamber on the same tabletops where the RF PASS components shall be placed during the attenuation test. The gain of these antennas shall be obtained from the manufacturer's specifications or by use of a technique such as a three-antenna method.

N **8.23.5.4.3** One calibration antenna shall be connected to the signal generator, and the other to the spectrum analyzer through bulkhead adapters in the body of the test chambers. The cables connecting the antennas to the bulkhead adapters shall be of a length that limits power loss to less than 2 dB.

N **8.23.5.4.4** The power loss in the cables connecting the signal generator and spectrum analyzer to the bulkheads of the chambers shall be determined through measurement.

N **8.23.5.4.5** The reverberation chamber paddle shall be on and operating at 0.2 RPM and path loss measurements shall be collected every 3 seconds.

N **8.23.5.4.6** The path loss measurements shall be averaged. This value shall be regarded as the total path loss between the reverberation chamber and the tabletop of the anechoic chamber.

N **8.23.5.4.7** The system path loss shall be measured between the reverberation chamber and the reference plane within the anechoic chamber specified in Figure 8.23.5.4.1 with the external attenuator set to 0 dB. The power loss between the measurement reference planes shall be a positive quantity that is measured and recorded as "measured path loss, 0 dB." Measurements shall be collected over the frequency of operation of the RF PASS under test. The resolution bandwidth of the spectrum analyzer shall be less than or equal to 1 kHz.

N **8.23.5.4.8** The calibrated path loss, 0 dB shall be calculated as measured path loss, 0 dB gain of calibration antennas, where gain of calibration antennas is the sum of the specified gain of each calibration antenna in decibels.

N **8.23.5.4.9** The external attenuator to achieve the total attenuation from table to table shall be calculated as total attenuation — calibrated path loss, 0 dB, where total attenuation is 80 dB between the anechoic chamber and reverberation chamber for the multi-hop RF test.

N **8.23.5.5 Procedure for Configuring Two Anechoic Chambers with Target Attenuation.** This procedure shall be carried out for the pair of anechoic chambers, antennas, and cables.

N **8.23.5.5.1** The chambers shall be configured as shown in Figure 8.23.5.5.1.

N **8.23.5.5.2** Two dual ridged horn antennas, as shown in Figure 8.23.5.5.1 shall be inserted into the anechoic chambers on the same tabletops where the RF PASS components shall be placed during the attenuation test. The gain of these antennas shall be

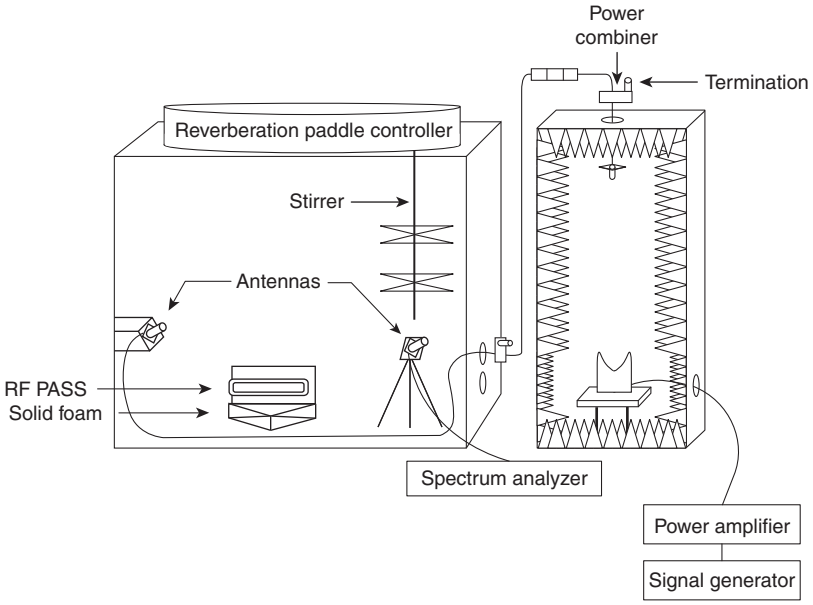


FIGURE 8.23.5.4.1 Configuration for Calibration of Target Path Loss Between Reverberation Chamber and Anechoic Chamber.

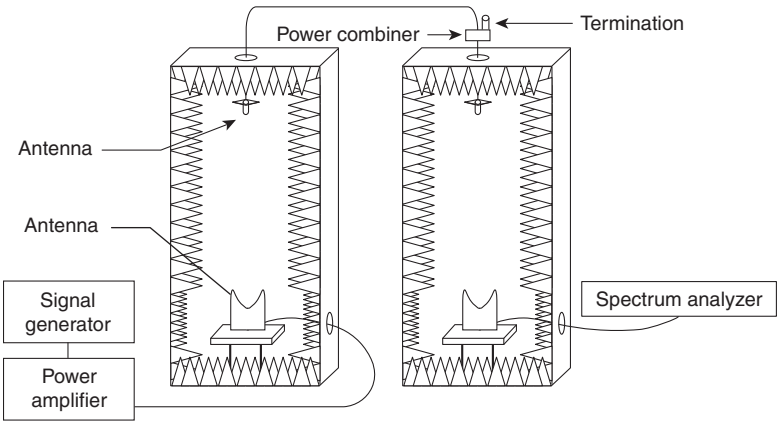


FIGURE 8.23.5.5.1 Configuration for Calibration of Target Path Loss Between Two Anechoic Chambers.

obtained from the manufacturer's specifications or by use of a technique such as a three-antenna method.

N **8.23.5.5.3** One calibration antenna shall be connected to the signal generator, and the other to the spectrum analyzer through bulkhead adapters in the body of the test chambers. The cables connecting the antennas to the bulkhead adapters shall be of a length that limits power loss to less than 2 dB.

N **8.23.5.5.4** The power loss in the cables connecting the signal generator and spectrum analyzer to the bulkheads of the chambers shall be determined through measurement.

N **8.23.5.5.5** The system path loss shall be measured between the two measurement reference planes specified in Figure 8.23.5.5.1. The power loss between the measurement reference planes shall be a positive quantity that is measured and recorded as "measured path loss, 0 dB." Measurements shall be collected over the frequency of operation of the RF PASS under test. The resolution bandwidth of the spectrum analyzer shall be less than or equal to 1 kHz.

N **8.23.5.5.6** The calibrated path loss, 0 dB shall be calculated as measured path loss, 0 dB gain of calibration antennas, where gain of calibration antennas is the sum of the specified gain of each calibration antenna in decibels.

N **8.23.5.5.7** The external attenuator to achieve the total attenuation from table to table shall be calculated as total attenuation — calibrated path loss, 0 dB, where total attenuation is 100 dB between two anechoic chambers.

N **8.23.5.6 Procedure for Multi-hop RF Test.**

N **8.23.5.6.1 Alarm Signal Test.** The test shall be conducted with the base station acting as the receiver and the RF PASS under test transmitting an alarm signal upon initiation of the alarm signal.

N **8.23.5.6.1.1** The total attenuation, including cables, connectors, free-space path loss, antenna loss, and external added attenuation between the two anechoic chambers shall correspond to 100 dB. The total attenuation between the reverberation chamber and anechoic chamber shall correspond to 80 dB.

N **8.23.5.6.1.2** The total attenuation, including cables, connectors, free-space path loss, antenna loss, and external added attenuation, between the base station and the RF PASS under test shall correspond to 260 dB using the calibration procedure specified in 8.23.5.2.

N **8.23.5.6.1.3** The reverberation chamber paddle shall be turned on and shall rotate at 3 RPM ± 2 RPM.

N **8.23.5.6.1.4** A wireless link shall be established between the base station and the RF PASS under test before closing the chambers' doors.

N **8.23.5.6.1.5** The chambers' doors shall be closed for 1 minute before proceeding.

N **8.23.5.6.1.6** The RF PASS with the largest amount of attenuation between it and the base station shall be the device under test. The duration of time between the initiation of the alarm signal until the reception of the alarm signal shall be recorded. This test shall be repeated three times.

N **8.23.5.6.1.7** The alarm signal test shall be conducted twice for each of the three trials.

N **(A)** The RF PASS system shall be tested with the RF PASS perpendicular to the surface of the tabletop and the base station antenna parallel to the surface of the tabletop.

N **(B)** The RF PASS system shall be tested with the RF PASS parallel to the surface of the tabletop and the base station antenna parallel to the surface of the tabletop.

N **8.23.5.6.2 Evacuation Alarm Test.** The test shall be conducted with the RF PASS under test acting as a receiver and the base station transmitting an evacuation alarm.

N **8.23.5.6.2.1** The total attenuation, including cables, connectors, free-space path loss, antenna loss, and external added attenuation between the two anechoic chambers shall correspond to 100 dB. The total attenuation between the reverberation chamber and anechoic chamber shall correspond to 80 dB.

N **8.23.5.6.2.2** The total attenuation, including cables, connectors, free-space path loss, antenna loss, and external added attenuation, between the base station and the RF PASS under test shall correspond to 260 dB using the calibration procedure specified in 8.23.5.2.

N **8.23.5.6.2.3** The reverberation chamber paddle shall be turned on and shall rotate at 3 RPM ± 2 RPM.

N **8.23.5.6.2.4** A wireless link shall be established between the base station and RF PASS under test before closing the chambers' doors.

N **8.23.5.6.2.5** An alarm shall be sent from the base station without opening the anechoic doors, using any necessary additional software or method. The alarm shall be sent 1.5 minutes after activating the automated click software.

N **8.23.5.6.2.6** The RF PASS under test shall be kept in motion so that the motion-sensing device shall not trigger the alarm signal. A mechanism to move the RF PASS under test shall be permitted to be used. Any mechanism employed to move the RF PASS under test shall not disturb the field uniformity of the chamber more than 3 dB as specified in 8.19.5.1.

N **8.23.5.6.2.7** The RF PASS with the highest total attenuation between it and the base station shall be the device under test. The duration of time between the initiation of the evacuation alarm and the reception of the alarm for the RF PASS under test shall be recorded.

N **8.23.5.6.2.8** The evacuation alarm test shall be conducted twice.

N **(A)** The RF PASS system shall be tested with the RF PASS perpendicular to the surface of the tabletop and the base station antenna parallel to the surface of the tabletop.

N **(B)** The RF PASS system shall be tested with the RF PASS parallel to the surface of the tabletop and the base station antenna parallel to the surface of the tabletop.

N **8.23.6 Report.** The report shall be as specified in 8.19.6.

N **8.23.7 Interpretation.**

N **8.23.7.1** Pass or fail performance shall be determined for each specimen. A signal that is not received from either test within 30 seconds shall constitute failing performance.

N **8.23.7.2** One or more specimens failing this test shall constitute failing performance.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

Δ **A.1.1.1** NFPA 1500 requires that each person involved in rescue, fire fighting, or other hazardous duties be provided with and use a PASS.

PASS should be worn on protective clothing or protective equipment, or as an integrated part of another item of protective clothing or protective equipment and used whenever the member is involved in fire suppression or similar activities, regardless of whether SCBA is worn. This might require the PASS to be moved from one protective clothing item to another or the department to purchase additional PASS for use where structural protective clothing is not worn, as in, for example, wildland fire fighting, technical rescue, and high-angle rescue.

PASS are designed to assist in locating fire fighters or other emergency services personnel who become incapacitated or are in need of assistance.

RF PASS contain an optional RF transceiver that enables the PASS to automatically transmit alarm signals and receive evacuation alarms via RF signals. The RF PASS responds to an evacuation alarm with an audible and visual signal. A complete RF PASS system includes a base station that monitors for an alarm signal from the portable RF PASS unit and emits an audible and visual signal when this alarm is received. The base station is also capable of sending an evacuation alarm to the RF PASS.

NFPA 1561 and Section 8.4 of NFPA 1500 require every fire department to establish a system of fire-fighter accountability that provides for the tracking and inventory of all members during emergency operations.

Δ **A.1.1.2** Appropriate testing criteria have been developed to include RF PASS in this standard as an option.

Purchasers and manufacturers of PASS should understand that NFPA 1982 addresses the minimum requirements for PASS. New technologies and capabilities are available for PASS for the tracking and accountability of emergency services personnel, and emergency services organizations might want to consider specifying such additional features and capabilities that are not included within the minimum standard.

PASS enhancements (accessories) could include the following:

(1) Electronic personnel accountability
(2) Person-to-person local distress notification
(3) Person locator systems
(4) Additional systems information (data logging features such as cylinder pressure, temperature, breathing rates, elapsed time, etc.)

Where purchasers are interested in RF PASS capabilities, they should consider the benefits and limitations of the additional capabilities before making a purchase. Emergency services organizations vary greatly in size, response types, and capabilities. Fire departments on the West Coast, for example, are more likely to encounter multiple-alarm wildland fires than New York City, Boston, or Chicago, which are more likely to experience multiple-alarm tenement or row house building fires than wildfires. Flood-prone regions are less likely to have underground garages, sub-basements, or subway systems. All these examples provide different challenges for the utilization of current versions of RF PASS.

RF PASS utilize radio signal technology. Radio signals react differently in variable and different environments. Different environments present different challenges to radio communications and radio signals. Transmission of radio signals is affected by topography, weather conditions, building layout and design, and construction material, as well as other obstructions that might be in a given area.

In the testing lab environment, alarm systems, monitoring devices, and even personal alert devices, such as PASS, cannot be "tested" in the total environment in which they could be used. Prospective end users, however, can conduct field testing of such devices in the total environment in which they could be used. Devices such as antennas or repeaters are incorporated into radio frequency (RF) systems used in large industrial, commercial, and residential facilities. Realistic and rigorous on-

site testing of systems and components will help ensure satisfactory coverage and help the user develop reasonable expectations. Physical testing of personnel safety systems utilizing any form of RF technology should be conducted in an actual or realistic environment. Current RF laboratory tests offer very good indicators regarding the reach and penetration of the RF signal(s). However, no lab test can take into account the variety of construction and obstructions commonly found, such as building layout and design, construction materials, topography, and environmental factors. Users must take local factors into consideration in their immediate response areas and consider such things as local topography, weather conditions, and local forms of construction for the system to meet their expectations.

Based on actual jurisdictional performance testing, appropriate public safety or government officials can make informed decisions regarding the purchase, use, and development of operational procedures to be used in providing the maximum level of personal protection for fire and rescue personnel in their jurisdiction.

Purchasers must be aware that a PASS is only one component of an overall accountability system or program. Purchasers must develop operational procedures to ensure that the system will function as expected.

Recommendations. Considering the factors noted in the preceding paragraphs, the purchaser should develop a testing and performance criteria similar to the following:

(1) Prior to using or purchasing a product or system, the local emergency services organization should select several different typical target hazard test locations in their normal response area for field testing of the product or system.
(2) Consideration should also be given that these target hazard test locations should provide rigorous testing scenarios and should include radio transmission dead spots, unusual topography, unusual building complexes, aboveground and belowground configurations, and construction.
(3) A person(s) designated by the local head of the emergency services organization(s) should participate in site selection and field testing.
(4) Testing should be conducted by simulation of actual emergency operations and conditions.
    (a) The emergency services official should designate an area where the base station receiving components of the RF PASS could be located if the incident were real.
    (b) Emergency responders should wear or carry the devices just as they would during an actual emergency and travel to all areas of the simulated emergency scene test area.
    (c) Alarm signals must be activated from many areas within the test site while the base station is monitored to ensure reception or acknowledgment of each alarm.
    (d) Attempts should be made to make the test scenarios for RF PASS as difficult and challenging as possible so problem areas where an RF signal could have difficulty penetrating a building or structure can be isolated and addressed.
    (e) Testing results should be recorded, with environmental factors such as the type of occupancy (residential, commercial, industrial, etc.), construction features, weather conditions, and location noted.
(5) Enhancement devices (leaky coaxial feeders, repeaters, enhanced radio receivers) can be used, as necessary, with placement and effectiveness recorded.
(6) Fire or emergency responders who would routinely have multiple base stations on the scene of an actual emergency should place multiple base stations in service during field-testing scenarios in accordance with their standard operating procedures.
(7) *NFPA 5000* outlines the eight basic types of construction that should be considered as part of the field-test criteria.
(8) Users should evaluate the effectiveness of the RF PASS as it relates to the developed operational procedures.

By conducting these recommended field tests, the end user can witness the performance of the product in the environment in which it is intended to be used, determine, with reasonable accuracy, whether the product does or does not meet their expectations, and then make an appropriate decision.

The committee clearly understands the benefits of not being able to provide an incident commander with immediate notification of fire fighters in distress as well as a method to evacuate fire fighters in the event of an imminent building collapse or other emergency. A study of the NIOSH Firefighter Death and Injury Reports over the past 10 years validates the necessity for these immediate notifications. As indicated in a letter from the CDC/NIOSH/DSR Investigation Team, dated April 14, 2011, "We are in agreement that providing PASS devices that offer two-way Mayday and Evacuation signal capabilities would greatly enhance fire-fighter safety at structure fires and other emergency response events." It is our intention to take a proactive approach to encourage government, educational institutions, and third-party compliance agencies to work in concert to develop appropriate test criteria that will validate the performance of new and emerging technologies.

N **A.1.1.3** Users of PASS and RF PASS certified to earlier editions of this standard often incorporate updated parts, components, or software to allow certification to the latest edition of NFPA 1982. This paragraph has been added so that the latest revision of the standard can be used for devices containing new parts, components, or software to certify their use on PASS devices certified to earlier editions or to upgrade the certification to the current edition.

A.1.2.2 Although all PASS that are in compliance with this standard have been tested to stringent requirements, there is no inherent guarantee against PASS failure or fire-fighter injury. Even the best-designed PASS cannot compensate for abuse or lack of a PASS training and maintenance program. The severity of these tests should not encourage or condone abuse of PASS in the field.

By themselves, the environmental and physical tests utilized in this standard might not simulate actual field conditions, but they are devised to put extreme stress loads on PASS in a manner that is accurate and reproducible by test laboratories. However, the selection of the environmental tests was based on summary values derived from studies of conditions that relate to field use.

A.1.3.2 Emergency response organizations are cautioned that accessories are not part of the certified product but could be attached to a certified product by means not engineered,

manufactured, or authorized by the certified product manufacturer.

Emergency response organizations are cautioned that if an accessory or its means of attachment causes the structural integrity of the certified product to be compromised, the certified product might not be compliant with the standard with which it was originally certified as compliant. Additionally, if an accessory or the accessory's means of attachment are not designed and manufactured from suitable materials for the hazardous environments of emergency incidents, the failure of the accessory or means of attachment could cause injury to the emergency responder.

Because the aftermarket for accessories for s is so broad, emergency response organizations are advised to contact both the accessory manufacturer and the manufacturer of the certified product and verify that the accessory and its means of attachment are suitable for use in the intended emergency response environment. Emergency response organizations should seek and receive written documentation from the accessory manufacturer to validate the following assurances:

(1) Accessories for a certified product and the means of attachment will not degrade the designed protection or performance of the certified product below the requirements of the standard to which it was designed, manufactured, tested, and certified.
(2) The accessory, when properly attached to the certified product, will not interfere with form, fit, or function of any of the certified product or with the form, fit, and function of any of the certified product's component parts.

Users are also cautioned that the means of attachment for accessories that fail to safely and securely attach the accessory to a certified product could allow the accessory to become inadvertently dislodged from the certified product, possibly posing a risk to emergency response personnel in the vicinity.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.6 Component. Components include items required for the design and construction of the product and are evaluated and tested individually or are evaluated and tested as part of the whole product.

A.4.1.6 The National Fire Protection Association (NFPA), from time to time, has received complaints that certain items of fire and emergency services protective clothing or protective equipment might be carrying labels falsely identifying them as complying with an NFPA standard.

The purpose of the requirement for placing the certification organization's mark on or next to the product label is to help ensure that the purchaser can readily determine compliance of the respective product through independent third-party certification.

Those purchasing PASS devices should be aware of the following information.

For PASS to meet the requirements of NFPA 1982, they must be certified by an independent third-party certification organization. In addition, the item must carry the label, symbol, or other identifying mark of that certification organization.

NOTE: Any PASS that does not bear the mark of an independent third-party certification organization is not compliant with NFPA 1982, even if the product label states that the PASS is compliant.

For further information about certification and product labeling, Chapters 4 and 5 of NFPA 1982 should be referenced. Also, the definitions for *certification/certified*, *labeled*, and *listed* in Chapter 3 should be reviewed.

Third-party certification is an important means of ensuring the quality of fire and emergency services protective clothing and equipment. To be certain that an item is properly certified, labeled, and listed, prospective purchasers should require appropriate evidence of certification for the specific product and model from the manufacturer. Prospective purchasers should also contact the certification organizations and request copies of the certification organization's list of certified products to the appropriate NFPA standard. This listing is a requirement of third-party certification by this standard and is a service performed by the certification organization.

All NFPA standards on fire and emergency services protective clothing and equipment require that the item be certified by an independent third-party certification organization, and, as with PASS devices that are certified as compliant with NFPA 1982, all items of fire and emergency services protective clothing and equipment must carry the label, symbol, or other identifying mark of that certification organization.

NOTE: Any item of protective clothing or protective equipment covered by an NFPA standard that does not bear the mark of an independent third-party certification organization