



National Fire Protection Association

1 Batterymarch Park, Quincy, MA 02169-7471
Phone: 617-770-3000 • Fax: 617-770-0700 • www.nfpa.org

MEMORANDUM

TO: NFPA Technical Correlating Committee on Electronic Safety Equipment
FROM: Dave Trebisacci, Staff Liaison
DATE: October 21, 2011
SUBJECT: NFPA 1982 ROP TCC Letter Ballot (F2012)

In accordance with the NFPA Regulations Governing Committee Projects, attached is the Letter Ballot on the Report on Proposals (ROP) for the 2013 Edition of NFPA 1982.

Since there were no TCC Notes only the Letter Ballot Authorizing the Release of the Report is attached.

Negative votes are limited to subjects within the purview of the TCC. Opposition on a strictly technical basis is not sufficient grounds for substantiating a negative vote. If you do have correlation issues please identify and describe your concerns.

Please complete and return your ballot as soon as possible but no later than November 2, 2011. As noted on the ballot form, please return the ballot to Yvonne Smith via e-mail to ysmith@nfpa.org or via fax to 617-984-7056. You may also mail your ballot to the attention of Yvonne Smith at NFPA, 1 Batterymarch Park, Quincy, MA 02169.

The return of ballots is required by the Regulations Governing Committee Projects.

Attachment: ROP Ballot Form

1982-1 Log #CP1 FAE-ELS
(Entire Document)

Final Action: Accept

Submitter: Technical Committee on Electronic Safety Equipment,

Recommendation: Review entire document to: 1) Update any extracted material by preparing separate proposals to do so, and 2) review and update references to other organizations documents, by preparing proposal(s) as required.

Substantiation: To conform to the NFPA Regulations Governing Committee Projects.

Committee Meeting Action: **Accept**

Committee Statement: The technical committee reviewed the entire document and updated any extracted material by preparing separate proposals, and reviewed and updated references to other organizations documents, by preparing proposal(s) as necessary.

Number Eligible to Vote: **22**

Ballot Results: Affirmative: 22

1982-2 Log #18 FAE-ELS
(Entire Document)

Final Action: **Accept in Principle**

Submitter: Gordon R. Sletmoe, Medford Fire-Rescue

Recommendation: This proposal adds RF PASS as optional equipment associated with PASS, and the methods to test and/or verify the performance of RF PASS. Extensive additions, deletions, and revisions are indicated throughout the document. These changes are indicated by underscore or strike-through.

INCLUDE 1982_L18_R.DOCX HERE

Substantiation:

INCLUDE 1982_L18_S.DOCX HERE

Committee Meeting Action: Accept in Principle

Committee Statement: The technical committee accepted the proposal in principle, and reviewed each item. The TC revised the text and is submitting a Committee Proposal based on this public proposal. Please see the recommendation and substantiation in 1982-3 (Log #CP3).

Number Eligible to Vote: 22

Ballot Results: Affirmative: 21 Negative: 1

Explanation of Negative:

PARKULO, C.: 3.3.1.5 **Out-of-Range Alarm.** An audible alarm signal that is initiated automatically when the RF communication between a *base station* and user-worn *RF PASS* is lost. The out-of-range alarm warns emergency services personnel that their *RF PASS* is no longer in radio communication with the base station.

The Committees members recommendation during the March 3-4, 2001 meeting was that the Out of Range Alarm was to be changed state “audible or visual”

6.2.1.1 *RF PASS* shall allow for two additional modes: (4) *remote distress alarm*, to be automatically engaged whenever the *audible distress alarm* is enabled, and (5) *evacuation sensing*, to be automatically engaged whenever the *motion sensing* and/or *audible/remote distress alarms* are active.

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

During the March meeting it was explained during the March 2001 meeting that there is no such mode on a PASS device “*evacuation sensing mode*”

Comment on Affirmative:

FEELY, M.: Sec 7.1.2.2 lists a frequency test at 500hz. This requirement was eliminated by the committee

Chapter 1 Administration

1.1 Scope.

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

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 RF PASS that are capable of transmitting a distress alarm 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 RF PASS for the receipt of a remote distress alarm and the transmission of an evacuation alarm via an RF signal.

Chapter 2 Referenced Publications

2.3.4 NIST Publications.

C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, D.F. Williams, S.A. Schima, S. Canales, D.T. Tamura, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a 13-Story Apartment Building," *Natl. Inst. Stand. Technol. Note 1540*, May 2005

C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, D.F. Williams, S.A. Schima, S. Canales, D.T. Tamura, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a Large Sports Stadium (Veterans' Stadium in Philadelphia)," *Natl. Inst. Stand. Technol. Note 1541*, October 2005.

C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, S.A. Schima, M. McKinley, R.T. Johnk, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a Large Convention Center," *Natl. Inst. Stand. Technol. Note 1542*, June 2006.

C.L. Holloway, W.F. Young, G. Koepke, K.A. Remley, D. Camell, Y. Becquet, "Attenuation of Radio Wave Signals Coupled Into Twelve Large Building Structures," *Natl. Inst. Stand. Technol. Note 1545*, Apr. 2008.

K.A. Remley, G. Koepke, C.L. Holloway, C. Grosvenor, D. Camell, J. Ladbury, D. Novotny, W.F. Young, G. Hough, M.D. McKinley, Y. Becquet, J. Korsnes, "Measurements to Support Broadband Modulated-Signal Radio Transmissions for the Public-Safety Sector," *Natl. Inst. Stand. Technol. Note 1546*, Apr. 2008.

K.A. Remley, G. Koepke, C. Grosvenor, R.T. Johnk, J. Ladbury, D. Camell, J. Coder, "NIST tests of the wireless environment in automobile manufacturing facilities," *Natl. Inst. Stand. Technol. Note 1550*, Oct. 2008.

W. F. Young, K. A. Remley, J. Ladbury, C. L. Holloway, C. Grosvenor, G. Koepke, D. Camell, S. Floris, W. Numan, and A. Garuti, "Measurements to support public safety communications: attenuation and variability of 750 MHz radio wave signals in four large building structures," NIST Technical Note 1552, Aug. 2009.

W.F. Young, K. A. Remley, D. W. Matolak, Q. Zhang, C. L. Holloway, C. Grosvenor, C. Gentile, G. Koepke, and Q. Wu "Measurements and models for the wireless channel in a ground-based urban setting in two public-safety frequency bands," NIST Technical Note 1557, May 2011.

K.A. Remley, G. Koepke, C.L. Holloway, C. Grosvenor, D. Camell, J. Ladbury, R.T. Johnk, and W.F. Young, "Radio wave propagation Into large building structures: Part 2, characterization of multipath," *IEEE Trans. Ant. Propagat.*, vol. 58, no. 4, Apr. 2010, pp. 1290-1301.

2.3.5 ~~2.3.4~~ Other Publications.

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

Chapter 3 Definitions

3.3 General Definitions.

3.3.1 Alarm Signal. An audible or visual warning that indicates an emergency services person is in need of assistance, is experiencing a low battery condition or, for RF PASS, must evacuate, or is experiencing an out-of-range condition.

3.3.1.1 Audible Distress Alarm Signal. An audible warning that is identifiable as an indication that an emergency services person is in need of assistance.

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

3.3.1.3 Remote Distress Alarm. A distress alarm initiated by a user-worn RF PASS, transmitted to a *base station* via an RF signal. When received, the *remote distress alarm* triggers an audible alarm signal at the *base station*.

3.3.1.4 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.

3.3.1.5 Out-of-Range Alarm. An audible alarm signal that is initiated automatically when the RF communication between a *base station* and

user-worn *RF PASS* is lost. The out-of-range alarm warns emergency services personnel that their *RF PASS* is no longer in radio communication with the base station.

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

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

3.3.14.3.1 Base Station. An *RF transceiver* used in conjunction with an *RF PASS* that monitors for a *remote distress alarm* and emits an audible and 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*. [Note: moved to 3.3.1.2].

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.

3.3.16 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. The *RF transceiver* is used to transmit and receive signals such as the *remote distress alarm* and the *evacuation alarm* for *RF PASS*.

Chapter 4 Certification

4.3 Inspection and Testing.

4.3.9.1 The Single-Hop RF Attenuation Test shall be performed with the *RF PASS* and the base station connected together as described in Section 8.18.

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
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 8.16), specimens 19–21
2	Alarm signal muffle (Section 8.17), 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		Single-Hop RF Attenuation Test (Section 8.18), specimens 19–21
3	Signal frequencies (Section 8.14), specimens 1–3	Impact acceleration — cold (Section 8.8), specimen 5	Electronic temperature stress — shock (8.3.7), specimens 7–9	Product label durability (Section 8.15), specimens 10–12	High temperature functionality (Section 8.12), specimens 13–15		Out-of-Range Alarm Test (Section 8.18), specimens 19–21
4	Heat/flame Test 1 (8.13.5.9), specimen 1	Impact acceleration — elevated (Section 8.8), specimen 6	Product label durability (Section 8.15), specimens 7–9		Single-Hop RF Attenuation Test (Section 8.18), specimen 13		
5	Heat/flame Test 1 (8.13.5.10), specimen 1		Heat and immersion leakage (Section 8.5), specimens 7–9				
6	Heat/flame Test 1 (8.13.5.11), specimen 1		Product label durability (Section 8.15), specimens 7–9				
7							

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
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 8.16), specimens 16-18
2	Alarm signal muffle (Section 8.17), 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	<u>Single-Hop RF Attenuation Test (Section 8.18), specimens 16-18</u>
3	Signal frequencies (Section 8.14), specimens 1-3		Electronic temperature stress — shock (8.3.7), specimens 7-9	Product label durability (Section 8.15), specimens 10-12	<u>Single-Hop RF Attenuation Test (Section 8.18), specimen 13</u>	<u>Out-of-Range Alarm Test (Section 8.18), specimens 16-18</u>
4	Heat/flame test 1 (8.13.5.9), specimen 1		Product label durability (Section 8.15), specimens 7-9			
5	Heat/flame test 1 (8.13.5.10), specimen 1		Heat and immersion leakage (Section 8.5), specimens 7-9			
6	Heat/flame test 1 (8.13.5.11), specimen 1		Product label durability (Section 8.15), specimens 7-9			
7						

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 Immersion/Leakage Resistance 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, *Pass audible distress alarm* Signal. The one specimen PASS that is selected shall be chosen at random from each of the respective series of three specimens for each test.

Chapter 5 Labeling and Information

5.1.10 The *base station* component of an *RF PASS* system shall identify the maximum number of *RF PASS remote distress alarms* 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.

5.2.4 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
 - (d) For RF PASS systems that utilize a portable computer as part of the base station, the danger of muting the computer's speaker, in which case the base station operator would not receive the *audible distress alarm* or *out-of-range alarm* from the user-worn RF PASS.
- (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.

6.1.2.5 *RF PASS*, in addition to emitting *audible distress alarms*, shall also transmit and receive alarm signals through the use of a modulated radio-frequency carrier. The *RF PASS* system shall consist of a wireless *RF transceiver* contained within the user-worn *RF PASS* and a *base station RF transceiver* that may be self-contained or designed to operate in conjunction with a portable computer. The *base station* unit must be capable of battery operation for up to one hour under alarm conditions. The use of repeaters is not precluded.

6.1.2.5.1 The *base station* shall be designed to emit an audible and visual signal when the *audible distress alarm* described in 6.4.3 is activated by the user-worn *RF PASS* unit, when the *evacuation alarm* is initiated, and/or when the *out-of-range alarm* is triggered.

6.1.2.5.2 Both the user-worn *RF PASS* unit and *base station* must 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 firefighting operations.

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

6.1.3.3 Data logging may be carried out via RF signals transmitted by an *RF PASS* and received by the *base station*.

6.2 Mode Selection Design Requirements for PASS.

6.2.1 PASS shall incorporate a mode selection device or devices to allow for operation in at least three modes: (1) *off*, (2) *alarm*, and (3) *sensing* (1) *off*, (2) *motion sensing* and (3) *audible distress alarm*.

6.2.1.1 *RF PASS* shall allow for two additional modes: (4) *remote distress alarm*, to be automatically engaged whenever the *audible distress alarm* is enabled, and (5) *evacuation sensing*, to be automatically engaged whenever the *motion sensing* and/or *audible/remote distress alarms* are active.

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

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 *motion sensing* mode to the *audible distress alarm mode/remote distress alarm mode*, with the mode selection device but shall not be able to be switched to remain in 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 *motion sensing/evacuation sensing* mode.

6.2.5 All mode selection devices shall be capable of being switched to the *audible/remote distress alarm* or *motion 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 (3/32 in. to 5/32 in.).

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

6.2.7 When PASS is sounding the *audible/remote distress alarm*, it shall require at least two separate and distinct manual actions to silence the *audible/remote distress alarm*.

6.2.7.1 Any action to silence the *audible/remote distress alarm* and the actual silencing of the *audible/remote distress alarm* shall not permit PASS to remain in the *off* mode.

6.2.7.2 The silencing of the *audible/remote distress alarm* shall automatically reset PASS to the *motion sensing* mode.

6.2.7.3 *Base station* units for *RF PASS* shall sound an audible alarm and indicate on a visual display the presence of all *RF PASS* units that are in *remote distress 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 *motion/evacuation sensing*, *off* to *audible/remote distress alarm*, and *audible/remote distress alarm* to *motion/evacuation sensing*.

6.2.8.1 *Base station* units for *RF PASS* shall utilize a different visual display to indicate *motion sensing*, *remote distress alarm*, and *evacuation alarm modes*.

6.3 Motion/Evacuation 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 *audible distress alarm* when lack of motion is detected for the specified time.

6.3.2 PASS shall sound the *audible distress 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 *remote distress alarm* within 30 seconds of its transmission by the *RF PASS*.

unless RF communication has been lost.

6.3.2.2 Base station units for RF PASS shall sound the audible alarm and indicate the visual display specified in 6.4.3.1 for all RF PASS units that are in remote distress alarm mode.

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

6.3.5 PASS shall be designed so that any failure of the motion sensing function shall cause the PASS to sound the audible distress 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.

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

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 motion 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 motion 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 primary pre-alarm signal shall be a distinct and different sound from the audible distress alarm signal.

6.4.2.4 PASS shall sound the pre-alarm signal(s) 10 seconds, ~~+3/-0~~ seconds prior to the sounding of the alarm signal.

6.4.2.6 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 audible distress alarm signal.

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

6.4.3 Alarm Signals.

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

6.4.3.2 While in the motion sensing mode, PASS shall sound the audible distress alarm signal when activated by the motion sensing component when motion is not detected for 30 seconds, ~~+5/-0 seconds~~

6.4.3.2.1 For RF PASS, while in the motion/evacuation sensing mode, when the audible distress alarm is activated, the remote distress alarm shall be transmitted within 3 seconds.

6.4.3.2.2 For RF PASS, while in the motion/evacuation sensing or audible/remote alarm modes, PASS shall sound an audible evacuation alarm within 30 seconds of the evacuation alarm being sent by the base station.

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

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

6.4.3.4.1 For RF PASS, during the audible distress alarm sounding, all other audible PASS signals shall be rendered inactive, with the exception of the evacuation alarm.

6.4.3.5 The audible distress alarm signal shall have a duration of at least 1 hour ~~at a sound pressure level of not less than 95 dBA~~ at the user-worn PASS.

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

6.4.3.6 The audible distress alarm signal shall be audible at the user-worn PASS in a variable or noncontinuous tone.

6.4.3.6.1 For RF PASS, the remote distress alarm shall be audible at the base station.

6.4.3.7 The audible distress alarm signal, once activated, shall not be deactivated by the motion detector.

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

6.4.3.9 The silencing of the audible distress alarm signal shall automatically reset the PASS to the motion sensing mode.

6.4.4 Low Power Source Warning Signal.

6.4.4.1 While in the motion/evacuation sensing mode, PASS shall emit a recurrent audible low power source warning signal when the power source voltage is depleted to the level that will maintain the ~~alarm signal audible distress alarm~~ level of at least 95 dBA for at least 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 audible distress 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~~ audible distress alarm.

6.4.5 Out-of-Range Alarm (RF PASS).

6.4.5.1 For RF PASS, when loss of RF communication is detected, the base station shall emit a recurrent audible out-of-range alarm to the base-station operator, and the user-worn RF PASS unit shall emit a recurrent audible out-of-range alarm to the user within 60 seconds of loss of

communication.

6.4.5.2 The *out-of-range alarm* shall consist of an audible and visual alarm, distinct from the *audible distress alarm*, the *remote distress alarm*, and the *evacuation signal*.

6.4.5.3 The *base station* and the user-worn *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.

6.4.5.4 The *out-of-range alarm* shall have an interval not to exceed 60 seconds.

Chapter 7 Performance Requirements

7.1 Sound Pressure Levels.

7.1.2 PASS Alarm Signal.

7.1.2.1 PASS shall be tested for the sound pressure level of the *audible distress alarm signal* as specified in Section 8.2, Sound Pressure Level Tests, shall not have the *audible distress alarm signal*, once activated, be deactivated by the motion detector; shall have the *audible distress alarm signal* sound pressure level not be less than 95 dBA for an uninterrupted duration of not less than 1 hour, and shall have PASS function properly as specified in 6.4.3.

7.1.2.1.1 For *RF PASS*, the *remote distress alarm* shall have an uninterrupted duration of at least 1 hour at the *base station*. The *remote distress alarm* sound pressure level shall be not less than 80 dBA at the *base station*.

7.1.2.1.2 If a portable computer is utilized in the *base station*, the sound pressure specified in 7.1.2.1.1 shall be tested using the manufacturer's supplied portable computer.

7.1.2.2 PASS shall be tested for signal frequency as specified in Section 8.14, Signal Frequency Test, and shall have the *audible distress alarm signal* consist of a minimum of three primary frequencies, at least one of which shall be 500 Hz, ± 20 Hz, and at least two other frequencies shall not be less than 1000 Hz nor more than 4000 Hz; and shall have these frequencies sounded either sequentially or simultaneously.

7.1.4 The *out-of-range alarm* sound pressure level shall be not less than 95 dBA at the user-worn *RF PASS*.

7.1.4.1 The *out-of-range alarm* sound pressure level shall be not less than 80 dBA at the *base station*.

7.4 Immersion Leakage Resistance.

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 6.4.2.4 and 6.4.3.2, shall meet the proper *audible distress 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.

7.5 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 6.4.2.4 and 6.4.3.2; shall meet the proper *audible distress 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.

7.12 Heat and Flame Resistance.

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 *audible distress alarm signal* shall sound and continue to sound as specified in 6.4.3.
- (2) The *audible distress 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 *audible distress alarm signal* to *motion 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.

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 *motion 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 *audible distress alarm signal* as specified in Section 6.3, Motion Sensing Design Requirements for PASS.
- (5) The *audible distress 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 *audible distress alarm signal* to *motion 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 *audible distress alarm signal* sound pressure level shall be as specified in 7.1.2.1.
- (9) The data logging functions specified in 6.1.3(1) through 6.1.3(6) shall operate properly.

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 *motion sensing* to *audible distress alarm signal* as specified in 6.2.5 and 6.2.6.
- (3) The *audible distress 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 *audible distress alarm signal* to *motion 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 *audible distress 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.

7.15 Radio System Tests – Single-Hop 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 8.18, Radio System Tests for RF PASS – Single-Hop RF Attenuation Test.

7.15.1 The base station shall automatically emit an audible alarm in response to a remote distress alarm received from the user-worn RF PASS within 30 seconds of alarm activation under the radio channel conditions specified in Section 8.18. The user-worn 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 8.18.

7.15.2 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.

7.15.3 The Single-Hop RF Attenuation Test is conducted to determine whether the user-worn RF PASS will operate in an RF propagation channel having a specified level of path loss. This level of attenuation shall be chosen to replicate that expected in certain firefighting conditions, as determined in Annex C “Single-Hop RF Attenuation Test for RF PASS.”

7.15.3.1 The Single-Hop RF Attenuation Test is conducted in two configurations (1) with the base station acting as the receiver and the user-worn RF PASS transmitting a remote distress alarm; (2) with the RF PASS acting as a receiver and the base station transmitting an evacuation alarm.

7.15.3.2 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 user-worn RF PASS shall correspond 100 dB +/- 3dB, which is representative of path loss associated with houses and small buildings with exterior-facing rooms at frequencies of approximately 1 GHz, as discussed in Annex C “Single-Hop RF Attenuation Test for RF PASS.” The total attenuation shall be calculated using the methods described in Annex C.

7.15.3.3 The Single-Hop RF Attenuation Test is conducted with no added radio interference. The single-hop attenuation test does not preclude the use of repeaters in the field.

7.16 Radio System Tests – Out-of-Range Alarm Test.

RF PASS shall be tested for initiation of audible and visual alarm signals when RF communication is lost as specified in Section 8.19, Radio System Tests for RF PASS – Out-of-Range Alarm Test.

7.16.1 The base station shall automatically initiate the out-of-range alarm in response to loss of RF communication with the user-worn RF PASS within 60 seconds under the radio channel conditions specified in Section 8.19. The user-worn RF PASS shall automatically initiate the out-of-range alarm within 60 seconds of loss of RF communication with the base station under the radio channel conditions specified in Section 8.19.

7.16.2 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.

Chapter 8 Test Methods

8.2 Sound Pressure Level Tests.

8.2.1 Application.

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

8.2.1.5 Modifications to this test method for testing *remote distress alarm* at the base station associated with RF PASS shall be as specified in 8.2.11.

8.2.6 Report.

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

8.2.6.4 The remote distress alarm sound pressure level after testing as specified in 8.2.11 shall be measured, recorded, and reported.

8.2.8 Specific Requirements for Testing ~~Alarm Signals~~ Audible Distress Alarm Signals

8.2.8.1 The sound pressure level for the ~~alarm signal~~ audible distress alarm shall be measured in a spherical radius at a distance of 3 m (9.9 ft) in from the specimen's annunciator.

8.2.8.4 The sound pressure level for the ~~alarm signal~~ audible distress alarm shall be measured for 60 minutes, +5/-0 minutes.

8.2.8.5 The ~~alarm signal~~ audible distress alarm signals sound pressure level shall be recorded, evaluated, and reported for the entire duration to determine pass or fail performance.

8.2.11 Specific Requirements for Testing Remote Distress Alarm Signals

This section applies to the base station associated with RF PASS

8.2.11.1 The sound pressure level for the remote distress alarm shall be measured in a spherical radius at a distance of 1 m (3.3 ft) in from the base station's annunciator.

8.2.11.2 The sound pressure level for the remote distress alarm shall be measured for 60 minutes.

8.2.8.5 The remote distress alarm 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.

8.3.5 Test Procedure 1.

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

8.3.6 Test Procedure 2.

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

8.3.7 Test Procedure 3.

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

8.3.8 Report.

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

8.4.4 Procedure.

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

8.4.5 Report.

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

8.5.5 Test Procedure 1.

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

8.5.6 Test Procedure 2.

8.5.7 Report.

8.5.7.1 For Test Procedure 1, the specimen audible distress alarm signal sound pressure level shall be measured, recorded, and reported.

8.6.4 Procedure.

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

8.6.5 Report.

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

8.8 Impact Acceleration Resistance Test.

8.8.4 Procedure.

8.8.4.5 Following each drop, the specimen shall remain motionless and shall sound the pre-alarm signal and the audible distress 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 audible distress alarm signal shall be stopped and the specimen reset to motion sensing mode for the next drop.

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

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

8.8.5 Report.

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

8.9 Vibration Resistance Test.

8.9.5 Procedure.

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

8.9.6 Report.

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

8.11 Water Drainage Test.

8.11.4 Procedure.

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

8.11.4.5 The *audible distress 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 *audible distress 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 *audible distress alarm signal* sound pressure level shall be measured, recorded, and reported.

8.12 High Temperature Functionality Test.

8.12.5 Procedure.

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 level for the *audible distress alarm signal* shall be measured in a spherical radius at a distance of 3 m, +1/-0 m (9.9 ft, +3.3/-0 ft) from the specimen's annunciator.

8.12.6 Report.

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

8.13 Heat and Flame Test.

8.13.5 Procedure.

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

8.13.5.13 For Test Procedure 1, specimens shall be observed for the continued sounding of the *audible distress alarm signal* to determine pass or fail performance as specified in 7.12.1(1).

8.13.5.17 For Test Procedure 1, following the drop sequence, specimens shall be observed for the continued sounding of the *audible distress alarm signal* to determine pass or fail performance as specified in 7.12.1(1).

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 *audible distress alarm signal*.

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

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

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 *audible distress alarm*.

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

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

8.13.5.21 The *audible distress 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.

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

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

8.14 Signal Frequency Test.

8.14.5 Procedure.

8.14.5.2 The *pre-alarm* or *audible distress alarm signal* shall be activated, and the signal frequency shall be measured.

8.14.5.5 The two primary *pre-alarm signal* frequencies and the three primary *audible distress alarm signal* frequencies shall be measured using the frequency analyzer.

8.14.6 Report.

8.14.6.2 The three *audible distress alarm signal* primary signal frequencies shall be recorded and reported.

8.14.7 Interpretation.

8.14.7.1 Pass or fail performance shall be determined for each specimen for both the *pre-alarm* and the *audible distress alarm signal* s.

8.15 Product Label Durability Test.

8.16 Tumble–Vibration Test.

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

8.16.6 Report.

8.16.6.1 The specimen *audible distress alarm signal* sound pressure level shall be measured, recorded, and reported.

8.17 PASS *Audible Distress Alarm Signal* Muffle Test.

8.17.5 Procedure.

8.17.5.5 The sound pressure level for the *audible distress alarm signal* shall be measured in a spherical radius at a distance of 3 m, +1/-0 m (9.9 ft, +3.3/-0 ft) in from the waist of the test subject.

8.17.6 Report. The *audible distress alarm signal* sound pressure levels shall be measured, recorded, and reported.

Section 8.18 Radio System Tests for RF PASS – Single-Hop RF Attenuation Test

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

8.18.2 Samples.

8.18.2.1 Samples shall be complete *RF PASS* systems.

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 *RF PASS* consisting of a user-worn *RF PASS* and the *base station* designed for use with it, provided by the manufacturer.

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

8.18.4 Test Apparatus

8.18.4.1 The Single-Hop RF Attenuation test is conducted with the apparatus described in Annex C “Single-Hop RF Attenuation Test for RF PASS.” A block diagram of the test apparatus is shown in **Figure 8.18.4.1**.

Figure 8.18.4.1: Apparatus used for Single-Hop RF Attenuation 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.

8.18.4.2 The field uniformity of the test chambers shall be tested once for each frequency of operation and set of antennas used in the test chambers.

8.18.5 Procedure.

8.18.5.1 The Single-Hop RF Attenuation Test is conducted according to the methodology described in Annex C “Single-Hop RF Attenuation Test for RF PASS.”

8.18.5.2 The target path loss specified in 7.15.3.2 shall be set up in the test chambers before the attenuation is measured. A different set up shall be completed for each frequency of operation and set of antennas used in the test chambers.

8.18.5.3 The *RF PASS* system shall be tested with the user-worn *RF PASS* placed in two orientations and the *base station* placed in one orientation for each of the *remote distress alarm* and *evacuation alarm* tests. This is a total of four measurements for each Single-Hop RF Attenuation Test.

8.18.5.4 Repeatability. Repeatability is established by measurement of the four separate devices specified in Table 4.3.10(a) (Specimens 13, 19-21) or Table 4.3.10(b) (Specimens 13, 16-18).

8.18.6 Report.

8.18.6.1 All quantities shall be reported to the nearest decibel.

8.18.6.2 The operator shall note the results of the all tests specified in 8.18.5, including the values of (1) Target path loss associated with the test environment. (2) Maximum difference in field uniformity within an area covering the center 30 cm x 30 cm of the test chamber, as measured in Annex C. (3) Value of measured path loss when the external attenuator is set to 0 dB (Called $S_{VNA,0dB}$ in Annex C). (4) Value of external attenuators used. (5) Frequency of operation (the minimum and maximum operating frequencies utilized).

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 this test shall constitute failing performance.

Section 8.19 Radio System Tests for RF PASS – Out-of-Range Alarm Test

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

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 a user-worn *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* are used in each test. Three different sets of units (portable + base station) shall be tested.

8.19.4 Test Apparatus

8.19.4.1 The test apparatus described in 8.18.4 for the Single-Hop RF Attenuation test shall be used.

8.19.5 Procedure.

8.19.5.1 The Out-of-Range Alarm Test is conducted with the user-worn *RF PASS* placed in one test chamber and the *base station* placed in a second chamber.

8.19.5.2 The path loss used in the Out-of-Range Alarm Test is infinite, implemented by disconnecting the coaxial cables that were connected to the attenuator in the Single-Hop RF Attenuation test. These cables are shown in Figure 8.18.4.1.

8.19.5.3 The orientation of the user-worn *RF PASS* and the *base station* is not critical.

8.19.5.4 An RF link is established between the *RF PASS* and *base station* with the doors to the test chambers open. When the link has been established, the doors are closed.

8.19.5.5 Upon closing the second door, the duration until the out-of-range alarm sounds from each of the user-worn *RF PASS* and the *base station* shall be noted.

8.19.5.6 Repeatability. The Out-of-Range Alarm Test shall be conducted once for each of three Specimens 19-21 (Table 4.3.10(a)) or Specimens 16-18 (Table 4.3.10(b)).

8.19.6 Report.

8.19.6.1 The operator shall note the results of the three tests specified in 8.19.5.6, including the duration before the out-of-range alarm sounds at the user-worn *RF PASS* and *base station*, and the frequency of operation.

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.

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.

A.1.1.1 NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 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 *remote distress alarms* 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 a *remote distress alarm* 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.

Section 5.3 of NFPA 1561, *Standard on Emergency Services Incident Management System*, and Section 8.4 of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 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.

A.1.1.4 After many years of exhaustive debate the Committee is now confident that the appropriate testing criteria have been developed to allow RF PASS to be included in this Standard as an option. searches of systems and testing applications, the Committee could not develop criteria to determine that the performance of such enhancements would be achieved with any degree of certainty and could not develop the appropriate test methods to determine that such features would perform *reliably and consistently* for the safety of the emergency services personnel.

Until such time that sound performance requirements and testing methods are developed that can verify the repeated reliability of the performance, within necessary operational and safety parameters, and that give a high degree of confidence of the performance of the enhancements, the Committee will not address such requirements in the standard. The Committee's opinion is that the inclusion at this time of requirements for such enhancements could potentially increase the risk to the emergency services personnel who might use PASS with such enhancements believing the enhancements would function in all situations to increase their margin of safety.

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) One-way distress notification
- (2) Two-way distress/evacuation and mass/team evacuation notification
- (3) Electronic personnel accountability
- (4) Person-to-person local distress notification
- (5) Person locator systems
- (6) Additional systems information (data logging features such as cylinder pressure, temperature, breathing rates, elapsed time, etc.)

Where purchasers are interested in enhancements RF PASS, 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 ~~enhanced~~ RF PASS PASS.

RF PASS Many, but not all, ~~enhancements to current 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 may be in a given area.

While the newly developed test criteria offer a very good predictor of the RF PASS performance, testing lab environments cannot be replicate the total environment in which RF PASS they could be used. ~~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 RF PASS such devices in the total environment in which they could be used. Devices such as antennas or repeaters ~~are~~ may be incorporated into RF PASS Systems radio frequency (RF) systems used in large industrial and commercial 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 RF PASS 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 testing methods cannot~~ 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 RF PASS 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 RF PASS is a PASS and a PASS with enhanced features are 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 (~~i.e., base station~~) where the base station receiving components of the RF PASS 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) Remote distress alarms and evacuation alarms ~~Alarm and distress signals~~ must be activated from many areas within the test site while the base station receiving devices ~~are~~ is monitored to ensure reception or acknowledgment of each remote distress or evacuation alarm ~~alarm or distress signal~~.
 - (d) Attempts should be made to make the test scenarios for RF PASS RF testing 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 receiving components on the scene of an actual emergency should place multiple base stations receiving devices in service during field-testing scenarios in accordance with their standard operating procedures.

- (7) *NFPA 5000, Building Construction and Safety Code*, 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 device 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~~ ~~consequences~~ 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." These facts weighed heavily on the Committee's decision to include RF PASS as an option in this Standard.

Personnel locating systems are next on the technical horizon. 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 ~~this~~ locating technology as we did with RF PASS.

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.4.3.9 Some manufacturers of PASS offer devices that incorporate temperature sensing, ~~radio transmission of distress signals~~, position location or other features that this document does not address. This document requires that the PASS, including all additional features installed on or in the PASS, comply with all requirements of this standard.

Users can investigate these features with the individual manufacturers to determine whether they want to specify such additional features.

Certification of the PASS to NFPA 1982 applies to the basic and RF PASS device only and not for any additional features not required by the standard.

A.6.1.5 Removing the power source cover and power source for inspection for water and performing the extended immersion test with the power source cover removed provide a test for the isolation requirement between the power source compartment and the electronics compartment stated in 6.1.5. The extended test is also meant to verify that the electronics compartment maintains a watertight seal when the power source cover is removed.

Note: Auto-On PASS has been a requirement since issuing the 1998 Edition of NFPA Standard 1982 for PASS. Since the introduction of the Auto-On PASS thirteen years ago, failure to turn on a PASS has become a moot issue.

A.6.2.2 ~~Over the years, several incidents have resulted in fire fighter deaths in situations where other fire fighters were in the vicinity. The common thread in far too many of these incidents was that the fire fighters were wearing PASS but did not have the PASS activated. While no one can definitely say that the fire fighters would have survived if their PASS had been activated, investigations have shown that other fire fighters were operating in the vicinity but were unaware that fire fighters were in trouble. Most of these fires were not fully involved conditions where no other fire fighters were operating in the interior when the victim fire fighters went down. In some of these incidents, other fire fighters walked or crawled over the downed fire fighters without realizing that they were there. In another incident, fire fighters heard the alarm signal from a PASS and were searching for the victim only to find the PASS lying on the floor and not attached to a fire fighter. The rescuers were unable to locate the victim fire fighter until the fire was extinguished. The fire fighter was found dead.~~

~~Fire fighters who have died without a PASS or wearing a non-activated PASS certainly would have had a significantly better chance of being rescued and surviving if their PASS had been activated.~~

~~An informal survey conducted by the Technical Committee to try to determine PASS problems that this standard could attempt to correct revealed some important and disturbing data. Nearly one thousand fire fighters from across the United States and Canada responded to the survey. To the question, "Do you activate your PASS at every fire?" over 60 percent answered, "No." To the question, "Why don't you activate your PASS at every fire?" 344 answered, "I forgot," and 206 answered that the operations were "routine, not thought to be dangerous."~~

~~The Phoenix Arizona Fire Department recognized the problem of its own fire fighters' not activating their PASS at emergency incidents and pioneered the SCBA-integrated PASS. The Phoenix Fire Department deserves considerable credit for taking a proactive position and working with manufacturers to develop PASS integrated with SCBA rather than just complaining that there were problems with existing PASS. The Phoenix Fire Department also participated in the standards development process and supplied the Committee with information and ideas to assist the Committee during the revision process. While the Committee recognizes that PASS integrated with SCBA helps with getting PASS activated, it depends on use of SCBA. There are still fire departments where all fire fighters do not routinely use and *breathe from* SCBA. There also are several types of operations where SCBA might not be used and stand-alone PASS is required by NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*.~~

~~Although all the requirements for PASS in NFPA 1982 are considered safety issues, the issue of fire fighters' not activating their PASS is one that has an actual body count attached to it. Fire fighters are dying while wearing PASS that is not activated. The Committee has addressed this issue with the design requirement for automatic activation for all PASS. This new requirement recognizes the advances made by PASS integrated with SCBA but is not limited to this single method. Because design requirement has been written without specifying the method for activation to reduce design restriction to the extent possible, manufacturers can be creative in designing automatic activation systems for their product. The Committee fully realizes the danger and consequences of non-activated PASS and is committed to correcting the problem.~~

~~Emergency services organizations that use PASS should make the commitment to provide PASS, educate personnel in the use of PASS, ensure that PASS are worn and used by all personnel participating in emergency operations, ensure that PASS are activated for every emergency~~

operation, frequently review their PASS program, and revise the program as necessary. Fire fighters and others using PASS should accept personal responsibility to use and activate PASS before engaging in emergency operations and not shut off PASS until the operation is finished or until they are clear of the danger area.

The function of the *pre-alarm signal* is not to annoy the PASS-wearer but to ask, in effect, "I'm not sensing any motion — are you OK?" Physical movement or shaking of the PASS will reset it and let it continue to function to perhaps help save the wearer's life. It cannot help if it is not activated or if it is turned off after the wearer is involved in an emergency operation.

Annex B Informational References

B.1 Referenced Publications.

The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

NIST testing criteria for RF PASS

NIST Publications.

C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, D.F. Williams, S.A. Schima, S. Canales, D.T. Tamura, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a 13-Story Apartment Building," *Natl. Inst. Stand. Technol. Note 1540*, May 2005

C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, D.F. Williams, S.A. Schima, S. Canales, D.T. Tamura, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a Large Sports Stadium (Veterans' Stadium in Philadelphia)," *Natl. Inst. Stand. Technol. Note 1541*, October 2005.

C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, S.A. Schima, M. McKinley, R.T. Johnk, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a Large Convention Center," *Natl. Inst. Stand. Technol. Note 1542*, June 2006.

C.L. Holloway, W.F. Young, G. Koepke, K.A. Remley, D. Camell, Y. Becquet, "Attenuation of Radio Wave Signals Coupled Into Twelve Large Building Structures," *Natl. Inst. Stand. Technol. Note 1545*, Apr. 2008.

K.A. Remley, G. Koepke, C.L. Holloway, C. Grosvenor, D. Camell, J. Ladbury, D. Novotny, W.F. Young, G. Hough, M.D. McKinley, Y. Becquet, J. Korsnes, "Measurements to Support Broadband Modulated-Signal Radio Transmissions for the Public-Safety Sector," *Natl. Inst. Stand. Technol. Note 1546*, Apr. 2008.

K.A. Remley, G. Koepke, C. Grosvenor, R.T. Johnk, J. Ladbury, D. Camell, J. Coder, "NIST tests of the wireless environment in automobile manufacturing facilities," *Natl. Inst. Stand. Technol. Note 1550*, Oct. 2008.

W. F. Young, K. A. Remley, J. Ladbury, C. L. Holloway, C. Grosvenor, G. Koepke, D. Camell, S. Floris, W. Numan, and A. Garuti, "Measurements to support public safety communications: attenuation and variability of 750 MHz radio wave signals in four large building structures," NIST Technical Note 1552, Aug. 2009.

W.F. Young, K. A. Remley, D. W. Matolak, Q. Zhang, C. L. Holloway, C. Grosvenor, C. Gentile, G. Koepke, and Q. Wu "Measurements and models for the wireless channel in a ground-based urban setting in two public-safety frequency bands," NIST Technical Note 1557, May 2011.

K.A. Remley, G. Koepke, C.L. Holloway, C. Grosvenor, D. Camell, J. Ladbury, R.T. Johnk, and W.F. Young, "Radio wave propagation Into large building structures: Part 2, characterization of multipath," *IEEE Trans. Ant. Propagat.*, vol. 58, no. 4, Apr. 2010, pp. 1290-1301.

Annex C: Single-Hop RF Attenuation Test for RF PASS

C.1 Introduction

The RF Attenuation Test verifies the performance of RF PASS systems operating under conditions where a significant path loss (also called "attenuation") is encountered, such as inside a building or other structure. A combination of two small anechoic chambers, antennas, cables, and an adjustable attenuator are used to create a repeatable RF propagation environment where a specified level of attenuation can be inserted between a user-worn RF PASS and its base station. Successful reception of an alarm signal under this level of attenuation constitutes a pass of the test. Two alarms are tested in the Single-Hop RF Attenuation Test. First, the reception of the remote distress alarm by the base station is tested when the audible distress alarm on the user-worn device is activated. Second, reception of the evacuation alarm by the user-worn device is tested when it is initiated at the base station.

This test method is designed to allow free-field testing of a complete RF PASS system, that is, testing of the system without the use of conducted measurements or removing the antennas. This is important because the antennas on many RF PASS devices are integrated into the user-worn SCBA, which can impact the radiation pattern of the antenna. Free-field testing allows the system to be characterized with any unusual antenna radiation pattern intact.

This test method was also designed to be as cost effective as possible. While the use of shielded anechoic chambers is rather expensive, the design of the units shown here is as inexpensive as possible. Inexpensive patch antennas are used. It is anticipated that, as more and more wireless electronic safety equipment becomes available, the chambers described here can be used for testing those systems as well. The chambers were also designed to be as easy to use and manipulate as possible because of the necessity for repeat measurements.

C.2 The Target Value of Attenuation

In the field, the amount of attenuation between a base station and RF PASS unit will be affected by many parameters, including the distance between them, the building materials, the location within a given building, the frequency of operation, and the type and orientation of the transmit and receive antennas, among other factors. The large range of possible values for these factors complicate the choice of a target value for the attenuation. Table C1 shows broad categories of path loss that were determined from a series of field tests carried out by NIST over the course of several years. These measurements are summarized in NIST Technical Notes 1540-1542 [1-3], 1545-1546 [4, 5], 1550 [6], 1552 [7], and 1557 [8].

Table C1: Proposed classification of Low, Medium, and High attenuation based on NIST studies.

<u>Classification</u>	<u>Attenuation (dB)</u>	<u>Typical structures</u>	<u>Current PASS</u>
<u>Low</u>	<u>Less than 100</u>	<u>Houses, small buildings with exterior-facing rooms</u>	<u>Single unit</u>
<u>Medium</u>	<u>100 to 150</u>	<u>Moderate-sized and tall structures with some interior rooms</u>	<u>With repeater</u>
<u>High</u>	<u>Over 150</u>	<u>Very large structures and those with subterranean floors</u>	<u>Multiple repeaters</u>

The Single-Hop RF Attenuation Test is designed to replicate the Low Attenuation classification, corresponding to houses, small buildings, and buildings with exterior-facing rooms, such as multi-story apartment buildings where each unit faces the outside of the building. Based on the NIST data, a target attenuation value of 100 dB was chosen for this test. The attenuation value represents the path loss between the transmit and receive antennas, referenced to a 3 m calibration measurement that removes the effects of the measurement system’s antennas. See [9] for more details on these measurements.

C.3 Measurement System Set-up

Error! Reference source not found. shows a typical Single-Hop RF Attenuation Test set-up. Two anechoic chambers provide shielding between the portable unit and the base station. The total path loss (or gain) associated with the environmental elements marked in Figure C1 simulates the path loss experienced by personnel carrying RF PASS within a building or structure when the base station is located outside. The value of the external attenuator is adjusted in a calibration step described below to match the target attenuation.

The chambers are shielded so that the user-worn RF PASS and base station are isolated from each other. This allows testing of RF attenuation alone. RF interference should be tested in a separate test method. The anechoic material in the chamber simulates a reflection-free environment. Multipath reflections should be tested with a separate test method.

*****Insert Figure C1: Test set up and sources of path loss (and gain) in the Single-Hop RF Attenuation Test. Here*****
(is same Figure as 8.18.4.1?-see original electronic file in digassets-elec-F2012rop-1982 Sletmoe pdf copy)

Antennas are mounted in the top of each chamber to receive the signal emitted by the device under test and couple it to the exterior of the chamber. The total system attenuation includes the gain (if any) in these antennas, the free space path loss between the PASS or base station and these antennas, the cables connecting the chambers, and external attenuators that are added to achieve the desired amount of path loss. The single-hop test method requires that the RF PASS system is able to send and receive alarms when the sum of these components of attenuation corresponds to that specified in the standard.

C.4 System Specifications

C.4.1 Anechoic Chambers

The chambers include non-conducting (for example, plywood) tables capable of supporting an SCBA containing an integrated PASS. The doors in the chambers must be large enough for inserting an SCBA. The top of the table must be positioned above the RF absorbing material covering the interior walls of the chamber. As an example, for RF PASS systems operating in the 900 MHz and 2.4 GHz unlicensed frequency bands, the test chambers must meet the following minimum specifications:

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

The height of the chamber should be maximized to reduce antenna near-field effects, yet low enough to fit within a standard ceiling height to reduce costs. Overall usable interior height should be no less than 40 inches (102 cm) between the antenna and table top or 55 inches (140 cm) total. Note that 1.0 m = 3 wavelengths at 900 MHz.

The user-worn device and base station must be RF-isolated from each other. At least 100 dB shielding from 900 MHz to 3 GHz when the bulkhead ports specified below are in place. Measured results verifying performance to be provided by manufacturer.

The chambers must replicate a reflection-free environment. RF attenuation of minimum 25 dB normal incidence, from 900 MHz to 3 GHz, provided by RF absorbing material. Measured results verifying performance to be provided by manufacturer.

Because many repeat measurements must be carried out for the Attenuation Test, the chamber must have a hinged door, not a hatch, with no more than two latches that must be operated to open the door, preferably operated with a single handle. Minimum door size approximately 18 inches (46 cm) x 12 inches (30.5 cm).

Top access panel to mount antennas with panel size 12 inches (30.5 cm) x 12 inches (30.5 cm).

Non-conducting table top minimum approximately 12 inches (30.5 cm) square, approximately 15 inches (38 cm) high.

Must be able to mount at least 2 type N precision or SMA bulkhead ports.

Access panel for antenna mounting located at top of structure.

Because the chambers must be positioned near to each other, they should have roll-around capability with wheels or casters.

C.4.2 Antennas

It is recommended that circularly polarized patch antennas be used to minimize the dependence of the test on the orientation within the chamber of the use-worn RF PASS and base station. Patch antennas provide good field uniformity, making test less sensitive to device placement. As well, they are relatively inexpensive. Four antennas are required for the path loss calibration step; two are used during test. Cables that are connected to the antennas should be as short as possible to minimize error during the calibration step, when, unless a three-antenna calibration is used, the manufacturer's reported antenna gain is used.

C.4.3 Cables

Cables should be high-quality shielded coaxial cables with type N or SMA connectors. At NIST, short (12") cables are permanently left in place at the top of each chamber to make changing antennas easier. These are accounted for in the path loss measurement. Torque wrenches should be used to tighten connectors.

C.4.4 Test Equipment

A three-axis field probe with high-impedance cable is used to characterize the field uniformity of the chamber/antenna combination. A vector network analyzer is used to calibrate the path loss. A signal source and spectrum analyzer could be used as well. A variable attenuator (or combination of fixed and variable) is used to set the path loss.

C.5 Characterizing the Test Chamber Field Uniformity

Before the RF-PASS system components are tested for their ability to operate under the specified path loss conditions, the test environment itself must be characterized. The antennas at the top of the chambers are selected to illuminate the table as uniformly as possible. However, nonidealities such as antenna near-field effects, reflections off of the walls due to imperfect absorber, antenna pattern, polarization, and beamwidth will cause deviations from uniform illumination. This will, in turn, affect the uniformity of the field on the table where the device under test is placed. Note that this characterization step must be completed for each antenna set up used in the Single-Hop RF Attenuation Test. That is, field uniformity must be tested for each frequency band with the antenna to be used at that frequency.

C.5.1 Procedure: Electric Field Uniformity

The basic procedure for measuring electric field uniformity is to use an electric field probe to determine the contribution of the three orthogonal components of the electric field near the surface of the table, that is, where the device under test will be placed. The electric field probe should be small relative to the wavelength of operation so that the fields inside chamber are not modified by it, and it should be connected through the wall of the chamber by a high-impedance cable to minimize coupling of fields on the cable to the fields in the chamber. Many such probes are commercially available.

The steps listed below include an example of field uniformity measured at 915 MHz because some commercially available RF PASS systems currently operate in the 902 to 928 MHz frequency band.

- (1) Setup the anechoic chamber and electric field probe as shown in

***Insert Figure C1 below. The antennas used should be those that will be used in the attenuation test. Note that connections into the chamber should be made through bulkhead-type connectors if possible. Any penetrations not using bulkhead connectors should be sealed with metal tape to preserve the shielding integrity provided by the metal shell of the chamber.

- (2) Set the signal generator to the center frequency in the frequency band of interest. The power level setting must provide sufficient electric field strength at the measurement area to provide a reading on the field probes, and may require the inclusion of an external power amplifier. In the example shown, the signal generator is connected to a linear broadband RF amplifier.
- (3) Connect the field probe to the external voltmeters through the bulkhead. In the case shown, the field probe is connected to three individual digital multimeters that display the x, y, and z components of the electric field.
- (4) Sequentially measure the three electric field components at the 13 points shown in **Error! Reference source not found.****Error! Reference source not found.**
- (5) Plot the contour lines of equal power levels, determined from the measured electric field results, $E_x, y, \text{ and } z$. Note that E is directly proportional to the measured voltage for the measurements here because we assume the distance between the antenna and all test points is constant. These power levels are relative to the minimum total power measured at one of the 13 points. The minimum total power is determined by calculating the total power at each of the measurement points, and then selecting the minimum value of those calculations. The equation is as follows:

$$P_k^i(\text{dB})_{\text{relative}} = 20 \times \log_{10} \left(\frac{E_k^i}{\text{minimum}(E_{\text{total}}^i)} \right) \quad (\text{C1})$$

Where $i = 1, 2, 3, \dots, 13$, (the measured points), $k = x, y, z$, or "total", and

$E_{\text{total}}^i = \sqrt{(E_x^i)^2 + (E_y^i)^2 + (E_z^i)^2}$. Note that the conversion to absolute power from electric field values is; $P = aE^2$ a is a constant that cancels in the calculation of the relative power.

In general, any mathematical software with a contour plotting capability may be used to generate the contour plots showing the lines of equal power. Some contour plotting packages may require additional points beyond the measured values within the defined grid. The contour plots generated here are based a 5×5 grid that contains 25 points, and since only 13 measured data points are available, the remaining points are interpolated by averaging the nearest measured values. For a perimeter location, three measured values are averaged, while for an interior location, four measured values are averaged. For example, in Figure C3, on the top, outside edge of the square an interpolated value is added by averaging the measured values from the top left corner, the middle of the top edge, and the middle of the top left quadrant. An interpolated interior point between the right and left upper quadrants is calculated by averaging the measured values from the middle of the top edge, the center, and the middle of the top left and right quadrants. Note that measuring all 25 points instead of interpolating between measured values is an option as well.

Error! Reference source not found. shows example results for one of the anechoic chambers tested in the NIST laboratory, where the total relative power is shown in **Error! Reference source not found.** (a). Note that in this case, the vertical component (**Error! Reference source not found.** (b)), is negligible compared to the two horizontal contributions (indicated by the negative dB values), and the y and z components (**Error! Reference source not found.** (c) and (d)) are within approximately 2 dB of each other over the center portion of the table. The total horizontal contribution of the electric field creates the circular nature of the contour curves in **Error! Reference source not found.** (a).

- (6) From the uniformity measurement results, the useable portion of the table for testing purposes is considered the center 30 cm (approximately one foot). It is anticipated that the devices under test will be placed within that portion of the table. This area includes approximately the contour line of 7 dB in **Error! Reference source not found.** (a). Thus, there could be up to 2 dB of variation in the received signal strength depending on the placement of the device within the chamber. Thus, the attenuation test results should account for this variability by increasing target path loss by, in this example, 4 dB (2 dB for each chamber).
- (7) Repeat this process for all of the anechoic chambers used in the measurements.

Insert Figure C1. Setup for testing the electric field uniformity using a signal generator and a three axis electric field probe. Here

*****Insert Figure C3. The measurement pattern for checking the electric field uniformity on the table surface. Field measurements are made at 13 positions on the surface of the table. Here*****

*****Insert Figure C2. Field uniformity check of an anechoic chamber at 915 MHz with a circularly polarized patch antenna; (a) total power, (b) x or vertical polarization, (c) y or one horizontal polarization contribution, and (d) z or the other horizontal component contribution. The numbers on the contour lines are decibels calculated relative to the minimum total power measured at the 13 measurement points (shown by the yellow circles.) here*****

C.6 Calibration Step to Find Attenuator Setting for Target Path Loss

As described above, the goal of the Single-Hop RF Attenuation Test is to verify that the RF PASS system is functional when the propagation channel includes a specified target path loss between the user-worn device and the base station. To replicate the target path loss in the laboratory test, the complete path loss between the two antennas is found, as shown in Figure C5. The losses (or gains) of certain fixed elements in the test-chamber environment are added together (in decibels). This fixed test chamber loss is augmented by an external, adjustable attenuator (or group of attenuators). The external attenuator allows one to incorporate enough attenuation to replicate the target path loss. The correct setting for the attenuator is found in a calibration step. The calibration requires the use of two additional antennas having a known gain, and a vector network analyzer, as described in the following.

The two additional antennas are first inserted into the test chambers on the same table tops where the RF PASS components are placed during the attenuation test. It is preferred that these antennas be circularly polarized patch antennas, as above, because they provide highly uniform illumination of the chamber, and are insensitive to polarization. The gain of these antennas should be known beforehand. The gain may be obtained from the manufacturer's specifications or by use of a more sophisticated technique such as a three-antenna method. As an example, the manufacturer-specified gain was 9 dBi for the 900 MHz antennas, and 3 dBi for the 2.4 GHz antennas that we used.

*****Insert Figure C5: The target path loss consists of the summation (in decibels) of the various fixed elements in the propagation path, plus the external attenuator. The external attenuator is adjusted until the target path loss is obtained. Here*****

The calibration antennas (Antennas 1 and 4, as shown in Figure C5) are connected to the VNA through bulkhead adapters in the body of the test chambers. The cables connecting the antennas to the bulkhead adapters should be short and, preferably, a block of RF absorber placed over them to minimize reradiation and reflections within the chamber.

The VNA is calibrated using standard techniques to reference planes as near to the bulkhead adapters as possible. S parameters are collected over the frequency of operation of the RF PASS system that is being tested. The IF bandwidth should be set to 1 kHz or less, and the number of points to around 400.

As shown in Figure C6, a VNA measurement in this configuration corresponds to the cascade of the elements in the RF propagation path shown in Figure C5. To identify the attenuator setting, we first define a variable SP that represents the combination of all of the fixed elements in the path loss except the attenuator:

$$SP_{dB} \equiv SC1_{dB} + S2_{dB} + SL1_{dB} + SL2_{dB} + S3_{dB} + SC2_{dB}. \quad (C2)$$

Figure C6: Graphical representation of the cascade of S parameters that are measured by the VNA, as shown in Figure C5.

We can then represent the cascade of all of the elements in terms of SP, the gain of the calibration antennas, and the attenuator. This cascade is first measured with the attenuator set to 0 dB, as shown graphically in Figure C7. This allows us to identify the contribution of SP to the total path loss, which in turn allows us to identify the correct attenuator setting to obtain the target path loss.

Figure C7: Graphical representation of the cascade of S parameters in terms of SP, defined in (1), with the attenuator set to zero. This cascade is measured as $S_{VNA,0dB}$.

Knowing $S_{VNA,0dB}$ and the gain of the two calibration antennas, we can then find the attenuator value as

$$SA_{T,dB} = T_{dB} - SP_{dB}$$

$$= T_{dB} - S_{VNA,0dB} + S_{I,dB} + S_{2,dB} \quad (C3)$$

where $S_{VNA,0dB}$, $S_{I,dB}$, and $S_{2,dB}$ are known. $SA_{T,dB}$ corresponds to the required path loss introduced by the attenuator, in decibels, given the other path loss mechanisms in the propagation path. As an example, suppose the target path loss is 100 dB, the manufacturer-specified gain of the calibration antennas is 9 dBi, and the measured value of $S_{VNA,0dB}$ is -30 dB at the frequency of operation. Then,

$$\begin{aligned} SA_{T,dB} &= -100dB - (-30dB) + 9dB + 9dB \\ &= -52dB \end{aligned} \quad (3)$$

The external attenuator should be set to 52 dB in this case. When we include the 4 dB calculated from the field uniformity tests above, the external attenuator would be set to 56 dB.

For the final system set-up, with the attenuator setting determined from $SA_{T,dB}$ in the last step, place the user-worn RF PASS in Chamber 1 and the base station in Chamber 2, as shown in Figure C1. If the base station utilizes a portable computer, this should be provided by the manufacturer and, unless the antennas are connected to the base station by way of a coaxial cable, the computer should be placed in Chamber 2 as well.

Establish a wireless link between the base station and user-worn device before closing the chambers' doors. Testing will be conducted with the RF PASS in two orientations: vertical (standing upright on the table) and horizontal (laying flat on the table) so that the directionality of the RF PASS antennas is less critical. The base station should be tested with its antenna laying horizontally on the table. This may require placing the base station on its back or side. This orientation is designed to maximize the signal level received at the antenna at the top of the chamber, which is presumably how the base station will be deployed in the field (oriented for maximum signal level).

C.7 Remote Distress Alarm Test

After the system is set up as described above, the Remote Distress Alarm test, Figure C8, is carried out as follows:

1. Close doors on both chambers and wait for remote distress alarm to sound.
2. Test: Does base station receive alarm within 30 seconds (y/n)?
3. Repeat test for second orientation of user-worn RF PASS.
4. Repeat test three times.
5. Successful receipt of remote distress alarm within 30 seconds of remote distress alarm sounding for all 12 tests constitutes pass of *Single-Hop Attenuation Test: Remote Distress Alarm (NFPA 1892 – 8.18)*.

*****Insert Figure C8. Graphical representation of the Remote Distress Alarm Test. Here*****

C.8 Evacuation Alarm Test

After system is set up as described in previous section, the Evacuation Alarm test, Figure C9, is carried out as follows:

1. Close door on Chamber 1 containing user-worn RF PASS.
2. With base station located within Chamber 2, initiate evacuation alarm.
3. Close door on Chamber 2 containing base station.
4. Test: Does base station receive alarm within 30 seconds (y/n)?
5. Repeat test three times.
6. Repeat test for second orientation of user-worn RF PASS.

7. Successful receipt of remote distress alarm within 30 seconds of remote distress alarm sounding for all 12 tests constitutes pass of *Single-Hop Attenuation Test: Evacuation Alarm (NFPA 1892 – 8.18)*.

Insert Figure C9. Graphical representation of the Evacuation Alarm Test. Here

C.9 Reporting

The report includes results for all configurations, repeats and tests. It should include the model of the devices that were tested. All quantities shall be reported to the nearest decibel. The operator should note the values of (1) Target path loss associated with the test environment. (2) Maximum difference in field uniformity within an area covering the center 30 cm x 30 cm of the test chamber, as measured above. (3) Value of measured path loss when the external attenuator is set to 0 dB (That is, SVNA,0dB). (4) Value of external attenuators used. (5) Frequency of operation (the minimum and maximum operating frequencies utilized). Pass or fail performance shall be determined for each specimen. One or more specimens failing this test shall constitute failing performance.

C.10 References

- [1] C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, D.F. Williams, S.A. Schima, S. Canales, D.T. Tamura, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a 13-Story Apartment Building," *Natl. Inst. Stand. Technol. Note 1540*, May 2005.
- [2] C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, D.F. Williams, S.A. Schima, S. Canales, D.T. Tamura, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a Large Sports Stadium (Veterans' Stadium in Philadelphia)," *Natl. Inst. Stand. Technol. Note 1541*, October 2005.
- [3] C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, S.A. Schima, M. McKinley, R.T. Johnk, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a Large Convention Center," *Natl. Inst. Stand. Technol. Note 1542*, June 2006.
- [4] C.L. Holloway, W.F. Young, G. Koepke, K.A. Remley, D. Camell, Y. Becquet, "Attenuation of Radio Wave Signals Coupled Into Twelve Large Building Structures," *Natl. Inst. Stand. Technol. Note 1545*, Apr. 2008.
- [5] K.A. Remley, G. Koepke, C.L. Holloway, C. Grosvenor, D. Camell, J. Ladbury, D. Novotny, W.F. Young, G. Hough, M.D. McKinley, Y. Becquet, J. Korsnes, "Measurements to Support Broadband Modulated-Signal Radio Transmissions for the Public-Safety Sector," *Natl. Inst. Stand. Technol. Note 1546*, Apr. 2008.
- [6] K.A. Remley, G. Koepke, C. Grosvenor, R.T. Johnk, J. Ladbury, D. Camell, J. Coder, "NIST tests of the wireless environment in automobile manufacturing facilities," *Natl. Inst. Stand. Technol. Note 1550*, Oct. 2008.
- [7] W. F. Young, K. A. Remley, J. Ladbury, C. L. Holloway, C. Grosvenor, G. Koepke, D. Camell, S. Floris, W. Numan, and A. Garuti, "Measurements to support public safety communications: attenuation and variability of 750 MHz radio wave signals in four large building structures," NIST Technical Note 1552, Aug. 2009.
- [8] W.F. Young, K. A. Remley, D. W. Matolak, Q. Zhang, C. L. Holloway, C. Grosvenor, C. Gentile, G. Koepke, and Q. Wu "Measurements and models for the wireless channel in a ground-based urban setting in two public-safety frequency bands," NIST Technical Note 1557, May 2011.
- [9] K.A. Remley, G. Koepke, C.L. Holloway, C. Grosvenor, D. Camell, J. Ladbury, R.T. Johnk, and W.F. Young, "Radio wave propagation Into large building structures; Part 2, characterization of multipath," *IEEE Trans. Ant. Propagat.*, vol. 58, no. 4, Apr. 2010, pp. 1290-1301.

Each year an average of 105 fire fighters die in the line of duty. To address this continuing national occupational fatality problem, NIOSH conducts independent investigations of fire fighter line of duty deaths. These excellent reports are very comprehensive and offer specific recommendations to improve firefighter safety. A technical committee task group carefully reviewed every line-of-duty death report posted for the past 10 years (the period of December 22, 1999 through May 22, 2010, exceeding 10 years) and discovered many of the same reoccurring problems we continue to see year after year. Fifty-eight Firefighters died in the line of duty during the forty-three incidents selected for this proposal. Had RF PASS technology been in place during this period many, if not most, of these deaths could have been avoided. The inclusion of RF PASS in this proposal is supported by recommendations made by NIOSH Investigators: The most redundant recommendations germane to this proposal are as follows:

- *Ensure that fire command always maintains close accountability for all personnel at the fire scene*
- *Consider ways to enhance the effectiveness of the personnel accountability system*
- *Ensure personnel accountability reports (PAR) are conducted in an efficient, organized manner and results are reported directly to the IC*
- *Use evacuation signals when command personnel decide that all fire fighters should be evacuated from a burning building or other hazardous area*
- *Instruct and train fire fighters on initiating emergency traffic (Mayday-Mayday) and on the importance of activating their personal alert safety system (PASS) device when they become lost, disoriented, or trapped*

In a letter dated April 14, 2011, from the Fire Fighter Fatality Investigation and Prevention Team at CDC/NIOSH/DSR they stated the following “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”

Substantiation for changes to Section 1: The 2007 Edition of NFPA 1982 does not include methods to test or verify the performance of RF PASS. In order to include RF PASS as optional equipment associated with PASS, it is necessary to include RF PASS in the Scope and Purpose of the standard.

Substantiation for changes to Section 2: Test methods for RF PASS are detailed in Annex C “Single-Hop RF Attenuation Test.” The values for attenuation used in the attenuation test were derived from the NIST Technical Notes references above.

Substantiation for changes to Section 3.3: The 2007 Edition of NFPA 1982 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. As a result, it is necessary to define RF PASS and the equipment associated with it. Because there are additional alarm capabilities associated with RF PASS, the definitions of the various alarm types have been revised in Section 3.3.1. To clearly differentiate the various types of alarms, the original audible *alarm signal* is now referred to as an *audible distress alarm*. Additionally, to ensure that all alarms are defined within Section 3.3.1, the *Pre-Alarm Signal* in Section 3.3.15 has been moved

to Section 3.3.1.2.

Substantiation for changes to Section 4.3: These additions describe the configuration and order (relative to other tests) in which the Single-Hop RF Attenuation Test for RF PASS, Section 8.18.5, shall be conducted. It is anticipated that elevated temperature and rough-duty handling will be the primary sources of failure of RF PASS. Thus, the Single-Hop RF Attenuation Test is conducted after these conditioning tests only. Modifications to Tables 4.3.10(a) and (b) include:

- (1) Attenuation test conducted after tumble test, Specimens 19-21 (for 4.3.10(a)) or 16-18 (for 4.3.10(b)). This will be 12 measurements.
- (2) Attenuation test conducted after high temperature test, Specimen 13. This will be four measurements.

Because the radio-system portion of the RF PASS system is tested by the Single-Hop Attenuation Test, the Out-of-Range Alarm Test is conducted only on Specimens 19-21 (for 4.3.10(a)) or 16-18 (for 4.3.10(b)). This will be 3 measurements.

Substantiation for changes to Section 5.1: These additions describe the labeling that should be included on optional RF PASS. Section 5.1.10 allows users to easily see the maximum number of user-worn units that may be monitored because exceeding this number could jeopardize the safety of firefighters who may inadvertently not be monitored. Section 5.1.11 is required by the FCC for any commercially available radio system technology.

Substantiation for adding Section 5.2.4, part (2)(d): This addition describes the danger of muting the speaker of a portable laptop when operating an RF PASS system.

Substantiation for Section 6.1: The 2007 Edition of NFPA 1982 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. This section describes the key aspects of system design necessary to ensure reliable performance of RF PASS, including the minimum design requirements for the base station and user-worn devices.

Substantiation for Section 6.2: The 2007 Edition of NFPA 1982 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. Additions to this section describe the additional mode sensing capabilities of RF PASS and how the RF PASS interfaces with the motion sensing device on the PASS. To clearly differentiate the different types of modes, the original mode designators (1) *off*, (2) *alarm*, and (3) *sensing* have been renamed and reordered to (1) *off*, (2) *motion sensing* and (3) *audible distress alarm*. RF PASS allows for two additional modes: (4) *remote distress alarm* and (5) *evacuation sensing*. These were defined and their interactions spelled out. Note that even when an RF PASS is in alarm mode, it continues to monitor for an evacuation alarm.

Substantiation for Section 6.3: The 2007 Edition of NFPA 1982 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. Additions to this section describe the additional alarm functions of RF PASS, and how the base station interfaces with the RF PASS in the various alarm modes. To clearly differentiate the various types of alarms, the original audible *alarm signal* is now referred to as an *audible distress alarm*. Language specifying signals

transmitted within xx seconds +5/-0 should just be within 30 seconds (quicker would be allowable and even better) .

Substantiation for Section 6.4.1: The 2007 Edition of NFPA 1982 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. To clearly differentiate the various modes of operation, it has been necessary to designate the motion sensing operation as “motion sensing” instead of “sensing.”

Substantiation for Section 6.4.2: The 2007 Edition of NFPA 1982 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. To clearly differentiate the various modes of operation, it has been necessary to designate the motion sensing operation as “motion sensing” instead of “sensing.” To clearly differentiate the various alarm signals, it has been necessary to designate the signal at the user-worn PASS device as an “audible distress alarm” instead of an “alarm signal.” Language specifying signals transmitted within 10 seconds +3/-0 should just be within 10 seconds (quicker would be allowable and even better) .

Substantiation for Section 6.4.3: The 2007 Edition of NFPA 1982 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. Additions to this section describe the alarm signals associated with RF PASS. To clearly differentiate the various alarm signals, it has been necessary to designate the signal at the user-worn PASS device as an “audible distress alarm” instead of an “alarm signal.” Note that even when an RF PASS is in alarm mode, it continues to monitor for an evacuation alarm.

Language specifying signals transmitted within xx seconds, +y/-z seconds should just be within xx seconds (quicker would be allowable and even better)

Substantiation for modifying Section 6.4.3.5: This deleted text describes the performance metric *sound pressure level*, which is given in Section 7.1.2.1.

Substantiation for Section 6.4.4: The 2007 Edition of NFPA 1982 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. To clearly differentiate the various modes of operation, it has been necessary to designate the motion sensing operation as “motion sensing” instead of “sensing.” To clearly differentiate the various alarm signals, it has been necessary to designate the signal at the user-worn PASS device as an “audible distress alarm” instead of an “alarm signal.”

Substantiation for modifying Section 6.4.4.1: The deleted text describes the performance metric *sound pressure level*, which is given in Section 7.1.2.1.

Substantiation for Section 6.4.5: The 2007 Edition of NFPA 1982 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. Updates to this section describe the key aspects of RF system design necessary to ensure reliable performance, the additional alarm capabilities of RF PASS, and how the RF PASS interfaces with the motion sensing device on the PASS. The definition and interval of an “out-of-range alarm” has been added to let users know when the RF portion of an RF PASS system is not functional. To clearly differentiate between the audible alarm signal emitted by the traditional PASS, and the RF PASS “remote distress alarm” and “evacuation alarm,” it has been necessary to change the nomenclature from “alarm

signal” to “audible distress alarm”

Substantiation for changes to Section 7.1: The 2007 Edition of NFPA 182 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. To clearly differentiate between the audible alarm signal emitted by the traditional PASS, and the RF PASS “remote distress alarm” and “evacuation alarm,” it has been necessary to change the nomenclature from “alarm signal” to “audible distress alarm.” In Section 7.1, the sound pressure level associated with the “remote distress alarm” and the “out of range alarm” have been added. A sound pressure of 80 dBA is the loudness of a ringing telephone according to the NIOSH web site. Sound levels greater than 85 dBA can cause hearing loss. See <http://www.cdc.gov/niosh/topics/noise>. The value of 80 dBA was chosen because the remote distress alarm may be heard within closed quarters. The value of 80 dBA was chosen for the out of range alarm so that the user does not become tired of hearing the out of range alarm when it is active for a long duration.

Substantiation for Sections 7.1 to 7.14: The 2007 Edition of NFPA 182 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. To clearly differentiate the various modes of operation, it has been necessary to designate the motion sensing operation as “motion sensing” instead of “sensing.” To clearly differentiate the various alarm signals, it has been necessary to designate the signal at the user-worn PASS device as an “audible distress alarm” instead of an “alarm signal.”

Substantiation for Section 7.15: The 2007 Edition of NFPA 182 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1802, it will be necessary to include test methods to verify the performance of these systems. Extensive NIST research on radiowave penetration into buildings and large structures has confirmed that attenuation (path loss) and interference from other radio systems are the key potential impairments to successful transmission of alarm signals such as those associated with commercially available RF PASS. This research is documented in various NIST Technical Notes, as documented in Annex C. Based on this research, attenuation tests and interference tests have been deemed the highest priorities in the development of radio-system tests for RF PASS. The Single-Hop RF Attenuation Test verifies system performance for a specified path loss.

Substantiation for Section 7.16: The 2007 Edition of NFPA 182 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1802, it will be necessary to include test methods to verify the performance of these systems. Because it is a necessity that firefighters and those monitoring the RF PASS signals are aware when a firefighter will no longer have the RF PASS link available, an out-of-range alarm has been designed into RF PASS systems. Section 8.19 specifies how this alarm will be tested repeatably in the laboratory.

Substantiation for additions to Section 8.2: The 2007 Edition of NFPA does not include methods to test or verify the performance of RF PASS. Additions to Section 8.2 describe the sound pressure level tests for the base station associated with RF PASS. These additions are necessary to ensure that those who monitor the RF PASS radio signals are aware of any remote distress alarm conditions. To clearly differentiate between the audible alarm signal emitted by the traditional PASS, and the RF PASS “remote distress alarm” and “evacuation alarm,” it has been necessary to change the nomenclature from “alarm signal” to “audible distress alarm”

Substantiation for Sections 8.1 to 8.17: The 2007 Edition of NFPA 182 does not include

methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. To clearly differentiate the various modes of operation, it has been necessary to designate the motion sensing operation as “motion sensing” instead of “sensing.” To clearly differentiate the various alarm signals, it has been necessary to designate the signal at the user-worn PASS device as an “audible distress alarm” instead of an “alarm signal.”

Substantiation for Section 8.18: The 2007 Edition of NFPA 1802 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1802, it will be necessary to include test methods to verify the performance of these systems. Extensive NIST research on radiowave penetration into buildings and large structures has confirmed that attenuation (path loss) and interference from other radio systems are key potential impairments to successful transmission of alarm signals such as those associated with commercially available RF PASS. This research is documented in NIST Technical Notes 1540-1542, 1546, 1550, 1552, and 1557, which are referenced in Annex C. Based on this research, attenuation tests and interference tests have been deemed the highest priorities in the development of radio-system tests for RF PASS.

The “Single-Hop RF Attenuation Test” verifies the performance of RF PASS systems operating under conditions where a significant path loss (or “attenuation”) is encountered, such as inside a building or other structure. A combination of two small anechoic chambers, antennas, cables, and an adjustable attenuator are used to create a repeatable RF propagation environment where a specified level of attenuation can be inserted between a user-worn RF PASS and its base station. Successful reception of an alarm signal under this level of attenuation constitutes a pass of the test. Two alarms are tested in the Single-Hop RF Attenuation Test. First, the reception of the remote distress alarm by the base station is tested when the audible distress alarm on the user-worn device is activated. Second, reception of the evacuation alarm by the user-worn device is tested when it is initiated at the base station.

This test method is designed to allow free-field testing of a complete RF PASS system, that is, testing of the system without the use of conducted measurements or removing the antennas. This is important because the antennas on many RF PASS devices are integrated into the user-worn SCBA, which can impact the radiation pattern of the antenna. Free-field testing allows the system to be characterized with any unusual antenna radiation pattern intact.

Substantiation for Section 8.19: The 2007 Edition of NFPA 1802 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1802, it will be necessary to include test methods to verify the performance of these systems. Because it is a necessity that firefighters and those monitoring the RF PASS signals are aware when a firefighter will no longer have the RF PASS link available, an out-of-range alarm has been designed into RF PASS systems. Section 8.19 specifies how this alarm will be tested in the laboratory.

Substantiation for Annex A and B: With the inclusion of RF-enabled PASS as an option in this Standard a great deal of language in Appendix A and B of the 2007 Edition of the Standard is no longer relevant. Irrelevant text has been deleted and new explanatory text has been inserted.

Substantiation for Annex C: The 2007 Edition of NFPA 1802 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1802, it will be necessary to include test methods to verify the performance of these systems. Extensive NIST research on radiowave penetration into buildings and large structures has confirmed that

attenuation (path loss) and interference from other radio systems are key potential impairments to successful transmission of alarm signals such as those associated with commercially available RF PASS. This research is documented in NIST Technical Notes 1540-1542, 1546, 1546, 1550, 1552, and 1557, which are referenced below. Based on this research, attenuation tests and interference tests have been deemed the highest priorities in the development of radio-system tests for RF PASS.

The “Single-Hop RF Attenuation Test” verifies the performance of RF PASS systems operating under conditions where a significant path loss (or “attenuation”) is encountered, such as inside a building or other structure. A combination of two small anechoic chambers, antennas, cables, and an adjustable attenuator are used to create a repeatable RF propagation environment where a specified level of attenuation can be inserted between a user-worn RF PASS and its base station. Successful reception of an alarm signal under this level of attenuation constitutes a pass of the test. Two alarms are tested in the Single-Hop RF Attenuation Test. First, the reception of the remote distress alarm by the base station is tested when the audible distress alarm on the user-worn device is activated. Second, reception of the evacuation alarm by the user-worn device is tested when it is initiated at the base station.

This test method is designed to allow free-field testing of a complete RF PASS system, that is, testing of the system without the use of conducted measurements or removing the antennas. This is important because the antennas on many RF PASS devices are integrated into the user-worn SCBA, which can impact the radiation pattern of the antenna. Free-field testing allows the system to be characterized with any unusual antenna radiation pattern intact.

1982-3 Log #CP3 FAE-ELS
(Entire Document)

Final Action: Accept

Submitter: Technical Committee on Electronic Safety Equipment,
Recommendation:

****Insert Include 1982_LCP3_R Here****

Substantiation: Each year an average of 105 fire fighters die in the line of duty. To address this continuing national occupational fatality problem, NIOSH conducts independent investigations of fire fighter line of duty deaths. These excellent reports are very comprehensive and offer specific recommendations to improve firefighter safety. A technical committee task group carefully reviewed every line-of-duty death report posted for the past 10 years (the period of December 22, 1999 through May 22, 2010, exceeding 10 years) and discovered many of the same reoccurring problems we continue to see year after year. Fifty-eight Firefighters died in the line of duty during the forty-three incidents selected for this proposal. Had RF PASS technology been in place during this period many, if not most, of these deaths could have been avoided. The inclusion of RF PASS in this proposal is supported by recommendations made by NIOSH Investigators: The most redundant recommendations germane to this proposal are as follows:

- Ensure that fire command always maintains close accountability for all personnel at the fire scene
- Consider ways to enhance the effectiveness of the personnel accountability system
- Ensure personnel accountability reports (PAR) are conducted in an efficient, organized manner and results are reported directly to the IC
- Use evacuation signals when command personnel decide that all fire fighters should be evacuated from a burning building or other hazardous area
- Instruct and train fire fighters on initiating emergency traffic (Mayday-Mayday) and on the importance of activating their personal alert safety system (PASS) device when they become lost, disoriented, or trapped

In a letter dated April 14, 2011, from the Fire Fighter Fatality Investigation and Prevention Team at CDC/NIOSH/DSR they stated the following "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."

Substantiation for changes to Section 1: The 2007 Edition of NFPA 1982 does not include methods to test or verify the performance of RF PASS. In order to include RF PASS as optional equipment associated with PASS, it is necessary to include RF PASS in the Scope and Purpose of the standard.

Substantiation for changes to Section 2: Test methods for RF PASS are detailed in Annex C "Point-to-Point RF Attenuation Test." The values for attenuation used in the attenuation test were derived from the NIST Technical Notes references above.

Substantiation for changes to Section 3.3: The 2007 Edition of NFPA 1982 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. As a result, it is necessary to define RF PASS and the equipment associated with it. Because there are additional alarm capabilities associated with RF PASS, the definitions of the various alarm types have been revised in Section 3.3.1.

Substantiation for addition of Section 3.3.16: The 2007 Edition of NFPA 1982 does not include methods to test the

performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. As a result, it is necessary to define RF PASS and the equipment associated with it. A test method related to RF interference is developed in Section 8.19, necessitating the definition of RF interference. Substantiation for changes to Section 4.3: These additions describe the configuration and order (relative to other tests) in which the Point-to-Point RF Attenuation Test for RF PASS, Section 8.18.5, shall be conducted. It is anticipated that elevated temperature and rough-duty handling will be the primary sources of failure of RF PASS. Thus, the Point-to-Point RF Attenuation Test is conducted after these conditioning tests only. Modifications to Tables 4.3.10(a) and (b) include:

(1) Attenuation test conducted after tumble test, Specimens 19-21 (for 4.3.10(a)) or 16-18 (for 4.3.10(b)). This will be 12 measurements.

(2) Attenuation test conducted after high temperature test, Specimen 13. This will be four measurements.

Because the radio-system portion of the RF PASS system is tested by the Point-to-Point Attenuation Test, the Loss-of-Signal Alarm Test is conducted only on Specimens 19-21 (for 4.3.10(a)) or 16-18 (for 4.3.10(b)). This will be 3 measurements.

Substantiation for addition of Section 4.3.9.2 and changes to Tables 4.3.10(a) and (b): In the original proposal, the loss-of-signal test was not specified in the test matrix. This change corrects that omission.

Substantiation for changes to Tables 4.3.10(a) and (b): These additions describe the configuration and order (relative to other tests) in which the Point-to-Point RF Attenuation Test, RF Interference Test for RF PASS, and Loss-of-Signal Test (Sections 8.18, 8.19, and 8.20, respectively) shall be conducted. It is anticipated that elevated temperature and rough-duty handling will be the primary sources of failure of RF PASS. Thus, the Radio System Tests are conducted after these conditioning tests only. Modifications to Tables 4.3.10(a) and (b) include: (1) Radio System Tests conducted after tumble test, Specimens 19-21 (for 4.3.10(a)) or 16-18 (for 4.3.10(b)). (2) Radio System Tests conducted after high temperature test, Specimen 13.

Substantiation for changes to Section 5.1: These additions describe the labeling that should be included on optional RF PASS. Section 5.1.10 allows users to easily see the maximum number of user-worn units that may be monitored because exceeding this number could jeopardize the safety of firefighters who may inadvertently not be monitored. Section 5.1.11 is required by the FCC for any commercially available radio system technology.

Substantiation for adding Section 5.2.4, part (2)(d): This addition describes the danger of muting the speaker of a portable laptop when operating an RF PASS system.

Substantiation for Section 6.1.8: The 2007 Edition of NFPA 1982 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. This section describes the key aspects of system design necessary to ensure reliable performance of RF PASS, including the minimum design requirements for the base station and user-worn devices.

Substantiation for Section 6.4: The 2007 Edition of NFPA 1982 does not include methods to test the performance of RF PASS. This edition of the standard will include test methods for RF PASS as optional equipment associated with PASS. This section describes the operational design requirements to ensure reliable performance of RF PASS, including the minimum design requirements for the base station and user-worn devices.

Substantiation for New Section 7.15: The 2007 Edition of NFPA 1982 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1982, it will be necessary to include test methods to verify the performance of these systems. Extensive NIST research on radiowave penetration into buildings and large structures has confirmed that attenuation (path loss) and interference from other radio systems are the key potential impairments to successful transmission of alarm signals such as those associated with commercially available RF PASS. This research is documented in various NIST Technical Notes, as documented in Annex C. Based on this research, attenuation tests and interference tests have been deemed the highest priorities in the development of radio-system tests for RF PASS. The Point-to-Point RF Attenuation Test verifies system performance for a specified path loss.

Substantiation for New Section 7.16: The 2007 Edition of NFPA 1982 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1982, it will be necessary to include test methods to verify the performance of these systems. Because it is a necessity that firefighters and those monitoring the RF PASS signals are aware when a firefighter will no longer have the RF PASS link available, an out-of-range alarm has been designed into RF PASS systems. Section 8.19 specifies how this alarm will be tested repeatably in the laboratory.

Substantiation for New Section 7.17: The 2007 Edition of NFPA 1982 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1982, it will be necessary to include test methods to verify the performance of these systems. Extensive NIST research on radiowave penetration into buildings and large structures has confirmed that attenuation (path loss) and interference from other radio systems are the key potential impairments to successful transmission of alarm signals such as those associated with commercially available RF PASS. This research is documented in various NIST Technical Notes, as documented in Annex C. Based on this

research, attenuation tests and interference tests have been deemed the highest priorities in the development of radio-system tests for RF PASS. The RF Interference Test verifies system performance when the user-worn device is in the presence of in-band RF interference from devices operating at power levels similar to that of the user-worn RF PASS device for a specified path loss. This configuration is tested because the user-worn device typically is restricted to a lower output power, and so is generally more susceptible to RF interference.

Substantiation for New Section 8.18: The 2007 Edition of NFPA 1982 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1982, it will be necessary to include test methods to verify the performance of these systems. Extensive NIST research on radiowave penetration into buildings and large structures has confirmed that attenuation (path loss) and interference from other radio systems are key potential impairments to successful transmission of alarm signals such as those associated with commercially available RF PASS. This research is documented in NIST Technical Notes 1540-1542, 1546, 1546, 1550, 1552, and 1557, which are referenced in Annex C. Based on this research, attenuation tests and interference tests have been deemed the highest priorities in the development of radio-system tests for RF PASS.

The “Point-to-Point RF Attenuation Test” verifies the performance of RF PASS systems operating under conditions where a significant path loss (or “attenuation”) is encountered, such as inside a building or other structure. A combination of two small anechoic chambers, antennas, cables, and an adjustable attenuator are used to create a repeatable RF propagation environment where a specified level of attenuation can be inserted between a user-worn RF PASS and its base station. Successful reception of an alarm signal under this level of attenuation constitutes a pass of the test. Two alarms are tested in the Point-to-Point RF Attenuation Test. First, the reception of the remote distress alarm by the base station is tested when the audible distress alarm on the user-worn device is activated. Second, reception of the evacuation alarm by the user-worn device is tested when it is initiated at the base station.

This test method is designed to allow free-field testing of a complete RF PASS system, that is, testing of the system without the use of conducted measurements or removing the antennas. This is important because the antennas on many RF PASS devices are integrated into the user-worn SCBA, which can impact the radiation pattern of the antenna. Free-field testing allows the system to be characterized with any unusual antenna radiation pattern intact.

Substantiation for New Section 8.19: The 2007 Edition of NFPA 1982 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1982, it will be necessary to include test methods to verify the performance of these systems. Because it is a necessity that firefighters and those monitoring the RF PASS signals are aware when a firefighter will no longer have the RF PASS link available, an out-of-range alarm has been designed into RF PASS systems. Section 8.19 specifies how this alarm will be tested in the laboratory.

Substantiation for New Section 8.20: The 2007 Edition of NFPA 1982 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1982, it will be necessary to include test methods to verify the performance of these systems. Extensive NIST research on radiowave penetration into buildings and large structures has confirmed that attenuation (path loss) and interference from other radio systems are key potential impairments to successful transmission of alarm signals such as those associated with commercially available RF PASS. This research is documented in NIST Technical Notes 1540-1542, 1546, 1546, 1550, 1552, and 1557, which are referenced in Annex C. Based on this research, attenuation tests and interference tests have been deemed the highest priorities in the development of radio-system tests for RF PASS.

The “RF Interference Test” verifies the performance of RF PASS systems operating under conditions where a significant path loss (or “attenuation”) is encountered, such as inside a building or other structure, and in the presence of external RF interference, such as may be encountered near a wireless personal-area-network (WPAN) or RFID reader used in buildings. Interference will be tested for devices that operate in the same frequency band as a given RF PASS system and at approximately the same output power level. A combination of two small anechoic chambers, antennas, cables, a power combiner, and an adjustable attenuator are used to create a repeatable RF propagation environment where a specified level of both attenuation and interference can be inserted between a user-worn RF PASS and its base station. The RF Interference Test verifies system performance when the user-worn device is in the presence of RF interference for a specified path loss. This configuration is tested to simulate the common condition where a firefighter is inside a building where an RF source is located.

This test method is designed to allow free-field testing of a complete RF PASS system, that is, testing of the system without the use of conducted measurements or removing the antennas. This is important because the antennas on many RF PASS devices are integrated into the user-worn SCBA, which can impact the radiation pattern of the antenna. Free-field testing allows the system to be characterized with any unusual antenna radiation pattern intact.

Substantiation for Annex A and B: With the inclusion of RF-enabled PASS as an option in this Standard a 'great deal of language in Appendix A and B of the 2007 Edition of the Standard is no longer relevant. Irrelevant text has been deleted and new explanatory text has been inserted.

Substantiation for Section B.1: NIST researchers have reported on work to develop RF interference tests for RF PASS. This research provides the basis for the tests described in Annex D.

Substantiation for Annex C: The 2007 Edition of NFPA 1982 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1982, it will be necessary to include test methods to verify the performance of these systems. Extensive NIST research on radiowave penetration into buildings and large structures has confirmed that attenuation (path loss) and interference from other radio systems are key potential impairments to successful transmission of alarm signals such as those associated with commercially available RF PASS. This research is documented in NIST Technical Notes 1540-1542, 1546, 1546, 1550, 1552, and 1557, which are referenced below. Based on this research, attenuation tests and interference tests have been deemed the highest priorities in the development of radio-system tests for RF PASS.

The “Point-to-Point RF Attenuation Test” verifies the performance of RF PASS systems operating under conditions where a significant path loss (or “attenuation”) is encountered, such as inside a building or other structure. A combination of two small anechoic chambers, antennas, cables, and an adjustable attenuator are used to create a repeatable RF propagation environment where a specified level of attenuation can be inserted between a user-worn RF PASS and its base station. Successful reception of an alarm signal under this level of attenuation constitutes a pass of the test. Two alarms are tested in the Point-to-Point RF Attenuation Test. First, the reception of the remote distress alarm by the base station is tested when the audible distress alarm on the user-worn device is activated. Second, reception of the evacuation alarm by the user-worn device is tested when it is initiated at the base station. This test method is designed to allow free-field testing of a complete RF PASS system, that is, testing of the system without the use of conducted measurements or removing the antennas. This is important because the antennas on many RF PASS devices are integrated into the user-worn SCBA, which can impact the radiation pattern of the antenna. Free-field testing allows the system to be characterized with any unusual antenna radiation pattern intact.

Substantiation for Annex D:

The 2007 Edition of NFPA 1982 does not include methods to test or verify the performance of RF PASS. When RF PASS is included as an option in NFPA 1982, it will be necessary to include test methods to verify the performance of these systems. Extensive NIST research on radiowave penetration into buildings and large structures has confirmed that attenuation (path loss) and interference from other radio systems are key potential impairments to successful transmission of alarm signals such as those associated with commercially available RF PASS. This research is documented in NIST Technical Notes 1540-1542, 1546, 1546, 1550, 1552, and 1557. Based on this research, attenuation tests and interference tests have been deemed the highest priorities in the development of radio-system tests for RF PASS.

The “RF Interference Test” verifies the performance of RF PASS systems operating under conditions where a significant path loss is encountered, such as inside a building or other structure, in the presence of RF interference that might be found in representative sites. A combination of two small anechoic chambers, antennas, cables, and an adjustable attenuator are used to create a repeatable RF propagation environment where a specified level of attenuation can be inserted between a user-worn RF PASS and its base station. A wireless device “development kit” is used to generate a representative interfering signal, based on the frequency of operation of the RF PASS system. The reception of the remote distress alarm by the base station is tested when the audible distress alarm on the user-worn device is activated. Successful reception of an alarm signal under this level of attenuation and interference constitutes a pass of the test. Interference will be tested for devices that operate in the same frequency band as a given RF PASS system and at approximately the same output power level.

This test method is designed to allow free-field testing of a complete RF PASS system, that is, testing of the system without the use of conducted measurements or removing the antennas. This is important because the antennas on many RF PASS devices are integrated into the user-worn SCBA, which can impact the radiation pattern of the antenna. Free-field testing allows the system to be characterized with any unusual antenna radiation pattern intact.

Committee Meeting Action: Accept

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

Revise text to read as follows:

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

Delete asterisk to 1.1.4*

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 RF PASS that are capable of transmitting a distress alarm 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 RF PASS for the receipt of a remote distress alarm and the transmission of an evacuation alarm via an RF signal.

Chapter 2 Referenced Publications

2.3.4 NIST Publications.

C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, D.F. Williams, S.A. Schima, S. Canales, D.T. Tamura, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a 13-Story Apartment Building," Natl. Inst. Stand. Technol. Note 1540, May 2005

C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, D.F. Williams, S.A. Schima, S. Canales, D.T. Tamura, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a Large Sports Stadium (Veterans' Stadium in Philadelphia)," Natl. Inst. Stand. Technol. Note 1541, October 2005.

C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, S.A. Schima, M. McKinley, R.T. Johnk, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a Large Convention Center," Natl. Inst. Stand. Technol. Note 1542, June 2006.

C.L. Holloway, W.F. Young, G. Koepke, K.A. Remley, D. Camell, Y. Becquet, "Attenuation of Radio Wave Signals Coupled Into Twelve Large Building Structures," Natl. Inst. Stand. Technol. Note 1545, Apr. 2008.

K.A. Remley, G. Koepke, C.L. Holloway, C. Grosvenor, D. Camell, J. Ladbury, D. Novotny, W.F. Young, G. Hough, M.D. McKinley, Y. Becquet, J. Korsnes, "Measurements to Support Broadband Modulated-Signal Radio Transmissions for the Public-Safety Sector," Natl. Inst. Stand. Technol. Note 1546, Apr. 2008.

K.A. Remley, G. Koepke, C. Grosvenor, R.T. Johnk, J. Ladbury, D. Camell, J. Coder, "NIST tests of the wireless environment in automobile manufacturing facilities," Natl. Inst. Stand. Technol. Note 1550, Oct. 2008.

W. F. Young, K. A. Remley, J. Ladbury, C. L. Holloway, C. Grosvenor, G. Koepke, D. Camell, S. Floris, W. Numan, and A. Garuti, "Measurements to support public safety communications: attenuation and variability of 750 MHz radio wave signals in four large building structures," NIST Technical Note 1552, Aug. 2009.

W.F. Young, K. A. Remley, D. W. Matolak, Q. Zhang, C. L. Holloway, C. Grosvenor, C. Gentile, G. Koepke, and Q. Wu "Measurements and models for the wireless channel in a ground-based urban setting in two public-safety frequency bands," NIST Technical Note 1557, May 2011.

K.A. Remley, G. Koepke, C.L. Holloway, C. Grosvenor, D. Camell, J. Ladbury, R.T. Johnk, and W.F. Young, "Radio wave propagation Into large building structures; Part 2, characterization of multipath," IEEE Trans. Ant. Propagat., vol. 58, no. 4, Apr. 2010, pp. 1290-1301.

2.3.4 ~~5~~ Other Publications.

3.3.1.3 Remote Distress Alarm. For RF PASS, a distress alarm triggered by any activation of PASS alarm signal, transmitted to a base station via an RF signal. When received, the remote distress alarm triggers an audible alarm signal at the base station.

3.3.1.4 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.

3.3.1.5 Loss-of-Signal Alarm. An audible or visual signal that is initiated automatically when the RF communication between a base station and user-worn RF PASS is lost. The loss-of-signal alarm warns emergency services personnel that their RF PASS is no longer in radio communication with the base station.

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

3.3.14.3 RF PASS. A PASS that contains an optional RF transceiver that enables the PASS to automatically transmit remote distress alarm and receive evacuation alarms via RF signals. The RF PASS responds to an evacuation alarm with an audible and visual signal.

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

3.3.15 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. The RF transceiver is used to transmit and receive signals such as the remote distress alarm and the evacuation alarm for RF PASS.

3.3.16 RF Interference. An unwanted radio-frequency signal that is present in the vicinity of an RF PASS system that may impede reception of a remote distress alarm or evacuation alarm.

4.3.9.1 The Point-to-Point RF Attenuation Test and RF Interference Test shall be performed with the RF PASS and the base station connected together as described in Section 8.18 and Section 8.19, respectively.

4.3.9.2 The Loss-of-Signal Alarm Test shall be performed with the RF PASS and the base station set up as described in Section 8.20.

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
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 8.16), specimens 19–21

2	Alarm signal muffle (Section 8.17), 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	<u>Radio System Tests (Sections 8.18 – 8.20), specimens 19-21</u>
3	Signal frequencies (Section 8.14), specimens 1-3	Impact acceleration — cold (Section 8.8), specimen 5	Electronic temperature stress — shock (8.3.7), specimens 7-9	Product label durability (Section 8.15), specimens 10-12	High temperature functionality (Section 8.12), specimens 13-15	
4	Heat/flame Test 1 (8.13.5.9), specimen 1	Impact acceleration — elevated (Section 8.8), specimen 6	Product label durability (Section 8.15), specimens 7-9		<u>Radio System Tests (Sections 8.18 – 8.20), specimen 13</u>	
5	Heat/flame Test 1 (8.13.5.10), specimen 1		Heat and immersion leakage (Section 8.5), specimens 7-9			
6	Heat/flame Test 1 (8.13.5.11), specimen 1		Product label durability (Section 8.15), specimens 7-9			

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
-------------------	----------------------	----------------------	----------------------	------------------------	------------------------	------------------------

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 8.16), specimens 16–18
2	Alarm signal muffle (Section 8.17), 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	<u>Radio System Tests (Sections 8.18 – 8.20), specimens 16–18</u>
3	Signal frequencies (Section 8.14), specimens 1–3		Electronic temperature stress — shock (8.3.7), specimens 7–9	Product label durability (Section 8.15), specimens 10–12	<u>Radio System Tests (8.18 – 8.20), specimen 13</u>	
4	Heat/flame test 1 (8.13.5.9), specimen 1		Product label durability (Section 8.15), specimens 7–9			
5	Heat/flame test 1 (8.13.5.10), specimen 1		Heat and immersion leakage (Section 8.5), specimens 7–9			
6	Heat/flame test 1 (8.13.5.11), specimen 1		Product label durability (Section 8.15), specimens 7–9			

5.1.10 The base station component of an RF PASS system shall identify the maximum number of RF PASS remote distress alarms 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.

5.2.4 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

(d) For RF PASS systems that utilize a portable computer as part of the base station, the danger of muting the computer's speaker, in which case the base station operator would not receive the alarm signal or loss-of-signal alarm from the user-worn RF 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 user-worn RF PASS and a base station RF transceiver that may 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 one hour under alarm conditions. The use of repeaters is not precluded.

6.1.2.5.1 The base station shall be designed to emit an audible and visual signal when the alarm signal described in 6.4.3 is activated by the user-worn 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 user-worn RF PASS unit and base station must 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 firefighting operations.

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

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

6.2.1.1 The software/firmware that controls the RF PASS shall allow for a test mode of operation in which the alarm signal and remote distress alarm are disabled for the duration of the evacuation alarm test portion of the Point-to-Point Attenuation Test described in Section 8.18. The test mode of operation shall not be available in normal operation of the PASS system.

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

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 motion sensing mode to the alarm signal mode/remote distress alarm mode, with the mode selection device but shall not be able to be switched to ~~remain in~~ 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 motion sensing/evacuation sensing mode.

6.2.5 All mode selection devices shall be capable of being switched to the audible/remote distress alarm or motion 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 (3/32 in. to 5/32 in.).

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

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

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

6.2.7.2 The silencing of the audible/remote distress alarm shall automatically reset PASS to the motion sensing mode.

6.2.7.3 Base station units for RF PASS shall sound an audible alarm and indicate on a visual display the presence of all RF PASS units that are in remote distress 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 motion/evacuation sensing, off to audible/remote distress alarm, and audible/remote distress alarm to motion/evacuation sensing.

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

6.3 Motion/Evacuation 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 remote distress alarm within 30 seconds of its transmission by the RF PASS unless RF communication has been lost.

6.3.2.2 Base station units for RF PASS shall sound the audible alarm and indicate the visual display specified in 6.4.3.1 for all RF PASS units that are in remote distress alarm mode.

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

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.

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

6.4.1.1 PASS shall emit an audible operational signal within 1 second of completing the required action to set PASS to the motion 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 motion 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 primary pre-alarm signal shall be a distinct and different sound from the alarm signal

6.4.2.4 PASS shall sound the pre-alarm signal(s) 10 seconds, ~~+3/-0 seconds~~ prior to the sounding of the alarm signal.

6.4.2.6 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

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

6.4.3 Alarm Signals.

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, ~~+5/ 0 seconds~~.

6.4.3.2.1 For RF PASS, while in the motion/evacuation sensing mode, when the alarm signal is activated, the remote distress alarm shall be transmitted within 3 seconds.

6.4.3.2.2 For RF PASS, while in the motion/evacuation sensing or audible/remote alarm modes, PASS shall sound an audible evacuation alarm within 30 seconds of the evacuation alarm being sent by the base station.

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 and transmission of the audible 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, with the exception of the evacuation alarm.

6.4.3.5 The alarm signal shall have a duration of at least 1 hour ~~at a sound pressure level of not less than 95 dBA~~ at the user-worn PASS.

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

6.4.3.6 The alarm signal shall be audible at the user-worn PASS in a variable or noncontinuous tone.

6.4.3.6.1 For RF PASS, the remote distress alarm shall be audible at the base station.

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

6.4.3.8 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.

6.4.3.9 The silencing of the alarm signal shall automatically reset the PASS to the motion 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 audible or visual loss-of-signal alarm to the base-station operator, and the user-worn RF PASS unit shall emit a recurrent audible or visual loss-of-signal alarm to the user within 60 seconds of loss of communication. Loss of communication may be due to, for example, 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 an audible or visual alarm, distinct from the audible distress alarm, the remote distress alarm, and the evacuation signal.

6.4.5.3 The base station and the user-worn 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.

6.4.5.4 The loss-of-signal alarm shall have an interval not to exceed 60 seconds.

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 8.18, Radio System Tests for RF PASS – Point-to-Point RF Attenuation Test.

7.15.1 The base station shall automatically emit an audible alarm in response to a remote distress alarm received from the user-worn RF PASS within 30 seconds of alarm activation under the radio channel conditions specified in Section 8.18. The user-worn 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 8.18.

7.15.2 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.

7.15.2.1 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.

7.15.3 The Point-to-Point RF Attenuation Test shall be conducted to determine whether the user-worn RF PASS will operate in an RF propagation channel having a specified level of path loss, as specified in Table 7.15.3. This level of attenuation shall be chosen to replicate that expected in certain firefighting conditions. (See Annex C).

<u>Table 7.15.3 Classification of Low, Medium, and High attenuation based on NIST studies.</u>			
<u>Classification</u>	<u>Attenuation (dB)</u>	<u>Typical structures</u>	<u>Current PASS</u>
<u>Low</u>	<u>Less than 100</u>	<u>Houses, small buildings with exterior-facing rooms</u>	<u>Single unit</u>
<u>Medium</u>	<u>100 to 150</u>	<u>Moderate-sized and tall structures with some interior rooms</u>	<u>With repeater</u>
<u>High</u>	<u>Over 150</u>	<u>Very large structures and those with subterranean floors</u>	<u>Multiple repeaters</u>

7.15.3.1 The Point-to-Point RF Attenuation Test shall be conducted in two configurations (1) with the base station acting as the receiver and the user-worn RF PASS transmitting a remote distress alarm; (2) with the RF PASS acting as a receiver and the base station transmitting an evacuation alarm.

7.15.3.2 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 user-worn RF PASS shall correspond 100 dB +/- 3dB, which is representative of path loss associated with houses and small buildings with exterior-facing rooms at frequencies of approximately 1 GHz. (See Annex C). The total attenuation shall be calculated using the methods described in Section 8.18.5.2.

7.15.3.3* The Point-to-Point RF Attenuation Test shall be conducted with no added radio interference.

7.16 Radio System Tests – Loss-of-signal Alarm Test.

RF PASS shall be tested for initiation of audible or visual alarm signals when RF communication is lost as specified in Section 8.19, Radio System Tests for RF PASS – Loss-of-signal Alarm Test.

7.16.1 The base station shall automatically initiate the loss-of-signal alarm in response to loss of RF communication with the user-worn RF PASS within 60 seconds under the radio channel

conditions specified in Section 8.19. The user-worn 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 8.19.

7.16.2 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.

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 8.20, Radio System Tests for RF PASS–RF Interference Test.

7.17.1 The base station shall automatically emit an audible alarm in response to a remote distress alarm received from the user-worn RF PASS within 30 seconds of alarm activation under the radio channel conditions specified in Section 8.20.

7.17.2 The user-worn 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 8.20.

7.17.3 The RF Interference Test shall be conducted to determine whether the user-worn RF PASS will operate in an RF propagation channel having a specified level of external RF interference as specified in Table 8.20. This level of interference shall be chosen to replicate that expected in certain firefighting conditions. (See Annex D).

7.17.3.1 The RF Interference Test shall be conducted in with the base station acting as the receiver and the user-worn RF PASS transmitting a remote distress alarm in the presence of RF interference. This configuration is chosen because the user-worn device typically is restricted to a lower output power, and so is generally more susceptible to RF interference.

7.17.3.2 The two test chambers shall be configured as shown in Figure 8.18.4.1. The total attenuation (including cables, connectors, free-space path loss, antenna loss, and external added attenuation) between the base station and the user-worn RF PASS shall correspond 100 dB +/- 3dB, which is representative of path loss associated with houses and small buildings with exterior-facing rooms at frequencies of approximately 1 GHz, as specified in Table 8.18.4. The total attenuation shall be calculated using the methods described in 8.18.5.

7.17.3.3 The RF interference Test shall be conducted by introducing a radio-frequency interfering signal into the test chamber in which the user-worn device is located. The RF interference shall be coupled from the interference source, 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 user-worn device test chamber, as described in 7.16.3.2 above. The signal level and type of interfering signal shall be as specified in Table 8.20.

8.18 Radio System Tests for RF PASS – Point-to-Point RF Attenuation Test

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

8.18.2 Samples.

8.18.2.1 Samples shall be complete RF PASS systems.

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 RF PASS consisting of a user-worn RF PASS and the base station designed for use with it, provided by the manufacturer.

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

8.18.4 Test Apparatus (Kate to provide revised text for 8.18.4)

8.18.4.1 The Point-to-Point RF Attenuation test is conducted with the apparatus described in Annex C “Point-to-Point RF Attenuation Test for RF PASS.” A block diagram of the test apparatus is shown in Figure 8.18.4.1.

*****Insert Figure 8.18.4.1 "Apparatus used for Point-to-Point RF Attenuation 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"*****

8.18.4.2 The field uniformity of the test chambers shall be tested once for each frequency of operation and set of antennas used in the test chambers.

8.18.5 Procedure

8.18.5.1 The Point-to-Point RF Attenuation Test shall be conducted according to the methodology described in Annex C “Point-to-Point RF Attenuation Test for RF PASS.”

8.18.5.2 The target path loss specified in 7.15.3.2 shall be set up in the test chambers before the attenuation is measured. A different set up shall be completed for each frequency of operation and set of antennas used in the test chambers.

8.18.5.3 The RF PASS system shall be tested with the user-worn RF PASS placed in two orientations and the base station placed in one orientation for each of the remote distress alarm and evacuation alarm tests. This is a total of four measurements for each Point-to-Point RF Attenuation Test.

8.18.5.4 Repeatability. Repeatability shall be established by measurement of the four separate devices specified in Table 4.3.10(a) (Specimens 13, 19-21) or Table 4.3.10(b) (Specimens 13, 16-18).

8.18.6 Report.

8.18.6.1 All quantities shall be reported to the nearest decibel.

8.18.6.2 The operator shall note the results of the all tests specified in 8.18.5, including the values of (1) Target path loss associated with the test environment. (2) Maximum difference in field uniformity within an area covering the center 30 cm x 30 cm of the test chamber, as measured in Annex (3) Value of measured path loss when the external attenuator is set to 0 dB (Called SVNA,0dB in Annex C) (Kate to provide revised text with Table insertion points).. (4) Value of external attenuators used. (5) Frequency of operation (the minimum and maximum operating frequencies utilized).

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 this test shall constitute failing performance.

Section 8.19 Radio System Tests for RF PASS – Loss-of-signal Alarm Test

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

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 a user-worn 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.

8.19.4 Test Apparatus

8.19.4.1 The test apparatus described in 8.18.4 for the Point-to-Point RF Attenuation test shall be used.

8.19.5 Procedure.

8.19.5.1* The Loss-of-signal Alarm Test shall be conducted with the user-worn RF PASS placed in one test chamber and the base station placed in a second chamber.

8.19.5.2 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 8.18.4.1.

8.19.5.4 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.

8.19.5.5 Upon closing the second door, the duration until the loss-of-signal alarm sounds from each of the user-worn RF PASS and the base station shall be noted.

8.19.5.6 Repeatability. The Loss-of-signal Alarm Test shall be conducted once for each of three Specimens 19-21 (Table 4.3.10(a)) or Specimens 16-18 (Table 4.3.10(b)).

8.19.6 Report.

8.19.6.1 The operator shall note the results of the three tests specified in 8.19.5.6, including the duration before the loss-of-signal alarm sounds at the user-worn RF PASS and base station, and the frequency of operation.

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.

Section 8.20 Radio System Tests for Optional RF PASS – RF Interference Test

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

8.20.1.1 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.

8.20.1.2 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 Point-to-Point RF Attenuation Test.

8.20.1.3 The total attenuation (including cables, connectors, free-space path loss, antenna loss, and external added attenuation) between the base station and the user-worn RF PASS shall correspond 100 dB +/- 3dB using the method described in Section 8.18.5.2.

8.20.1.4 The RF Interference Test shall be conducted with the base station acting as the receiver and the user-worn RF PASS transmitting a remote distress alarm in the presence of RF interference.

8.20.1.5 The RF Interference test does not preclude the use of repeaters in the field.

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 a user-worn 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 that have passed the Point-to-Point RF Attenuation Test described in Section 8.18 and the Loss-of-Signal Alarm Test described in Section 8.19 shall be tested.

8.20.4 Test Apparatus

8.20.4.1 The RF Interference test shall be conducted with apparatus that meets the following guidelines, such as that illustrated in Figure 8.20.4.1.

****** Insert Figure 8.20.4.1: "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."******

8.20.4.1 Test Chambers. The two test chambers shall be configured as shown in Figure 8.18.4.1. The anechoic chambers, antennas, and cables used in the RF Interference Test are the same as those described in 8.18.4 Test Apparatus for the Point-to-Point Attenuation Test.

8.20.4.2 Power Combiner. A power combiner shall be used to combine the signal from the base station with the interfering signal, as shown in 8.20.4.1. The power combiner shall have two input ports and one output port, shall use Type N connectors, and shall have a minimum isolation between the input ports of 20 dB.

8.20.4.3 Interferer. A programmable signal generator capable of emitting common wireless protocols described in Table 8.20.4.3 shall be used. The signal generator shall be programmed to provide the parameters specified in Table 8.20.4.3 for the frequency of operation of the RF PASS system.

Table 8.20.4.3: Definition of interference sources for RF Interference Test.

<u>Frequency Range</u>	<u>Transmission Format or Modulation Scheme</u>	<u>Subcarrier or Channel Bandwidth</u>	<u>Output power and FCC part</u>
------------------------	---	--	----------------------------------

450 MHz	<u>TBD</u>	<u>TBD</u>	<u>TBD</u>
<u>902-928 MHz</u>	<u>Frequency Hopping (200 ms hop time)</u>	<u>100 kHz subcarrier</u>	<u>1 W peak power (30 dBm) into antenna (w/ max 6 dBi gain), FCC Part 15.247 [2]</u>
<u>2.4-2.472 GHz</u>	<u>Direct Sequence Spread Spectrum</u>	<u>2 MHz (IEEE 802.15.4 channels)</u>	<u>63 mW peak power (18 dBm) into antenna, FCC Part 15 (See example 2 [2] for determination of correction factor.)</u>

8.20.5 Procedure.

8.20.5.1 Prior to conducting the RF Interference Test, each anechoic chamber shall be characterized using the techniques described in 8.18.5.1 Procedure for Field Uniformity Calibration.

8.20.5.2 The total attenuation (including cables, connectors, free-space path loss, antenna loss, and external added attenuation) between the base station and the user-worn RF PASS shall correspond 100 dB +/- 3dB. The total attenuation shall be calculated using the methods described in 8.18.5.2 Procedure for Determination of Total Attenuation. A different configuration shall be used for each frequency of operation and set of antennas used in the test chambers.

8.20.5.3 The signal from the RF interferer shall be coupled into the test chamber in which the user-worn 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 user-worn RF PASS test chamber, as described in 8.18.5.2. The loss due to the coaxial cable and power combiner must be added to the nominal output power specified in Table 8.20.4.3.

8.20.5.4 A wireless link shall be established between the base station and user-worn device before closing the chambers' doors.

8.20.5.5 The chamber doors shall be closed.

8.20.5.6 The interferer shall be turned on.

8.20.5.7 The duration until the reception of the remote distress alarm shall be recorded.

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

8.20.5.9 Repeatability. Repeatability shall be established by measurement of the four separate devices specified in Table 4.3.10(a) (Specimens 13, 19-21) or Table 4.3.10(b) (Specimens 13, 16-18).

8.20.6 Report.

8.20.6.1 All quantities shall be reported to the nearest decibel.

8.20.6.2 The operator shall note the results of all tests specified in 8.20.5, including the values of: (1) Target path loss associated with the test environment. (2) Maximum difference in field

uniformity within an area covering the center 30 cm x 30 cm of the test chamber, as described in Section 8.18.5.1. (3) Measured path loss when the external attenuator is set to 0 dB (Called SVNA,0dB in Section 8.18.5.2.6). (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 and output power of interferer at test chamber top input port (including cable loss and loss through power combiner). (8) Relevant interferer parameters, as specified in Table 8.20.4.3.

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.

A.1.1.1 NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, 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 remote distress alarms 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 a remote distress alarm 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.

Section 5.3 of NFPA 1561, Standard on Emergency Services Incident Management System, and Section 8.4 of NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, 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.

Asterisk 1.1.2, delete asterisk to 1.1.4

A.1.1.2 Appropriate testing criteria has been developed to include RF PASS in this Standard as an option.

~~Searches of systems and testing applications, the Committee could not develop criteria to determine that the performance of such enhancements would be achieved with any degree of certainty and could not develop the appropriate test methods to determine that such features would perform reliably and consistently for the safety of the emergency services personnel. Until such time that sound performance requirements and testing methods are developed that can verify the repeated reliability of the performance, within necessary operational and safety parameters, and that give a high degree of confidence of the performance of the enhancements, the Committee will not address such requirements in the standard. The Committee's opinion is that the inclusion at this time of requirements for such enhancements could potentially increase the risk to the emergency services personnel who might use PASS with such enhancements believing the enhancements would function in all situations to increase their margin of safety. 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) One-way distress notification~~
- ~~(2) Two-way distress/evacuation and mass/team evacuation notification~~
- (3) Electronic personnel accountability
- (4) Person-to-person local distress notification
- (5) Person locator systems
- (6) Additional systems information (data logging features such as cylinder pressure, temperature, breathing rates, elapsed time, etc.)

Where purchasers are interested in enhancements, 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 enhanced PASS.

~~RF PASS Many, but not all, enhancements to current 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 may 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 may be 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 testing methods cannot~~ 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 and a PASS with enhanced features are 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 below ground 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 (~~i.e., base station~~) 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 and distress signals must be activated from many areas within the test site while the base station receiving devices ~~are~~ is monitored to ensure reception or acknowledgment of each remote distress or evacuation alarm ~~or distress signal~~.

(d) Attempts should be made to make the test scenarios for RF PASS ~~RF testing~~ 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 receiving components on the scene of an actual emergency should place multiple base stations receiving devices in service during field-testing scenarios in accordance with their standard operating procedures.

(7) NFPA 5000, Building Construction and Safety Code, 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 ~~device~~ 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 ~~consequences~~ 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. (Strikeout remaining existing text).

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.4.3.9 Some manufacturers of PASS offer devices that incorporate temperature sensing, ~~radio transmission of distress signals~~, position location or other features that this document does not address. This document requires that the PASS, including all additional features installed on or in the PASS, comply with all requirements of this standard.

Users can investigate these features with the individual manufacturers to determine whether they want to specify such additional features.

Certification of the PASS to NFPA 1982 applies to the basic and RF PASS device only and not for any additional features not required by the standard.

A.6.1.5 Removing the power source cover and power source for inspection for water and performing the extended immersion test with the power source cover removed provide a test for the isolation requirement between the power source compartment and the electronics compartment stated in 6.1.5. The extended test is also meant to verify that the electronics compartment maintains a watertight seal when the power source cover is removed.

A.7.15.3.3 The Point-to-Point attenuation test does not preclude the use of repeaters in the field.

A.8.19.5.1 The orientation of the user-worn RF PASS and the base station is not critical.

Annex B Informational References

B.1 Referenced Publications.

The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

NIST Publications.

C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, D.F. Williams, S.A. Schima, S. Canales, D.T. Tamura, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a 13-Story Apartment Building," Natl. Inst. Stand. Technol. Note 1540, May 2005.

C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, D.F. Williams, S.A. Schima, S. Canales, D.T. Tamura, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a Large Sports Stadium (Veterans' Stadium in Philadelphia)," Natl. Inst. Stand. Technol. Note 1541, October 2005.

C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, S.A. Schima, M. McKinley, R.T. Johnk, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a Large Convention Center," Natl. Inst. Stand. Technol. Note 1542, June 2006.

C.L. Holloway, W.F. Young, G. Koepke, K.A. Remley, D. Camell, Y. Becquet, "Attenuation of Radio Wave Signals Coupled Into Twelve Large Building Structures," Natl. Inst. Stand. Technol. Note 1545, Apr. 2008.

K.A. Remley, G. Koepke, C.L. Holloway, C. Grosvenor, D. Camell, J. Ladbury, D. Novotny, W.F. Young, G. Hough, M.D. McKinley, Y. Becquet, J. Korsnes, "Measurements to Support Broadband Modulated-Signal Radio Transmissions for the Public-Safety Sector," Natl. Inst. Stand. Technol. Note 1546, Apr. 2008.

K.A. Remley, G. Koepke, C. Grosvenor, R.T. Johnk, J. Ladbury, D. Camell, J. Coder, "NIST tests of the wireless environment in automobile manufacturing facilities," Natl. Inst. Stand. Technol. Note 1550, Oct. 2008.

W. F. Young, K. A. Remley, J. Ladbury, C. L. Holloway, C. Grosvenor, G. Koepke, D. Camell, S. Floris, W. Numan, and A. Garuti, "Measurements to support public safety communications: attenuation and variability of 750 MHz radio wave signals in four large building structures," NIST Technical Note 1552, Aug. 2009.

W.F. Young, K. A. Remley, D. W. Matolak, Q. Zhang, C. L. Holloway, C. Grosvenor, C. Gentile, G. Koepke, and Q. Wu "Measurements and models for the wireless channel in a ground-based urban setting in two public-safety frequency bands," NIST Technical Note 1557, May 2011.

K.A. Remley, G. Koepke, C.L. Holloway, C. Grosvenor, D. Camell, J. Ladbury, R.T. Johnk, and W.F. Young, "Radio wave propagation Into large building structures; Part 2, characterization of multipath," IEEE Trans. Ant. Propagat., vol. 58, no. 4, Apr. 2010, pp. 1290-1301.

M. R. Souryal, D. R. Novotny, D. G. Kuester, J. R. Guerrieri, and K.A. Remley, "Impact of RF Interference between a Passive RFID System and a Frequency Hopping Communications System in the 900 MHz ISM Band," IEEE Electromagnetic Compatibility Society Symposium Digest, July 2010, pp. 495-500.

K. A. Remley, M. R. Souryal, W. F. Young, D. G. Kuester, D. R. Novotny, J. R. Guerrieri, "Interference Tests for 900 MHz Frequency-Hopping Public-Safety Wireless Devices," IEEE Electromagnetic Compatibility Society Symposium Digest, August 2011.

Annex C Point-to-Point Attenuation for RF PASS

C.1 Introduction

The RF Attenuation Test verifies the performance of RF PASS systems operating under conditions where a significant path loss (also called "attenuation") is encountered, such as inside a building or other structure. A combination of two small anechoic chambers, antennas, cables, and an adjustable attenuator are used to create a repeatable RF propagation environment where a specified level of attenuation can be inserted between a user-worn RF PASS and its base station. Successful reception of an alarm signal under this level of attenuation constitutes a pass of the test. Two alarms are tested in the Point-to-Point RF Attenuation Test. First, the reception of the remote distress alarm by the base station is tested when the alarm signal on the user-worn device is activated. Second, reception of the evacuation alarm by the user-worn device is tested when it is initiated at the base station.

This test method is designed to allow free-field testing of a complete RF PASS system, that is, testing of the system without the use of conducted measurements or removing the antennas. This is important because the antennas on many RF PASS devices are integrated into the user-worn SCBA, which can impact the radiation pattern of the antenna. Free-field testing allows the system to be characterized with any unusual antenna radiation pattern intact.

This test method was also designed to be as cost effective as possible. While the use of shielded anechoic chambers is rather expensive, the design of the units shown here is as inexpensive as possible. Inexpensive patch antennas are used. It is anticipated that, as more and more wireless electronic safety equipment becomes available, the chambers described here can be used for testing those systems as well. The chambers were also designed to be as easy to use and manipulate as possible because of the necessity for repeat measurements.

C.2 The Target Value of Attenuation

In the field, the amount of attenuation between a base station and RF PASS unit will be affected by many parameters, including the distance between them, the building materials, the location within a given building, the frequency of operation, and the type and orientation of the transmit and receive antennas, among other factors. The large range of possible values for these factors complicate the choice of a target value for the attenuation. Table C1 shows broad categories of path loss that were determined from a series of field tests carried out by NIST over the course of several years. These measurements are summarized in NIST Technical Notes 1540-1542 [1-3], 1545-1546 [4, 5], 1550 [6], 1552 [7], and 1557 [8].

Table C1: Proposed classification of Low, Medium, and High attenuation based on NIST studies.			
<u>Classification</u>	<u>Attenuation (dB)</u>	<u>Typical structures</u>	<u>Current PASS</u>
<u>Low</u>	<u>Less than 100</u>	<u>Houses, small buildings with exterior-facing rooms</u>	<u>Single unit</u>
<u>Medium</u>	<u>100 to 150</u>	<u>Moderate-sized and tall structures with some interior rooms</u>	<u>With repeater</u>
<u>High</u>	<u>Over 150</u>	<u>Very large structures and those with subterranean floors</u>	<u>Multiple repeaters</u>

The Point-to-Point RF Attenuation Test is designed to replicate the Low Attenuation classification, corresponding to houses, small buildings, and buildings with exterior-facing rooms, such as multi-story apartment buildings where each unit faces the outside of the building. Based on the NIST data, a target attenuation value of 100 dB was chosen for this test. The attenuation value represents the path loss between the transmit and receive antennas, referenced to a 3 m calibration measurement that removes the effects of the measurement system’s antennas. See [9] for more details on these measurements.

C.3 Measurement System Set-up

Error! Reference source not found. shows a typical Point-to-Point RF Attenuation Test set-up. Two anechoic chambers provide shielding between the portable unit and the base station. The total path loss (or gain) associated with the environmental elements marked in Figure C1 simulates the path loss experienced by personnel carrying RF PASS within a building or structure when the base station is located outside. The value of the external attenuator is adjusted in a calibration step described below to match the target attenuation. The chambers are shielded so that the user-worn RF PASS and base station are isolated from each other. This allows testing of RF attenuation alone. RF interference should be tested in a separate test method. The anechoic material in the chamber simulates a reflection-free environment. Multipath reflections should be tested with a separate test method.

******Insert Figure C1: Test set up and sources of path loss (and gain) in the Point-to-Point RF Attenuation Test******

Antennas are mounted in the top of each chamber to receive the signal emitted by the device under test and couple it to the exterior of the chamber. The total system attenuation includes the gain (if any) in these antennas, the free space path loss between the PASS or base station and these antennas, the cables connecting the chambers, and external attenuators that are added to achieve the desired amount of path loss. The Point-to-Point test method requires that the RF PASS system is able to send and receive alarms when the sum of these components of attenuation corresponds to that specified in the standard.

C.4 System Specifications

C.4.1 Anechoic Chambers

The chambers include non-conducting (for example, plywood) tables capable of supporting an SCBA containing an integrated PASS. The doors in the chambers must be large enough for inserting an SCBA. The top of the table must be positioned above the RF absorbing material covering the interior walls of the chamber. As an example, for RF PASS systems operating in the 900 MHz and 2.4 GHz unlicensed frequency bands, the test chambers must meet the following minimum specifications:

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

The height of the chamber should be maximized to reduce antenna near-field effects, yet low enough to fit within a standard ceiling height to reduce costs. Overall usable interior height should be no less than 40 inches (102 cm) between the antenna and table top or 55 inches (140 cm) total. Note that 1.0 m = 3 wavelengths at 900 MHz.

The user-worn device and base station must be RF-isolated from each other. At least 100 dB shielding from 900 MHz to 3 GHz when the bulkhead ports specified below are in place.

Measured results verifying performance to be provided by manufacturer.

The chambers must replicate a reflection-free environment. RF attenuation of minimum 25 dB normal incidence, from 900 MHz to 3 GHz, provided by RF absorbing material. Measured results verifying performance to be provided by manufacturer.

Because many repeat measurements must be carried out for the Attenuation Test, the chamber must have a hinged door, not a hatch, with no more than two latches that must be operated to open the door, preferably operated with a single handle. Minimum door size approximately 18 inches (46 cm) x 12 inches (30.5 cm).

Top access panel to mount antennas with panel size 12 inches (30.5 cm) x 12 inches (30.5 cm).

Non-conducting table top minimum approximately 12 inches (30.5 cm) square, approximately 15 inches (38 cm) high.

Must be able to mount at least 2 type N precision or SMA bulkhead ports.

Access panel for antenna mounting located at top of structure.

Because the chambers must be positioned near to each other, they should have roll-around capability with wheels or casters.

C.4.2 Antennas

It is recommended that circularly polarized patch antennas be used to minimize the dependence of the test on the orientation within the chamber of the use-worn RF PASS and base station.

Patch antennas provide good field uniformity, making test less sensitive to device placement. As well, they are relatively inexpensive. Four antennas are required for the path loss calibration step; two are used during test. Cables that are connected to the antennas should be as short as possible to minimize error during the calibration step, when, unless a three-antenna calibration is used, the manufacturer's reported antenna gain is used.

C.4.3 Cables

Cables should be high-quality shielded coaxial cables with type N or SMA connectors. At NIST, short (12") cables are permanently left in place at the top of each chamber to make changing antennas easier. These are accounted for in the path loss measurement. Torque wrenches should be used to tighten connectors.

C.4.4 Test Equipment

A three-axis field probe with high-impedance cable is used to characterize the field uniformity of the chamber/antenna combination. A vector network analyzer is used to calibrate the path loss. A signal source and spectrum analyzer could be used as well. A variable attenuator (or combination of fixed and variable) is used to set the path loss.

C.5 Characterizing the Test Chamber Field Uniformity

Before the RF-PASS system components are tested for their ability to operate under the specified path loss conditions, the test environment itself must be characterized. The antennas at the top of the chambers are selected to illuminate the table as uniformly as possible. However, nonidealities such as antenna near-field effects, reflections off of the walls due to imperfect absorber, antenna pattern, polarization, and beamwidth will cause deviations from uniform illumination. This will, in turn, affect the uniformity of the field on the table where the device under test is placed. Note that this characterization step must be completed for each antenna set up used in the Point-to-Point RF Attenuation Test. That is, field uniformity must be tested for each frequency band with the antenna to be used at that frequency.

C.5.1 Procedure: Electric Field Uniformity

The basic procedure for measuring electric field uniformity is to use an electric field probe to determine the contribution of the three orthogonal components of the electric field near the surface of the table, that is, where the device under test will be placed. The electric field probe should be small relative to the wavelength of operation so that the fields inside chamber are not modified by it, and it should be connected through the wall of the chamber by a high-impedance cable to minimize coupling of fields on the cable to the fields in the chamber. Many such probes are commercially available.

The steps listed below include an example of field uniformity measured at 915 MHz because some commercially available RF PASS systems currently operate in the 902 to 928 MHz frequency band.

(1) Setup the anechoic chamber and electric field probe as shown in Figure C1. The antennas used should be those that will be used in the attenuation test. Note that connections into the chamber should be made through bulkhead-type connectors if possible. Any penetrations not using bulkhead connectors should be sealed with metal tape to preserve the shielding integrity provided by the metal shell of the chamber.

(2) Set the signal generator to the center frequency in the frequency band of interest. The power level setting must provide sufficient electric field strength at the measurement area to provide a reading on the field probes, and may require the inclusion of an external power amplifier. In the example shown, the signal generator is connected to a linear broadband RF amplifier.

(3) Connect the field probe to the external voltmeters through the bulkhead. In the case shown, the field probe is connected to three individual digital multimeters that display the x, y, and z components of the electric field.

(4) Sequentially measure the three electric field components at the 13 points shown in Error! Reference source not found.

(5) Plot the contour lines of equal power levels, determined from the measured electric field results, E,x,y, and z Note that E is directly proportional to the measured voltage for the measurements here because we assume the distance between the antenna and all test points is constant. These power levels are relative to the minimum total power measured at one of the 13 points. The minimum total power is determined by calculating the total power at each of the measurement points, and then selecting the minimum value of those calculations. The equation is as follows:

$$P_k^i (dB)_{relative} = 20 \times \log_{10} \left(\frac{E_k^i}{\text{minimum}(E_{total}^i)} \right) \quad (C1)$$

Where =1,2,3...13 , (the measured points), $k = x, y, z, \text{ or } "total,"$ and

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

Note that the conversion to absolute power from electric field values is; $P = aE^2$ a is a constant that cancels in the calculation of the relative power.

In general, any mathematical software with a contour plotting capability may be used to generate the contour plots showing the lines of equal power. Some contour plotting packages may require

additional points beyond the measured values within the defined grid. The contour plots generated here are based a 5×5 grid that contains 25 points, and since only 13 measured data points are available, the remaining points are interpolated by averaging the nearest measured values. For a perimeter location, three measured values are averaged, while for an interior location, four measured values are averaged. For example, in Figure C3, on the top, outside edge of the square an interpolated value is added by averaging the measured values from the top left corner, the middle of the top edge, and the middle of the top left quadrant. An interpolated interior point between the right and left upper quadrants is calculated by averaging the measured values from the middle of the top edge, the center, and the middle of the top left and right quadrants. Note that measuring all 25 points instead of interpolating between measured values is an option as well.

Error! Reference source not found. shows example results for one of the anechoic chambers tested in the NIST laboratory, where the total relative power is shown in Error! Reference source not found.(a). Note that in this case, the vertical component (Error! Reference source not found.(b)), is negligible compared to the two horizontal contributions (indicated by the negative dB values), and the y and z components (Error! Reference source not found.(c) and (d)) are within approximately 2 dB of each other over the center portion of the table. The total horizontal contribution of the electric field creates the circular nature of the contour curves in Error! Reference source not found.(a).

(6) From the uniformity measurement results, the useable portion of the table for testing purposes is considered the center 30 cm (approximately one foot). It is anticipated that the devices under test will be placed within that portion of the table. This area includes approximately the contour line of 7 dB in Error! Reference source not found.(a). Thus, there could be up to 2 dB of variation in the received signal strength depending on the placement of the device within the chamber. Thus, the attenuation test results should account for this variability by increasing target path loss by, in this example, 4 dB (2 dB for each chamber).

(7) Repeat this process for all of the anechoic chambers used in the measurements.

******Insert Figure C3. The measurement pattern for checking the electric field uniformity on the table surface. Field measurements are made at 13 positions on the surface of the table******

******Insert Figure C2. Field uniformity check of an anechoic chamber at 915 MHz with a circularly polarized patch antenna; (a) total power,(b)x or vertical polarization, (c) y or one horizontal polarization contribution, and (d) z or the other horizontal component contribution. The numbers on the contour lines are decibels calculated relative to the minimum total power measured at the 13 measurement points (shown by the yellow circles)******

C.6 Calibration Step to Find Attenuator Setting for Target Path Loss

As described above, the goal of the Point-to-Point RF Attenuation Test is to verify that the RF PASS system is functional when the propagation channel includes a specified target path loss between the user-worn device and the base station. To replicate the target path loss in the laboratory test, the complete path loss between the two antennas is found, as shown in Figure C5. The losses (or gains) of certain fixed elements in the test-chamber environment are added together (in decibels). This fixed test chamber loss is augmented by an external, adjustable attenuator (or group of attenuators). The external attenuator allows one to incorporate enough attenuation to replicate the target path loss. The correct setting for the attenuator is found in a calibration step. The calibration requires the use of two additional antennas having a known gain, and a vector network analyzer, as described in the following.

The two additional antennas are first inserted into the test chambers on the same table tops where the RF PASS components are placed during the attenuation test. It is preferred that these antennas be circularly polarized patch antennas, as above, because they provide highly uniform illumination of the chamber, and are insensitive to polarization. The gain of these antennas should be known beforehand. The gain may be obtained from the manufacturer's specifications or by use of a more sophisticated technique such as a three-antenna method. As an example, the manufacturer-specified gain was 9 dBi for the 900 MHz antennas, and 3 dBi for the 2.4 GHz antennas that we used.

******Insert Figure C5: The target path loss consists of the summation (in decibels) of the various fixed elements in the propagation path, plus the external attenuator. The external attenuator is adjusted until the target path loss is obtained******

The calibration antennas (Antennas 1 and 4, as shown in Figure C5) are connected to the VNA through bulkhead adapters in the body of the test chambers. The cables connecting the antennas to the bulkhead adapters should be short and, preferably, a block of RF absorber placed over them to minimize reradiation and reflections within the chamber.

The VNA is calibrated using standard techniques to reference planes as near to the bulkhead adapters as possible. S parameters are collected over the frequency of operation of the RF PASS system that is being tested. The IF bandwidth should be set to 1 kHz or less, and the number of points to around 400.

As shown in Figure C6, a VNA measurement in this configuration corresponds to the cascade of the elements in the RF propagation path shown in Figure C5. To identify the attenuator setting, we first define a variable SP that represents the combination of all of the fixed elements in the path loss except the attenuator:

$$\underline{SP_{dB} \equiv SC1dB + S2dB + SL1dB + SL2dB + S3dB + SC2dB} \quad (C2)$$

******Insert Figure C6: Graphical representation of the cascade of S parameters that are measured by the VNA, as shown in Figure C5******

We can then represent the cascade of all of the elements in terms of SP, the gain of the calibrations antennas, and the attenuator. This cascade is first measured with the attenuator set to 0 dB, as shown graphically in Figure C7. This allows us to identify the contribution of SP to the total path loss, which in turn allows us to identify the correct attenuator setting to obtain the target path loss.

******Insert Figure C7: Graphical representation of the cascade of S parameters in terms of SP, defined in (1), with the attenuator set to zero. This cascade is measured as SVNA, 0dB******

Knowing SVNA,0dB and the gain of the two calibration antennas, we can then find the attenuator value as

$$\underline{SAT,dB = TdB - SPdB} \quad (C3)$$

$$\underline{= TdB - SVNA,0dB + S1dB + S2dB}$$

where SVNA,0dB , S1dB , and S2dB are known. SAT,dB corresponds to the required path loss introduced by the attenuator, in decibels, given the other path loss mechanisms in the propagation path. As an example, suppose the target path loss is 100 dB, the manufacturer-specified gain of the calibration antennas is 9 dBi, and the measured value of SVNA,0dB is -30 dB at the frequency of operation. Then,

$$\underline{SAT, dB = -100dB - (-30dB) + 9dB + 9dB}$$

$$\underline{= -52dB} \quad (3)$$

The external attenuator should be set to 52 dB in this case. When we include the 4 dB calculated from the field uniformity tests above, the external attenuator would be set to 56 dB.

For the final system set-up, with the attenuator setting determined from SAT,dB in the last step, place the user-worn RF PASS in Chamber 1 and the base station in Chamber 2, as shown in Figure C1. If the base station utilizes a portable computer, this should be provided by the manufacturer and, unless the antennas are connected to the base station by way of a coaxial cable, the computer should be placed in Chamber 2 as well.

Establish a wireless link between the base station and user-worn device before closing the chambers' doors. Testing will be conducted with the RF PASS in two orientations: vertical (standing upright on the table) and horizontal (laying flat on the table) so that the directionality of the RF PASS antennas is less critical. The base station should be tested with its antenna laying horizontally on the table. This may require placing the base station on its back or side. This orientation is designed to maximize the signal level received at the antenna at the top of the chamber, which is presumably how the base station will be deployed in the field (oriented for maximum signal level).

C.7 Remote Distress Alarm Test

After the system is set up as described above, the Remote Distress Alarm test, Figure C8, is carried out as follows:

Close doors on both chambers and wait for remote distress alarm to sound.

Test: Does base station receive alarm within 30 seconds (y/n)?

Repeat test for second orientation of user-worn RF PASS.

Repeat test three times.

Successful receipt of remote distress alarm within 30 seconds of remote distress alarm sounding for all 12 tests constitutes pass of

Point-to-Point Attenuation Test: Remote Distress Alarm (NFPA 1892 – 8.18).

******Insert Figure C8. Graphical representation of the Remote Distress Alarm Test******

C.8 Evacuation Alarm Test

After system is set up as described in previous section, the Evacuation Alarm test, Figure C9, is carried out as follows:

1. Close door on Chamber 1 containing user-worn RF PASS.
2. With base station located within Chamber 2, initiate evacuation alarm.
3. Close door on Chamber 2 containing base station.
4. Test: Does base station receive alarm within 30 seconds (y/n)?
5. Repeat test three times.
6. Repeat test for second orientation of user-worn RF PASS.

7. Successful receipt of remote distress alarm within 30 seconds of remote distress alarm sounding for all 12 tests constitutes pass of Point-to-Point Attenuation Test: Evacuation Alarm (NFPA 1892 – 8.18).

******Insert Figure C9. Graphical representation of the Evacuation Alarm Test******

C.9 Reporting

The report includes results for all configurations, repeats and tests. It should include the model of the devices that were tested. All quantities shall be reported to the nearest decibel. The operator should note the values of (1) Target path loss associated with the test environment. (2) Maximum difference in field uniformity within an area covering the center 30 cm x 30 cm of the test chamber, as measured above. (3) Value of measured path loss when the external attenuator is set to 0 dB (That is, SVNA,0dB). (4) Value of external attenuators used. (5) Frequency of operation (the minimum and maximum operating frequencies utilized). Pass or fail performance shall be determined for each specimen. One or more specimens failing this test shall constitute failing performance.

C.10 References

- [1] C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, D.F. Williams, S.A. Schima, S. Canales, D.T. Tamura, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a 13-Story Apartment Building," Natl. Inst. Stand. Technol. Note 1540, May 2005
- [2] C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, D.F. Williams, S.A. Schima, S. Canales, D.T. Tamura, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a Large Sports Stadium (Veterans' Stadium in Philadelphia)," Natl. Inst. Stand. Technol. Note 1541, October 2005.
- [3] C.L. Holloway, G. Koepke, D. Camell, K.A. Remley, S.A. Schima, M. McKinley, R.T. Johnk, "Propagation and Detection of Radio Signals Before, During, and After the Implosion of a Large Convention Center," Natl. Inst. Stand. Technol. Note 1542, June 2006.
- [4] C.L. Holloway, W.F. Young, G. Koepke, K.A. Remley, D. Camell, Y. Becquet, "Attenuation of Radio Wave Signals Coupled Into Twelve Large Building Structures," Natl. Inst. Stand. Technol. Note 1545, Apr. 2008.
- [5] K.A. Remley, G. Koepke, C.L. Holloway, C. Grosvenor, D. Camell, J. Ladbury, D. Novotny, W.F. Young, G. Hough, M.D. McKinley, Y. Becquet, J. Korsnes, "Measurements to Support Broadband Modulated-Signal Radio Transmissions for the Public-Safety Sector," Natl. Inst. Stand. Technol. Note 1546, Apr. 2008.
- [6] K.A. Remley, G. Koepke, C. Grosvenor, R.T. Johnk, J. Ladbury, D. Camell, J. Coder, "NIST tests of the wireless environment in automobile manufacturing facilities," Natl. Inst. Stand. Technol. Note 1550, Oct. 2008.

[7] W. F. Young, K. A. Remley, J. Ladbury, C. L. Holloway, C. Grosvenor, G. Koepke, D. Camell, S. Floris, W. Numan, and A. Garuti, "Measurements to support public safety communications: attenuation and variability of 750 MHz radio wave signals in four large building structures," NIST Technical Note 1552, Aug. 2009.

[8] W.F. Young, K. A. Remley, D. W. Matolak, Q. Zhang, C. L. Holloway, C. Grosvenor, C. Gentile, G. Koepke, and Q. Wu "Measurements and models for the wireless channel in a ground-based urban setting in two public-safety frequency bands," NIST Technical Note 1557, May 2011.

[9] K.A. Remley, G. Koepke, C.L. Holloway, C. Grosvenor, D. Camell, J. Ladbury, R.T. Johnk, and W.F. Young, "Radio wave propagation Into large building structures; Part 2, characterization of multipath," IEEE Trans. Ant. Propagat., vol. 58, no. 4, Apr. 2010, pp. 1290-1301.

Annex D: RF Interference Test for RF PASS

D.1 Introduction

The RF Interference Test verifies the performance of RF PASS systems operating under conditions where a significant path loss (also called "attenuation") is encountered along with external interference from an RF wireless device operating in the same frequency band as the RF PASS system. For RF PASS that operate in the unlicensed Industrial, Scientific, and Medical (ISM) frequency bands, interfering signals may include those from wireless personal-area network or an RFID inventory-control system.

The interfering source in this test method will operate at approximately the same output power as the RF PASS. Higher-power signals that are transmitted either within the same band as the RF PASS (for example, signals that operate in the 900 MHz frequency band that are licensed for land-mobile radio operations) or at frequencies other than the RF PASS system (for example, broadcast radio or cellular telephone operations) are not considered in this test method.

The interfering signal is introduced into the test chamber that contains the user-worn RF PASS. This configuration is tested to simulate the condition where a firefighter is indoors in the presence of some other system. Because it is expected that the firefighter will typically be some distance from the RF interfering source, in this test method, the output power of the interferer is reduced by the free-space path loss corresponding to 2 m distance.

The type of interfering signal used in this test method depends on the frequency of operation of the RF PASS system. Modulated RF signals that are commonly encountered in the field and that might be expected to cause interference to specific RF PASS configurations are specified for this test. Successful reception of an alarm signal under a specified level of attenuation and type of interference constitutes a pass of the test.

This test method is designed to allow free-field testing of a complete RF PASS system, that is, testing of the system without the use of conducted measurements or removing the antennas. This is important because the antennas on many RF PASS devices are integrated into the user-worn SCBA, which can impact the radiation pattern of the antenna. Free-field testing allows the system to be characterized with any unusual antenna radiation pattern intact.

This test method was also designed to be as cost effective as possible. The design of the anechoic chambers described here is as inexpensive as possible. Inexpensive patch antennas are used. It is anticipated that, as more and more wireless electronic safety equipment becomes available, the chambers described here can be used for testing those systems as well. The development boards used for simulating an RF interferer are also inexpensive, yet versatile enough to replicate signals encountered in the field.

D.2 The Target Value of Interference

The RF Interference Test is designed to introduce into the RF propagation channel the types of interference that may be found in environments where firefighters are deployed. This test focuses on replicating conditions for structures where radio communication is typically difficult, for example large building structures such as office buildings, factories, convention centers and apartment buildings. Certain wireless transmissions that may cause interference are commonly found within these structures. For example, in offices and apartment buildings, the use of wireless local-area networks (WLAN) or wireless personal-area networks (WPAN) is common. In warehouses and factories, the use of RFID technology is common. Wireless systems such as WPAN and RFID operate in the unlicensed “Industrial, Medical, and Scientific” frequency bands, with frequencies and power levels specified by the FCC. Because many RF PASS units also operate within these unlicensed frequency bands, in-band interference is possible. Consequently, the RF Interference Test is designed to test systems that operate in similar frequency bands using commonly encountered transmission protocols. The set of interference tests described below focus on three primary frequency bands and transmission formats. These target values of interference are detailed in Table D2. The transmission formats used in this test (including power level, modulation and encoding schemes, and signal bandwidth) have been designed to replicate commonly found wireless devices.

Table D2: Definition of interference sources for RF Interference Test.			
<u>Frequency Range</u>	<u>Transmission Format or Modulation Scheme</u>	<u>Subcarrier or Channel Bandwidth</u>	<u>Output power and FCC part</u>
<u>450 MHz</u>	<u>TBD</u>	<u>TBD</u>	<u>TBD</u>
<u>902-928 MHz</u>	<u>Frequency Hopping (200 ms hop time)</u>	<u>100 kHz subcarrier</u>	<u>1 W peak power (30 dBm) into antenna (w/ max 6 dBi gain), FCC Part 15.247 [2]</u>
<u>2.4-2.472 GHz</u>	<u>Direct Sequence Spread Spectrum</u>	<u>2 MHz (IEEE 802.15.4 channels)</u>	<u>63 mW peak power (18 dBm) into antenna, FCC Part 15 (See example 2 [2] for determination of correction factor.)</u>

D.3 Measurement System Set-up

Figure D1 shows a typical RF Interference Test set-up. Two anechoic chambers provide shielding between the portable unit and the base station. The total path loss (or gain) associated with the environmental elements (shown in Figure C1, Annex C) simulates the path loss

experienced by personnel carrying RF PASS within a building or structure when the base station is located outside. The value of the external attenuator is adjusted in a calibration step described in Annex C. Note that the attenuation path now includes the power combiner, and so the external attenuator value must be changed from that used in the Point-to-Point Attenuation Test. The interferer is connected to the test chamber containing the user-worn device through a coaxial cable connected to the power combiner. The loss due to the coaxial cable and power combiner must be added to the nominal output power specified in Table D1.

******Insert Figure D1: Test set up and sources of path loss (and gain) in the Point-to-Point RF Attenuation Test******

D.3.1 Orientation of RF PASS. Testing is conducted with the RF PASS in two orientations: vertical (standing upright on the table) and horizontal (laying flat on the table) so that the directionality of the RF PASS antennas is less critical. The base station should be tested with its antenna laying horizontally on the table. This may require placing the base station on its back or side. This orientation is designed to maximize the signal level received at the antenna at the top of the chamber, which is presumably how the base station will be deployed in the field (oriented for maximum signal level).

D.4 System Specifications

D.4.1 Test Chambers. The anechoic chambers, antennas, and cables used in the RF Interference Test are the same as those described in the Point-to-Point Attenuation Test described in Annex C (see Sections C.4.1 through C.4.4).

D.4.2 Power Combiner

A power combiner is used to combine the signal from the base station with the interfering signal, as shown in Figure D1. The power combiner should have two input ports and one output port, should use Type N connectors, and should have a minimum isolation between the input ports of 20 dB.

D.4.3 Interferer

Development kits are available for most wireless system protocols used in the ISM bands (see [1] for an example). Such kits typically take the form of circuit boards with RF connectors. The kits can be programmed with a computer to generate wireless protocols having the parameters specified above.

For the 900 MHz frequency hopping system, configurations can be generated varying in data rate, channel bandwidth, and hop duration. For the 900 MHz system, the system should hop over 51 channels in the 902 MHz to 928 MHz band. Data is transmitted with filtered non-return-to-zero (NRZ) encoding modulated onto a carrier with binary frequency shift keying (FSK).

For the 2.4 GHz WPAN emulator, the system should be capable of simulating an 802.15.4 system. Specifically, the system should be capable of occupying one of 15 channels spaced

every 5 MHz from 2.405 GHz to 2.475 GHz using direct sequence spread spectrum and offset quadrature phase shift keying (O-QPSK).

The development boards should be programmed to provide the parameters specified in Table D1.

D.7 References

[1] M. R. Souryal, D. R. Novotny, D. G. Kuester, J. R. Guerrieri, and K.A. Remley, "Impact of RF Interference between a Passive RFID System and a Frequency Hopping Communications System in the 900 MHz ISM Band," IEEE Electromagnetic Compatibility Society Symposium Digest, July 2010, pp. 495-500.

[2] G. Moore, "Simplifying FCC Compliance for 802.15.4 2.4 GHz Devices," National Technical Systems White Paper. Available at http://www.nts.com/pdf/whitepapers/6_NTS%2080215%20FCC%20white%20paper.pdf.

1982-4 Log #11 FAE-ELS
(Chapter 1 through 6)

Final Action: Reject

Submitter: Kate A. Remley, National Institute of Standards and Technology (NIST)

Recommendation: Add text to read as follows:

****Insert include 1982_L11_R.doc here****

Substantiation: RF-based PASS have been recently made available commercially. The 2007 Edition of NFPA does not include methods to test or verify the performance of RF-based PASS. This proposal provides informational background to support the NIST proposal. It is anticipated that this background material would be included as an informational Appendix in NFPA 1982.

Committee Meeting Action: **Reject**

Committee Statement: The technical committee rejected the proposal. See Committee Proposal 1982-3 (Log #CP2).

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

Comment on Affirmative:

WOLF, T.: alarm signal not specific enough, audible distress alarm is a acceptable and expected type of alarm.

1982-5 Log #10 FAE-ELS
(2.3.1)

Final Action: Accept in Principle

Submitter: Bob Eugene, Underwriters Laboratories Inc.

Recommendation: Revise text as follows:

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, July 31, 2006, Revised August 12, 2008.~~

ANSI B46.1, Surface Texture, 1978

ANSI S1.13, Methods for Measurement of Sound Pressure Level®, 2005.

ANSI Y1.1, Abbreviations for Use on Drawings and Text, 1972.

ANSI Y14.SM, Dimensioning and Tolerancing, 1982.

Substantiation: The edition published July 31, 2006 is the seventh edition. The differences between the sixth edition and the seventh edition of UL 913 are based on international harmonization efforts. The 2008 revisions to the standard correlate with the acceptable protection techniques defined in Section 506.8 of the NEC.

Committee Meeting Action: **Accept in Principle**

Revise text to read as follows:

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, July 31, 2006, Revised August 12, 2008.~~ Seventh Edition, July 31, 2006, Revised August 12, 2008.

Committee Statement: The technical committee accepted the proposal in principle (see meeting action text). The TC is also requesting that the TCC review this issue for possible correlation with other standards in the project.

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

NIST Tests of Representative Radio Propagation Environments to Support Development of RF-Based PASS Standards

Executive Summary

The National Institute of Standards and Technology (NIST) has been involved in a multi-year project to support development of performance metrics and test methods for standards for RF-based PASS devices. The work to date has focused on side-by-side tests designed to relate radio-propagation environment characteristics in representative firefighter environments to actual PASS performance in these same environments. Identifying which radio channel characteristics have the most significant effect on PASS performance enables development of lab-based test methods that can be used to evaluate PASS performance in the field.

NIST's work on RF-based PASS standards has been funded by the U.S. Department of Homeland Security's Office of Standards. The NIST Public-Safety Communications Research Lab has funded the measurements of the propagation channel.

In the propagation channel studies, NIST engineers measured path loss and the level of reflectivity (or "multipath," given by the RMS delay spread) in large public structures and environments where radio communications would potentially be difficult. These environments include multi-story buildings; buildings with subterranean floors; buildings with large, deep interior spaces; those with few windows; and outdoor "urban canyons," consisting of city streets surrounded by tall buildings.

To simulate an incident command post in the propagation environment studies, the transmit antenna was located outside each structure at an appropriate location. The receive antenna was placed at various discrete locations within the buildings in positions intended to provide data on locations that could potentially be problematic for radio reception. In each location, the path loss and RMS delay spread were measured using the VNA-based measurement method described in Section 2.

RF-based PASS measurements were conducted in the same locations as the channel characterization measurements by placing the PASS base station unit at the location of the VNA transmit antenna. Portable RF-based PASS devices were then carried to the same locations that the receive antenna had been placed. At each test location, the portable PASS operator sent an alarm from the PASS device, and the base station operator noted whether the alarm was received, not received, or received with a significant delay.

Because the portable RF-based PASS device has a lower transmit power than does the base station, the alarm from the PASS device was typically lost closer to the base station than vice versa. This is why our tests focused on whether or not the alarm from the portable RF-based PASS device was received by the base station.

We conducted tests in several environments, seven of which are described here, in terms of path loss, RMS delay spread, and success or failure of RF-based PASS transmissions. We tested two different commercially available RF-based PASS systems, one that operates on a licensed frequency in the 450 MHz public-safety narrowband frequency allocation, and one that operates in the unlicensed spectrum between 902 MHz and 938 MHz. The latter system was tested alone and with one repeater unit.

From these side-by-side measurements of the radio-propagation channel and RF-based PASS devices, we have been able to draw several important conclusions. First, the data indicate that attenuation, rather than multipath, is the most common cause of a missed alarm from an RF-based PASS device in the representative medium-to-large-structure radio-propagation environments that were studied.

A second conclusion is that there is a range of path-loss values that can be used to roughly classify various structures in terms low-, medium-, and high-attenuation environments. In the low-attenuation environments (defined here as less than 100 dB path loss), RF-based PASS devices could typically be operated successfully without a repeater. In the medium-attenuation environments, RF-based PASS devices could typically be operated with a single repeater. In the high attenuation environments, it is expected that RF-based PASS may face significant obstacles to reliable RF transmission (using current 2010 technology consisting of a base station transceiver and portable, body-worn transceivers).

A third conclusion can be drawn looking at the PASS performance tests conducted at an apartment building that had a cell-phone base station located on its roof. This structure did not present significant attenuation, yet both types of RF-based PASS devices we tested had significant difficulty in reliably communicating with the PASS base station. Radio interference such as this can present a potentially serious obstacle to RF-based PASS transmissions, and should be considered when deploying such systems.

The data and corresponding discussion have been used to develop recommendations for lab-based test methods for RF-based PASS devices. The test methods developed to date focus on inserting a controllable amount of attenuation

between the portable PASS device and the PASS base station. The level of attenuation is increased to simulate a given amount of path loss, and the performance of the RF-based PASS system is noted when an alarm is sent from the portable unit to the base station. It is anticipated that additional test methods and standards will be forthcoming in the near future as well.

1.0 Introduction

This document describes NIST tests to characterize the radio propagation channel in representative firefighter environments, along with performance test of RF-based PASS devices in the same environments. In Section 2, we describe the measurement system and data-processing algorithms that we used in the channel characterization measurements, as well as certain assumptions and approximations that were made in analyzing the data. In Section 3, we then summarize the results of our measurements, relating RF-based PASS performance to radio channel characteristics where possible. The final sections present a complete summary of the environments that were studied and the data that were collected.

Because the data presented here were collected during field measurements, in some cases the RF-based PASS performance does not entirely agree with what might be expected theoretically. However, as will be shown, we can generally predict device performance based on the proposed attenuation limits described above.

2.0 Measurements of Path Loss and RMS Delay Spread

The goal of these channel characterization measurements was to provide typical values of path loss and RMS delay spread in representative responder environments for use in the development of technically sound standards and test methods. The work discussed here focuses on RF-Based PASS devices. We measured the wideband frequency response and time-delay characteristics of the outside-to-inside channel using a measurement system based on a vector network analyzer, shown in the figure below. This instrument collects data over a wide frequency range, by stepping through frequencies one at a time. This system, described in more detail in [1, 2], lets us measure the complex transfer function of the radio propagation channel. Using a free-space reference measurement, we can then calculate the path loss without including the effects of the antenna or other instrumentation. By taking the Fourier transform of the measured transfer function, the power delay profile and RMS delay spread of the channel may also be found in post processing.

We made measurements over a “low” frequency band that ranged from 100 MHz to 1.2 GHz, and a “high” frequency band, that ranged from 1 GHz to 18 GHz. The low-band measurements are reported on here because they coincide with the operating frequencies of the PASS devices we tested. We used omnidirectional transmit and receive antennas. The beamwidth of the omnidirectional antennas is approximately 40 ° to 50 ° in the vertical direction.

****Insert Figure 1 here****

Figure 1: Wideband measurement system based on a vector network analyzer. Frequency-domain measurements, synchronized by the optical fiber link, are transformed to the time domain in post-processing. Use of this system enables determination of path loss, time-delay spread, and other figures of merit important in characterizing modulated-signal transmissions.

To make a measurement, the vector network analyzer is first calibrated by use of standard techniques where known impedance standards are measured. The calibration enables us to correct for the response of the fiber-optic system, amplifiers, passive elements, and other electronics used in the measurement. We also high-pass filter our measurements in post processing to suppress the large, low-frequency oscillation that occurs in the optical fiber link.

2.1 Wideband Frequency Response and Path Loss

Our wideband measurements provide a complex channel transfer function $H(f)$, where $H(f)$ typically is derived from the measured transmission parameter $S_{21}(f)$. To find the frequency-dependent path loss between the transmit and receive antennas, we first compute $|H(f)|^2/|H_r(f)|^2$, where $H_r(f)$ is a free-space reference made at a known distance d_r from the transmit antenna. The use of a ratio to find the path loss enables us to calibrate out the antenna response of the system. Because the antenna response is common to both the reference and the measurement, dividing one by the other removes the antenna effects from the measurement. We correct the measurements for the free-space path loss between the transmit antenna and the reference location by dividing $|H_r(f)|^2$ by $(4\pi d_r/\lambda)^2$.

The reference may be acquired either during field tests or from a laboratory measurement. For the measurements discussed in Section 3, the reference measurement distance d_r is specified in each case, and the free-space path loss corresponding to this distance is added to the path loss.

Because the measurements typically involve weak received signals, we use an amplifier in the link. To protect the instrumentation and optical fiber link, we include an attenuator when we are calibrating the VNA. As a result, the value of this attenuator must be added to the overall path loss as well.

Based on the above discussion, we calculate free-space path loss from our VNA measurements as (all quantities expressed in decibels):

Total Path Loss = $10 \cdot \log_{10}(|S_{21}(f)|^2 / |S_{21r}(f)|^2)$ + calibration attenuator + reference measurement free-space loss.

2.2 RMS Delay Spread

The RMS delay spread is a figure of merit that quantifies the time it takes for reflections in a received signal to die out. We found the RMS delay spread from the measured complex channel transfer function as follows. First, transfer functions were windowed by means of a Hamming window to reduced delay-domain sidelobes. This technique is often employed with VNA measurements. Then the windowed transfer functions were inverse-Fourier-transformed to obtain bandpass channel impulse responses. These bandpass channel impulse responses were then downconverted and low-pass filtered with a fifth-order elliptic filter to suppress the double-frequency components. For a channel impulse response denoted $h(\tau, t_i)$, the corresponding i^{th} (“instantaneous”) power delay profile (PDP) was computed as $P_i(\tau) = |h(\tau, t_i)|^2$, where τ denotes the decay time and t denotes the time at which the measurement was taken.

When multiple measurements were available from a particular site, we took the average of the instantaneous power delay profiles to compute the RMS delay spread. When only a single measurement was available, we found the “instantaneous” RMS delay, which provides a rough approximation of the RMS delay spread. RMS delay spread is calculated as the square root of the second central moment of the power-delay profile of a measured signal. The RMS delay spread σ_τ can be defined as

$$\sigma_\tau = \sqrt{\overline{\tau^2} - (\overline{\tau})^2}. \quad (1)$$

In (1), $\overline{\tau}$ is defined as the average value of the power-delay profile in the defined

dynamic range window, and $\overline{\tau^2}$ is the variance of the power-delay profile within this window. The figure above shows the power-delay profile for a representative building

propagation measurement. The peak level usually occurs when the signal first arrives at the receiving antenna, although in high multipath environments we sometimes see the signal build up over time to a peak value and then fall off.

******Insert Figure 2 here******

Figure 2: Power-delay profile for a building propagation measurement. Important parameters for a measured signal are the peak level, the maximum dynamic range, the mean delay, and the RMS delay spread.

A common rule of thumb is to calculate the RMS delay spread from signals at least 10 dB above the noise floor of the measurement. For the measurements described in the following sections, we used the method described in [2] to determine the useful dynamic range of each measurement. Where insufficient dynamic range existed, no RMS delay spread was calculated.

2.3 Measurement considerations

Several additional factors contributed to the measurement results presented in Section 3. We describe them here so that readers will be aware of the approximations involved in the propagation channel measurements below. These considerations lead to increased uncertainties in the path loss measurements described in Section 3.

2.3.1 Path Loss at 700 MHz

The path loss and RMS delay spread data presented in Sections 3 and 5 were gathered over the frequency band 725 MHz to 800 MHz (unless noted), rather than at the operating frequencies of the RF-based PASS devices. This was done for two reasons: First, both the 450 MHz and 900 MHz bands are typically heavily used. Collecting propagation channel data that is unaffected by external radio interference is difficult, as shown in Figure 3 on the next page.

NIST also had collected a significant amount of propagation channel data in the 700 MHz frequency band as part of a study for emergency response use of the newly allocated band. We were able to leverage the data collected for that project in our study of RF-based PASS performance.

An analysis was conducted of the difference in received power in the 700-800 MHz band compared to 400-500 MHz and 900-1000 MHz. Data from measurements at a high-rise building (Republic Plaza, Denver, CO) were used. For this analysis, four sites were selected: Receive sites 1, 2, 16 and 21 (shown in the diagram in Section 4 of

this document). The analysis was conducted by averaging the $|S_{21}|^2$ over the 700-800 MHz band and comparing that number to the average $|S_{21}|^2$ across another band. Between the four sites analyzed, the difference between the band averages ranged from 1.50 dB to 3.10 dB depending on the site. The results are presented in the table below.

Site Number	Average over 700-800 MHz (dB)	Average over 400-500 MHz (dB)	Average over 900-1000 MHz (dB)	Max. Difference (dB), absolute value
1	-20.59	-21.77	-17.49	3.10
2	-40.58	-38.86	-39.58	1.72
16	-57.42	-59.95	-58.96	2.53
21	-60.39	-61.89	-61.75	1.50

It should be emphasized that, due to the potential presence of interferers, the 400 MHz and 900 MHz values may be incorrect. This comparison simply shows that an additional uncertainty in the path loss calculations of around 1 to 3 dB can be expected by using the 700 MHz band.

******Insert Figure 3 here******

Figure 3: The lower red curve in each graph shows the “noise floor” of the VNA measurements made in the Denver urban canyon. The large spikes correspond to interference from radio signals present in the environment. The upper left graph shows the frequency range from 300 MHz to 1 GHz. Interferers can be seen in the mid-400 MHz band and the 900 MHz band. The other graphs show zoomed-in views of these bands, and the 725 MHz to 800 MHz band used in the data presented below. Nine measurements were taken in the 700 MHz band, with the mean and standard deviation indicated.

2.3.2 Use of Field Reference Files vs. Controlled Environment Reference Files

As described above, path loss measurements require the use of a reference file to calibrate out the frequency-dependent loss of the antenna and connecting cables. The reference measurement is made by placing the receive antenna a known distance from the transmit antenna and conducting a VNA measurement. Subsequent measurements made at the field test location are corrected using the reference measurement. Reference measurements made on site at a field test location can include the effects of environmental reflections and interferers. Figure 4 shows two reference measurements covering the frequency range from 100 MHz to 1.2 GHz. The

top plot shows a 4 m reference made in the Denver Urban Canyon environment described in the following sections, while the bottom plot shows a 4 m reference made on the NIST open-area test site. The controlled reference measurement is smoother and does not show the dips around 400 MHz, 600 MHz, and 1 GHz that the field reference shows.

******Insert Figure 4 here******

Figure 4: Graphs showing two different 4 m reference files over the frequency range 100 MHz to 1.2 GHz. Top: Denver, CO urban canyon. Bottom: NIST open-area test site.

Based on the graphs in Figure 4 above, it appears to be preferable to use reference measurements made in a controlled environment such as an open-area test site. However, the controlled-environment tests must be made using the same equipment, (antennas, cables, amplifiers, etc.) that were used in the field tests or the calibration will have some errors. It was not possible to perform the controlled-environment reference measurement for all measurements reported in the following sections.

An analysis was conducted of the difference in path loss when two different reference files were used. The data below correspond measurements at five locations on the second floor of the Horizon West apartment building, Boulder, CO. It is clear that even though the reference files may appear to be quite different, the effect on the final path loss result is minimal.

Receiver Location	Field Reference File (dB)	Controlled-environment Reference File (dB)
1	86.13	86.13
2	82.78	82.79
3	77.66	77.67
4	78.34	78.35
5	91.12	91.12

2.4 References

[1] Kate A. Remley, Galen Koepke, Christopher L. Holloway, Chriss Grosvenor, Dennis Camell, John Ladbury, Robert T. Johnk, William F. Young, "Radio Wave Propagation Into Large Building Structures; Part 2, Characterization of Multipath," *IEEE Trans. Antennas Propagat.*, accepted for publication, 2010.

[2] David W. Matolak, Kate A. Remley, Camillo Gentile, Christopher L. Holloway, Qiong Wu, Qian Zhang, "Ground-Based Urban Channel Characteristics for Two Public Safety Frequency Bands," *In review*, 2010.

3.0 Data Analysis

In this section, we discuss the results of NIST measurements of path loss and RMS delay spread from several different environments. The presentation of the data is designed to assist in classifying propagation environments for development of standards for RF-based PASS. The key points that we extract from the data are: (1) Typical levels of attenuation and RMS delay spread for representative firefighter environments (this will allow us to set limits for lab-based RF-PASS testing); (2) The mechanisms that cause the RF-based PASS transmissions to fail, specifically, whether attenuation, multipath, or external radio interference the dominant impairment (this will allow us to develop appropriate lab-based test methods).

The data also provide a qualitative comparison of RF-based PASS performance with and without repeaters, and at two different frequencies of operation. Note that the PASS results are purely qualitative: during testing, the position of the device was slightly different from the VNA measurements, the device battery charge was not monitored, and numerous other small differences between the tests mean that direct comparison is not possible.

The data presented below are ordered with the environments providing the lowest path loss first. We plot the RMS delay spread vs. path loss at each location within a structure. The success of a PASS transmission is indicated by a blue circle, the failure of a transmission by a red x and a significant delay (over 1 minute) by a green diamond. This representation allows us to investigate which mechanisms have the most impact on PASS performance. The complete set of graphs follows the discussion in Sections 3.1 – 3.3.

3.1 Notes on measurement results

Here we provide additional information on the measurement data collected in various radio-propagation environments. Consult the graphs that follow for more information.

- **Denver urban canyon – down street, around one corner:** This was the only outdoor-to-outdoor environment studied. The path loss was between 45 dB and 90 dB, but the RMS delay spread is as high as 220 ns, one of the larger values measured. With few exceptions, the PASS devices operated successfully in this environment.
- **Horizon West – 12-story apartment building, floors 2 and 7:** The path loss was not high, between 75 dB and 100 dB, and the RMS delay spread was less than 55 ns on floor two, and 80 ns on floor seven. Still, the RF-based PASS transmissions were not successfully received by the base station. A cell-phone base station located on the roof of the apartment building may have caused interference.
- **Republic Plaza – 60 story office building, floors 1-10 including stairwell:** Based on measurements at other locations and in the NIST lab, it is evident that the path loss values reported in the graph (~70 dB to 115 dB) are too small to be realistic for this large structure. In the NIST lab, the RF-based PASS devices failed to successfully transmit an alarm at an attenuation level between approximately 120 dB and 135 dB, depending on the device. Thus, we expect that there was a problem with the measurement of the path loss data shown here, perhaps because the PASS base station antennas were not reoriented to align with the remote units on the higher floors. The base station antennas likely have a null in the vertical direction. We estimate actual path loss to be 20 to 30 dB higher than the calculated values. The RMS delay spread values ranged from 50 ns to 400 ns.
- **NIST Building 27 – small main building connected by long subterranean tunnel to small back room:** Attenuation values ranged from around 85 dB to 100 dB, and RMS delay spread was generally low, but in one case it jumped to 250 ns, probably because of multipath in the front building before the signal propagated down the hall to the receiver. PASS measurements were not made in this structure.
- **NIST Building 24 – office/lab building with basement:** Measured attenuation values ranged from 95 dB to 115 dB, although the attenuation in the basement was actually higher but we were unable to measure it due to limited dynamic

range of the VNA test set-up. The RMS delay spread values were low, only up to 50 ns for the locations we measured. Where there was not enough dynamic range to calculate the RMS delay spread, it is plotted as zero.

- **NIST Building 1- office/lab building with long, partly subterranean hallway:** Measured attenuation values in this structure ranged from 100 dB to 140 dB and the RMS delay spread values were up to 100 ns. We were only able to measure locations nearest the transmitter because there was insufficient dynamic range to acquire path loss and RMS delay spread data. It is expected that the path loss is significantly higher deeper into the building. Where there was not enough dynamic range to calculate the RMS delay spread, it is plotted as zero.
- **Colorado Convention Center - main entry, one corridor, and downstairs:** The measured attenuation in this large structure was between 80 dB and 150 dB, and the RMS delay spread up to 200 ns. However, our measurement instruments had insufficient dynamic range far into the building, so it is anticipated that the path loss was much higher than this. Where there was not enough dynamic range to calculate the RMS delay spread, it is plotted as zero.

3.2 Typical levels of attenuation

Most of the environments we tested provided at least 50 dB of attenuation, created by the penetration of signals from outside-to-inside a structure (or vice versa), or the distance between transmitter and receiver. Only the outdoor urban canyon environment and the shallow apartment building had maximum attenuation less than 100 dB, which we classify as “low attenuation.” It is expected that typical house structures, small commercial buildings (such as small stores in strip malls and office buildings with exterior-facing offices) and small-to-moderate sized apartment buildings (all apartments with an exterior wall) would provide an environment where the total signal attenuation is less than 100 dB. With current technology, it appears that an individual RF-based PASS unit (no repeater) can operate successfully in these environments, unless external radio interference is experienced, as it was in the Horizon West apartment building measurements.

Some of the environments we studied had maximum attenuation values between 100 dB and 150 dB, which we classify as “medium attenuation.” We expect that the Republic Plaza building attenuation values were on this order, and the NIST Building 27. It is expected that moderate-sized structures such as small hospitals, moderate-sized and tall commercial, office, and apartment buildings would provide an

environment with attenuation between 100 dB and 150 dB. With current RF-based PASS technology, the use of a repeater can often overcome this level of attenuation.

Very large structures and those with subterranean floors can be expected to provide attenuation greater than 150 dB, which we classify as “high attenuation.” NIST Buildings 24 and 1, and the convention center had these high levels of attenuation. It is expected that multiple repeaters would need to be used in such environments, using current RF-based PASS technology. A summary is provided in the table below.

Classification	Attenuation (dB)	Typical structures	Current PASS
Low	Less than 100	Houses, small buildings with exterior-facing rooms	Single unit
Medium	100 to 150	Moderate-sized and tall structures with some interior rooms	With repeater
High	Over 150	Very large structures and those with subterranean floors	Multiple repeaters

3.3 Mechanisms that cause the RF-based PASS transmissions to fail (attenuation, multipath, and external radio interference)

For the environments we studied, it is clear that attenuation (path loss) is the dominant failure mechanism. In almost every case, there is a direct correlation between an increasing path loss and the failure of the RF-based PASS device transmission. Conversely, there seems to be little correlation between RMS delay spread and success or failure of the RF-based PASS. However, most of the environments we studied had relatively short RMS delay spread values of 200 ns or less.

We conclude that lab-based tests providing methods for testing RF-based PASS in a controlled attenuation environment would predict device performance in the majority of real-world firefighter environments. Tests utilizing various values of attenuation could be used to verify device performance in environments having the attenuation classifications listed in the table above.

Additional field tests and analysis should be conducted to determine the level of multipath in highly reflective environments such as factories, utility installations, and other manufacturing environments, and lab-based tests should be developed if it is found that these environments affect RF-based PASS performance.

The complete set of graphs described above appear on the next few pages, followed by the descriptions of the environments and data in Sections 4 and 5.

Denver Urban Canyon: Transmit site 1

******Insert Denver Urban Canyon: Transmit site 1, Figure 1 here******

******Insert Denver Urban Canyon: Transmit site 1, Figure 2 here******

******Insert Denver Urban Canyon: Transmit site 1, Figure 3 here******

Denver Urban Canyon: Transmit site 2

******Insert Denver Urban Canyon: Transmit site 2, Figure 1 here******

******Insert Denver Urban Canyon: Transmit site 2, Figure 2 here******

******Insert Denver Urban Canyon: Transmit site 2, Figure 3 here******

Horizon West 12-story apartment building: Floor 2

******Insert Horizon West 12-story apartment building: Floor 2, Figure 1 here******

******Insert Horizon West 12-story apartment building: Floor 2, Figure 2 here******

******Insert Horizon West 12-story apartment building: Floor 2, Figure 3 here******

Horizon West – 12-story apartment building: Floor 7

******Insert Horizon West – 12-story apartment building: Floor 7, Figure 1 here******

******Insert Horizon West – 12-story apartment building: Floor 7, Figure 2 here******

******Insert Horizon West – 12-story apartment building: Floor 7, Figure 3 here******

Republic Plaza – 60 story office building, floors 1-10 including stairwell.

******Insert Republic Plaza – 60 story office building, floors 1-10 including stairwell,
Figure 1 here******

******Insert Republic Plaza – 60 story office building, floors 1-10 including stairwell,
Figure 2 here******

******Insert Republic Plaza – 60 story office building, floors 1-10 including stairwell,
Figure 3 here******

NIST Building 27: Small main building connected by long subterranean tunnel to small back room.

No PASS tests conducted, channel characterization only

*******Insert No PASS tests conducted, channel characterization only Figure Here*******

NIST Building 24: office/lab building with basement

******Insert NIST Building 24: office/lab building with basement, Figure 1 here******

******Insert NIST Building 24: office/lab building with basement, Figure 2 here******

******Insert NIST Building 24: office/lab building with basement, Figure 3 here******

NIST Building 1: office/lab building with long, partly subterranean hallway

******Insert NIST Building 1: office/lab building with long, partly subterranean hallway, Figure 1 here******

******Insert NIST Building 1: office/lab building with long, partly subterranean hallway, Figure 2 here******

******Insert NIST Building 1: office/lab building with long, partly subterranean hallway, Figure 3 here******

Colorado Convention Center: main entry, one corridor, and downstairs

450 MHz PASS only

******Insert Colorado Convention Center: main entry, one corridor, and downstairs 450 MHz PASS only Figure here******

4.0 Test Environments

4.1 Denver Urban Canyon

Measurements were taken outdoors in the financial district of downtown Denver on Saturday, June 20, 2009. This area contains many large (over 20 story) buildings.

The figure below left shows an illustration of the test area constructed from a Google map view.¹ Street widths were on the order of 20 m. Three transmitter (TX) locations and eleven receiver (RX) locations were used. Results here are presented for TX1 and TX2. The figure below right shows a photograph of the two receiver antennas located at position R5 on the corner of Welton and 17th Streets. The diagram below shows LOS distances ranged from 10 m to 80 m, with NLOS distances placed every 10 m past R5.

******Insert 4.1 Denver Urban Canyon, Figure 1 here******

******Insert 4.1 Denver Urban Canyon, Figure 2 here******

******Insert 4.1 Denver Urban Canyon, Figure 3 here******

4.2 Horizon West Apartment Building, Boulder, Colorado

This building was the 12-story Horizon West apartment building in Boulder, Colorado. The building is constructed of reinforced concrete, steel, and brick with standard interior finish materials. The building was fully furnished and occupied during the experiments. Measurements were performed during daytime hours and, as a result, people were moving throughout the building during the experiments.

The base station site was located on the east side of the apartment building, approximately 60 m from the building. The locations of the tests are shown in the sketch. These measurements were acquired approximately every 5 m down the main hallways, as indicated in the figure, on floors 2 and 7 of the building.

******Insert 4.2 Horizon West Apartment Building, Boulder, Colorado, Figure 1 here******

******Insert 4.2 Horizon West Apartment Building, Boulder, Colorado, Figure 2 here******

******Insert 4.2 Horizon West Apartment Building, Boulder, Colorado, Figure 3 here******

******Insert 4.2 Horizon West Apartment Building, Boulder, Colorado, Figure 4 here******

¹ © 2009 Google, Map Data © 2009 Tele Atlas.

4.3 Republic Plaza, Denver, Colorado

The Republic Plaza is a 57-story office building in downtown Denver. The construction materials are a typical combination of concrete and steel. The interior building materials are a combination of metal framing, drywall, and trim, with stone finishes in lobby. The exterior is a combination of glass and metal. The photographs below illustrate the exterior and interior of the building.

The receive site, depicted in the sketch, was located on the 17th Street side, approximately 10 m from the building. This location was intended to simulate the location of a command vehicle in an emergency response scenario.

Pink numbers on the sketch show the locations within the building where testing was conducted. The vertically stacked numbers indicate testing conducted in a stairwell. The highest floor tested, the tenth floor, had been gutted in preparation for remodeling, as shown in the photographs.

******Insert 4.3 Republic Plaza, Denver, Colorado,
Figure 1 here******

******Insert 4.3 Republic Plaza, Denver, Colorado,
Figure 2 here******

******Insert 4.3 Republic Plaza, Denver, Colorado,
Figure 3 here******

******Insert 4.3 Republic Plaza, Denver, Colorado,
Figure 4 here******

Republic Plaza Building, tenth floor level, and ground floor lobby.

4.4 NIST Building 27

The entry to this small concrete building is above ground and consists of a room approximately 5.5 m (18.0 ft) wide and 7.1 m (23.3 ft) deep, shown in the photograph, below left. There are two small windows in the main room. The room is used for storage and contains many boxes of electronics equipment, as shown in the photograph, below right. The room is connected to a much smaller room by a 24.5 m (80.4 ft) long corridor, as shown in the photograph, bottom left. The corridor and small room at the end, which is 3 m x 3 m (9.8 ft x 9.8 ft), are below ground and used to access the NIST open-area test site. The diagram at the bottom of the page shows the dimensions of the building.

****Insert 4.4 NIST Building 27, Figure 1 here****

****Insert 4.4 NIST Building 27, Figure 2 here****

****Insert 4.4 NIST Building 27, Figure 3 here****

****Insert 4.4 NIST Building 27, Figure 4 here****

4.5 NIST Building 24

This building consists of offices and laboratories, including a large semi-anechoic antenna test chamber approximately 25 m x 6 m. The building footprint is approximately 30 m x 30 m. The building is constructed of cinder block, concrete, and steel. There are few windows except in the offices and storage spaces. There are two levels of offices/lab space and a large, open, unfinished basement.

The base station was set up immediately outside the building due to construction behind the building. Tests were conducted by entering the building on the south side, turning west and going down the stairs to the basement, walking to various sites throughout the basement, including into an elevator at the end of a hallway, ascending the stairs on the north side, and walking down a corridor to the original entry position.

****Insert 4.5 NIST Building 24, Figure 1 here****

****Insert 4.5 NIST Building 24, Figure 2 here****

****Insert 4.5 NIST Building 24, Figure 3 here****

NIST Building 24: Left side: View from N. Right side: View from W. PASS basestation was set up on the picnic table.

4.6 NIST Building 1

This building is the main building (referred to as the Radio Building) at the NIST laboratories in Boulder, CO. The building is constructed of reinforced concrete and is basically a four-story building. However, the building is built on a hillside, and consequently, some locations in the building are below ground level. Measurements were made on the 3rd floor hallway called “Wing 4”, continuing in to “Wing 3” on the 3rd floor, around the corner on the “main spine.” The measurements were performed during

daytime hours and, as a result, people were moving throughout the building during the experiments.

Two fixed transmit sites were assembled on the south side of the laboratory building (see Figure below). The receive site at Wing 4 was located on the loading dock, while the receive site at Wing 6 was approximately 10 m from the building. Channel measurements were performed with the receiving antennas polarized in the vertical direction.

******Insert 4.6 NIST Building 1, Figure 1 here******

******Insert 4.6 NIST Building 1, Figure 2 here******

******Insert 4.6 NIST Building 1, Figure 3 here******

NIST Building 1 Corridor. Left side: Wing 4 hallway. Right side: Base station outside Wing 6.

4.7 Colorado Convention Center

This massive three-level structure is constructed of reinforced concrete, steel, and standard interior finish materials. The exterior of the building is a combination of glass, metal, and concrete. As shown in the sketch, the convention has a basement and two above-ground levels.

The base station was located approximately 10 m from the entrance on the Speer Boulevard side. A large lobby area and auditorium were located inside this entrance. Testing was conducted only at the points marked by a number in a white square. Only one of the PASS devices was tested at the convention center location.

******Insert 4.7 Colorado Convention Center, Figure 1 here******

******Insert 4.7 Colorado Convention Center, Figure 2 here******

******Insert 4.7 Colorado Convention Center, Figure 3 here******

******Insert 4.7 Colorado Convention Center, Figure 4 here******

5.0: Measured Data

5.1 Denver Urban Canyon

Location and Notes	Test Point	VNA Loss Data (dB)	Path Loss @700 MHz (mean of 9) (dB)	RMS Delay Spread @700 MHz (mean of 9) (ns)	908 MHz PASS Unit 1	908 MHz PASS Unit 2	450 MHz PASS
Denver Urban Canyon TX1	1	17.25	58.63	51.70	O	O	O
	2	5.15	46.53	20.55	O	O	O
	5	21.01	62.39	107.30	O	O	O
	7	34.24	75.62	146.11	O	O	O
	9	36.54	77.92	134.68	O	X	O
	10	43.48	84.86	210.97	O	O	O
TX2	1	36.84	78.22	114.26	O	O	O
	2	17.06	58.44	32.49	D	O	O
	5	27.65	69.03	81.57	O	X	O
	7	40.13	81.51	108.45	O	O	O
	9	42.34	83.72	94.84	O	X	O
	10	49.71	91.09	NaN	O	O	O

O = Alarm received

D = Alarm received with Delay

X = Alarm not received

Measurement details

Calibration Attenuator: 40 dB for the high bands, 20 dB for the low bands

Note: Denver Urban Canyon data: attenuator in place during measurements. No path loss correction for atten needed.

Reference measurement distance: 4 m (ref. from OATS => 20 dB atten)

Formula: VNA data + free-space loss = Path Loss

5.2 Horizon West Apartments:

Location and Notes	Test Point	VNA Loss Data (dB)	Path Loss @700 MHz (dB)	RMS Delay Spread @700 MHz	908 MHz PASS	908 MHz PASS w/ repeater	450 MHz PASS
--------------------	------------	--------------------	-------------------------	---------------------------	--------------	--------------------------	--------------

				(ns)			
Horizon West Floor 2 Notes: - System 1 repeater at test point 2.	1	21.41	86.13	24.97	D	X	X
	2	16.29	82.79	16.09	D	X	X
	3	16.97	77.67	32.14	D	D	X
	4	29.74	78.35	18.34	D	X	X
	5	35.44	91.12	54.28	D	X	X
	6	26.29	96.82	37.48	X	X	X
	7	26.34	87.67	48.52	D	X	X
	8	24.05	87.72	19.72	X	X	X
	9	24.25	85.43	46.78	D	X	X
	10	22.38	85.63	31.23	X	X	X
	11	20.68	83.76	20.06	X	X	X
	12	25.77	82.06	34.75	D	X	X
	13	23.47	87.15	46.46	X	X	X
Horizon West Floor 7	1	28.22	89.60	33.94	D	X	O
	2	18.68	80.06	24.43	D	X	O
	3	17.16	78.54	29.79	D	X	O
	4	35.12	96.50	51.40	D	X	O
	5	37.71	99.09	52.43	D	X	O
	6	33.78	95.16	77.07	D	X	X
	7	34.08	95.46	46.22	D	X	O
	8	30.62	92.00	41.53	O	X	X
	9	28.92	90.30	51.29	D	X	O
	10	31.09	92.47	56.53	D	X	X
	11	33.51	94.89	47.39	D	X	X
	12	36.38	97.76	69.66	D	X	O
	13	28.50	89.88	28.24	D	X	O

O = Alarm received

D = Alarm received with Delay

X = Alarm not received

Measurement Details

Calibration Attenuator: 30 dB for the high bands, 30 dB for the low bands (Chriss doesn't know, but 30dB is in the file name)

Reference measurement distance: 4 m (OATS, so use 20 dB atten)

Note: 2m ref file (collected at Horizon West) gives 10 dB lower PL than OATS ref.
 Formula: VNA data + atten + free-space loss = Path Loss

5.3 Republic Plaza Building:

Location and Notes	Test Point	VNA Loss Data (dB)	Path Loss @700 MHz (dB)	RMS Delay Spread @700 MHz (ns)	908 MHz PASS	908 MHz PASS w/ repeater	450 MHz PASS
Republic Plaza Notes: - System 1 repeater at test point 2.	1	7.23	68.61	44.99	O	O	O
	2	27.06	88.44	39.52	D	O	O
	3	38.15	99.53	52.30	X	X	O
	4	37.60	98.98	133.41	X	X	O
	5	37.18	98.56	81.25	X	O	O
	6	42.26	103.64	102.78	X	O	O
	7	46.04	107.42	138.29	X	X	O
	8	44.88	106.26	104.69	X	O	O
	9	48.30	109.68	376.10	X	X	O
	10	45.34	106.72	338.17	X	O	O
	11	50.25	111.63	167.91	X	O	O
	12	50.48	111.86	231.57	X	O	O
	13	50.98	112.36	209.07	X	O	O
	14	51.82	113.20	192.25	X	O	O
	15	49.60	110.98	240.20	X	O	O
	16	44.64	106.02	377.45	X	X	O
	17	29.28	90.66	296.87	O	O	O
	18	30.45	91.83	161.75	O	O	O
	19	42.24	103.62	429.90	O	O	O
	20	39.30	100.68	333.25	O	O	O
	21	47.07	108.45	453.47	O	O	O

O = Alarm received

D = Alarm received with Delay

X = Alarm not received

Measurement Details

Calibration attenuator (atten): 30 dB for the high bands, 10 dB for the low bands

Reference measurement distance (free-space loss): 4 m (OATS => 20 dB atten used)

Formula: VNA data + atten + free-space loss = Path Loss

5.4 NIST Building 27

Location and Notes	Test Point	VNA Loss Data (dB)	Path Loss @700 MHz (dB)	RMS Delay Spread @700 MHz (ns)	908 MHz PASS	908 MHz PASS w/ repeater	450 MHz PASS
Building 27 Notes: - No PASS tests yet.	1LOS	47.26	108.65	228.20	-	-	-
	2LOS	30.18	91.56	18.40	-	-	-
	3LOS	22.89	84.27	13.36	-	-	-
	1NLOS	48.43	109.82	-	-	-	-
	2NLOS	35.61	97.00	15.88	-	-	-
	3NLOS	21.17	89.55	11.71	-	-	-

O = Alarm received

D = Alarm received with Delay

X = Alarm not received

Measurement details

Calibration Attenuator: 40 dB for the high bands, 20 dB for the low bands

Reference measurement distance: 4 m (ref. from OATS => 20 dB atten)

Formula: VNA data + atten + free-space loss = Path Loss

5.5 NIST Building 24 Outside-to-Inside:

Location and Notes	Test Point	VNA Loss Data (dB)	Path Loss @700 MHz (mean of 9) (dB)	RMS Delay Spread @700 MHz (mean of 9) (ns)	908 MHz PASS	908 MHz PASS w/ repeater	450 MHz PASS
NIST Bldg	1	37.65	99.03	39.46	O	O	O

24 Notes: - Path Loss and RMS Delay calculated with TX outdoors. - System 1 repeater at test point 2.	2	46.55	107.93	NaN	O	O	O
	3	53.16	114.54	NaN	O	O	O
	4	–	–	NaN	X	O	O
	5	–	–	NaN	X	D	X
	6	–	–	NaN	X	D	X
	7	–	–	NaN	X	O	X
	8	52.81	114.19	NaN	D	D	X
	9	51.90	113.28	NaN	X	D	X
	10	–	–	NaN	X	O	X

O = Alarm received

D = Alarm received with Delay

X = Alarm not received

NIST Building 24 Inside-to-Inside:

Location and Notes	Test Point	VNA Loss Data (mean of 9) (dB)	Path Loss @700 MHz (mean of 9) (dB)	RMS Delay Spread @700 MHz (mean of 9) (ns)	908 MHz PASS (Data from TX outdoors)	908 MHz PASS w/ repeater (Data from TX outdoors)	450 MHz PASS (Data from TX outdoors)
NIST Bldg 24 Notes: - Path Loss and RMS Delay calculated with TX indoors. - System 1 repeater at test point 2.	1	56.29	77.67	41.25	O	O	O
	2	42.72	64.10	33.88	O	O	O
	3	48.47	69.85	35.44	O	O	O
	4	55.50	76.88	35.44	X	O	O
	5	63.36	84.74	NaN	X	D	X
	6	–	–	–	X	D	X
	7	–	–	–	X	O	X
	8	49.16	70.54	41.44	D	D	X
	9	55.05	76.43	25.89	X	D	X
	10	62.02	83.40	NaN	X	O	X

Measurement details

Calibration attenuator: 40 dB for the high bands, 20 dB for the low bands

Ref measurement distance: 4 m (OATS => 20 dB atten): free-space loss=41.38 dB

Formula: VNA data + atten + free-space loss = Path Loss

5.6 NIST Building 1 Corridor:

Location and Notes	Test Point	VNA Loss Data (dB)	Path Loss @700 MHz (dB)	RMS Delay Spread @700 MHz (ns)	908 MHz PASS	908 MHz PASS w/ repeater	450 MHz PASS	
NIST Bldg 1 Corridor: Outside-Inside Notes: - TX inside in "Wing 4" - 908 MHz repeater at test point 8.	1	49.70	105.06	55.86	O	O	O	
	2	56.21	111.57	53.76	O	O	O	
	3	60.33	115.70	34.10	O	O	O	
	4	70.06	125.70	95.05	O	O	O	
	5	72.33	127.69	88.12	O	O	O	
	6	75.10	133.17	84.00	O	O	D	
	7	73.93	129.29	79.10	O	O	D	
	8	77.80	133.17	72.41	O	O	X	
	9	74.11	129.47	36.93	X	D	X	
	10	84.21	139.57	-	X	D	X	
	11	86.41	141.77	-	X	X	X	
	12	85.15	140.51	-	X	D	X	
	13	87.90	143.26	-	X	D	X	
	14	86.47	141.83	-	X	D	X	
	15					X	O	X
	16					O	O	X
	17					X	O	X
	18					X	O	X

O = Alarm receive

D = Alarm received with Delay

X = Alarm not received

Measurement Details

Calibration attenuator: 40 dB for the high bands, 20 dB for the low bands

Reference measurement distance: 2 m => free-space loss @ 700 MHz = 35.36 dB

Formula: VNA data + atten + free-space loss = Path Loss

5.7 Colorado Convention Center

Location and Notes	Test Point	VNA Loss Data (dB)	Path Loss @1 GHz (dB)	RMS Delay Spread @ 1 GHz (ns)	908 MHz PASS	908 MHz PASS w/ repeater	450 MHz PASS
Colorado Convention Center Notes: - 450 MHz system tested only.	1	24.65	97.57	85.56	–	–	O
	2	26.92	103.65	68.19	–	–	X/O
	3	37.47	113.03	79.60	–	–	O
	4	55.00	123.16	159.31	–	–	O
	5	73.05	137.04	180.61	–	–	D
	6	82.61	137.07	128.77	–	–	X
	7	91.11	137.51	0	–	–	X
	8	91.35	137.58	0	–	–	X
	9	91.74	137.31	0	–	–	X
	10	92.29	137.47	0	–	–	X
	11	91.81	137.52	0	–	–	X

O = Alarm received

D = Alarm received with Delay

X = Alarm not received

Measurement details

Note: Data shown is for 1 to 1.2 GHz band, horn antenna to omnidirectional antenna

Calibration attenuator: 30 dB for the high bands, 10 dB for the low bands

Reference measurement distance: 3 m

Formula: VNA data + atten + free-space loss = Path Loss

6.0 Path Loss

Free space path loss:

$$PL = 10 * \log_{10} \left[\left(\frac{\lambda}{4\pi d} \right)^2 \right] (dB),$$

where

$$\lambda = c/f,$$

f = carrier frequency (Hz)

c = speed of light, 3e8 m/s

At 700 MHz:

2 m: PL = 35.36 dB

3 m: PL = 38.89 dB

4 m: PL = 41.38 dB

1982-6 Log #17 FAE-ELS
(2.3.1)

Final Action: Accept in Principle

Submitter: John F. Bender, Underwriters Laboratories Inc.

Recommendation: Revised text as follows:

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*, 2006, Revised 2010.

ANSI B46.1, Surface Texture, 1978

ANSI S1.13, Methods for Measurement of Sound Pressure Level®, 2005.

ANSI Y1.1, Abbreviations for Use on Drawings and Text, 1972.

ANSI Y14.SM, Dimensioning and Tolerancing, 1982.

Substantiation: Reason: Update referenced standard to most recent revision.

Committee Meeting Action: Accept in Principle

See Committee Action on Proposal 1982-5 (Log #10).

Committee Statement: See Committee Statement on Proposal 1982-5 (Log #10).

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

1982-7 Log #16 FAE-ELS
(3.3.2 Annunciator)

Final Action: Accept in Principle

Submitter: Glossary of Terms Technical Advisory Committee,

Recommendation: The Glossary of Terms Committee requests that the term "Annunciator" used in NFPA 1982 be changed to "Pass Annunciator" or "Audible Alert Component" .

~~Annunciator.~~ Pass annunciator. The component designed to emit audible signals.

or ~~Annunciator.~~ Audible Alert Component. The component designed to emit audible signals.

Substantiation: NFPA 72, 730, and 731 all use the term Annunciator for a different application and changing the term in 1982 would eliminate confusion.

Your technical committee has the following options:

- a) Adopt the preferred definition
- b) Modify the term to make it unique
- c) Request that the Standards Council reassign responsibility for the term
- d) Request that the standards council authorize a second *preferred* definition

Committee Meeting Action: Accept in Principle

Revise definition to read as follows:

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

Committee Statement: The technical committee accepted the recommendation of the Glossary of Terms TAC, and is utilizing the term "PASS Annunciator."

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

1982-8 Log #14 FAE-ELS
(5.1.8)

Final Action: Reject

Submitter: Craig Gestler, Mine Safety Appliances Company

Recommendation: Delete 5.1.8 and replace with:

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 II hazardous locations specified in ANSI/ISA-12.12.01, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*,

Substantiation: A change to the Division to which a PASS device is certified to in section 7.6 would require a change to the applicable labeling requirements. This proposal is valid only if section 7.6 is changed from requiring a Div. 1 approval to requiring a Div. 2 approval.

Committee Meeting Action: Reject

Committee Statement: The technical committee rejected the proposal. The TC accepted the report of the IS task group presented at the TC meeting in San Diego January 13-14, 2011 which recommended that no change be made.

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

1982-9 Log #12 FAE-ELS
(Chapter 6 through 8)

Final Action: Reject

Submitter: Kate A. Remley, National Institute of Standards and Technology (NIST)

Recommendation: Add text to read as follows:

****Insert include 1982_L12_R.doc here****

Substantiation: RF-based PASS have been recently made available commercially. The 2007 Edition of NFPA does not include methods to test or verify the performance of RF.-based PASS. The proposal includes proposed language, definitions, performance metrics, and test methods for RF-based PASS for possible inclusion in NFPA standard 1982.

Committee Meeting Action: Reject

Committee Statement: The technical committee rejected the proposal. See Committee Proposal 1982-3 (Log #CP2).

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

Chapter 6: Design Requirements

6.1.2.5 PASS that, in addition to emitting audible alarms, transmit and receive alarm signals through the use of a modulated radio-frequency carrier shall be designated as *RF-based PASS*. The *RF-based PASS* designation may be used in conjunction with any of the designators given in 6.1.2.2 through 6.1.2.4.

6.1.2.5.1 The RF-based PASS shall consist of a wireless transceiver contained within the user-worn PASS unit and a base station transceiver that may be self-contained or designed to operate in conjunction with a portable computer. The base station unit must be capable of battery operation for up to one hour under alarm conditions. The use of repeaters is not precluded as long as their use does not introduce undue latency (delay in transmission or reception) into the system.

6.1.2.5.2 The base station shall be designed to emit an audible alarm when the *alarm signal* described in 6.4.3 is activated by the user-worn RF-based PASS unit.

6.1.2.5.3 Both user-worn PASS unit and base station must comply with FCC regulations for radio-frequency transmissions for the frequency of operation and transmission format chosen by the manufacturer.

6.1.2.5.4 Antennas and/or other peripheral electronic components designed for use with RF-based PASS shall not interfere with or impede firefighting operations.

6.1.2.5.5 Software used in conjunction with RF-based PASS units shall be updated as necessary within six months by the manufacturer for newly released versions of the computer operating system for which the software was designed.

6.2.1.5.6 Data logging may be carried out via the RF-based PASS system base station based on RF transmissions from the body-worn RF PASS.

Chapter 7: Performance Requirements

7.1.2.1.1 The RF-based PASS base station shall be tested for sound pressure level of *alarm signal* as specified in Section 8.2, Sound Pressure Level Tests, and shall not have the alarm signal, once activated, be deactivated unless the PASS is reset.

7.15 RF-based PASS shall be tested for reliable wireless transmission and reception of alarm signals as specified in Section 8.18, Radio System Tests for RF-Based PASS.

7.15.1 RF-based PASS base station shall automatically emit an alarm signal in response to an alarm signal received from the user-worn RF-based PASS within 30 seconds of alarm activation under the radio channel conditions specified in Section 8.18. The user-worn RF-based PASS shall automatically emit an audible alarm within 30 seconds of alarm activation by the base station under the radio channel conditions specified in Section 8.18.

7.15.2 RF-based PASS shall be tested in conjunction with the model of base station with which it is intended to be deployed.

7.15.3 The **Attenuation Test** is conducted to determine whether the user-worn PASS will operate in an RF propagation channel having a specified level of attenuation. The level of attenuation shall be chosen to replicate that expected in certain firefighting conditions, as determined in the informational Appendix “NIST Tests of Representative Radio Propagation Environments to Support Development of Standards for RF-Based PASS.”

7.15.3.1 The attenuation test is conducted with the base station acting as the receiver and the user-worn PASS acting as the transmitter. This configuration is tested because the user-worn PASS generally transmits at a lower power level than the base station to conserve batteries and thus represents the weaker RF link in the system.

7.15.3.2 The attenuation classifications to be used for the attenuation test shall correspond to a total path loss (free space path loss + external attenuation + cable and connector loss) as specified in the table below.

Table 7.15.3.2: Classification of environments for attenuation test.

Classification	Attenuation (dB)	Typical structures
Low	Less than 100	Houses, small buildings with exterior-facing rooms
Medium	100 to 150	Moderate-sized and tall structures with some interior rooms
High	Over 150	Very large structures and those with subterranean floors

Chapter 8: Test Methods

Section 8.18 Radio System Tests for RF-Based PASS – Attenuation Test

8.18.1 Application. This test method shall apply to all RF-based PASS systems.

8.18.2 Samples.

8.18.2.1 Samples 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 systems

8.18.3.2 A single RF-based PASS and a single base station are used in each test. Three different units shall be tested, for a total of nine tests.

8.18.3.3 The repeaters for RF-based PASS that use repeaters, shall additionally be tested as described in future revisions of this standard.

8.18.4 Test Apparatus

8.18.4.1 The attenuation test is conducted with the base station placed in a shielded test chamber. The shielded chamber shall have a minimum of 110 dB of isolation below 1 GHz and 100 dB above 1 GHz. Manufacturer's certification of shielding is satisfactory. The test chamber may be reflective or anechoic because conducted tests are to be carried out in the test chamber.

8.18.4.2 The room in which the shielded chamber is located shall be constructed of standard building materials rather than highly reflective metal walls. Its suitability will be determined in Section 8.18.5.3.

8.18.4.3 The base station and PASS unit shall be configured as shown in Figure 8.18.4.3. The base station, rather than the user-worn PASS, is placed in the shielded chamber to minimize the effect of reflections on the radiation pattern of the user-worn PASS antenna.

8.18.4.4 Separate tests shall be conducted for every RF-based PASS antenna set-up and amplifier configuration, if applicable.

8.18.4.5 Unused bulkhead connectors on the shielded chamber shall be terminated in short circuits.

8.18.4.6 RF connectors shall be tightened using a appropriate torque wrench.

******Insert Artwork here******

(a)

******Insert Artwork here******

(b)

Figure 8.18.4.3: Test apparatus set up for the Attenuation Test method.

8.18.4.5 Test set-up within the shielded chamber

8.18.4.5.1 The base station and control computer, if applicable, shall operate on batteries to eliminate coupling of RF signals into the shielded chamber on the power lines.

8.18.4.5.2 For RF-based PASS systems with separate transmit and receive antenna ports, the base station transmit antenna shall be left intact (that is, not terminated in a non-radiating load) in case coupling of RF energy occurs through that antenna port. This represents the most realistic use case.

8.18.4.5.3 The base station receive antenna shall be connected through a shielded 50 Ω coaxial cable to a 50 Ω fixed attenuator of a minimum of 30 dB. The fixed attenuator shall be connected to a 50 Ω variable RF attenuator that operates in 1 dB steps over a minimum 10 dB range, and the variable attenuator shall be connected to a feedthrough bulkhead connector on the shielded test chamber using a shielded 50 Ω coaxial cable. Type N, SMA, or higher-frequency connectors shall be used for all connections. An RF adapter may be used at the antenna port of the base station only.

The value of 30 dB for the fixed attenuator was chosen to protect the variable attenuator from damage for PASS base stations that have a single transmit/receive antenna port, but small enough that the majority of the external attenuation remains outside the test chamber, limiting the received RF energy inside. The operator shall ensure that the power rating on the 30 dB attenuator is sufficient to prevent damage of the attenuator when the RF-PASS base station is operated. The same cables shall be used in each of the nine tests of the PASS system.

8.18.4.5.4 For the case of RF-based PASS systems that utilize multiple receive antennas, each antenna port shall be connected to the shielded chamber's bulkhead connectors as described above using identical set-ups: The cables shall be made by the same manufacturer, of the same model, length, and connector type (N, SMA, or higher-frequency). The variable attenuators shall be of the same model.

8.18.4.6 Test set-up for the receive antennas outside the shielded chamber

8.18.4.6.1 A metallic ground plane fixture containing a sufficient number of chassis-mount connectors to accommodate the receive antennas from the base station shall be fabricated. The receive antennas to be used with the base station unit shall be connected to the chassis-mount RF connector on the top side of the metallic ground plane. The ground plane shall have a surface area within 120% of the top surface area of the base station unit for antennas mounted directly to the base station unit, and no larger than 1 m square for antennas intended to magnetically mount on a vehicle. Magnetically mounted antennas shall be attached to the metallic ground plane and the RF cables shall be attached to the chassis-mount connectors described above. Pole mounted or other self-contained antennas shall not be attached to the metallic ground plane.

8.18.4.6.2 The receive antennas, including the metallic ground plane fixture, if applicable, shall be mounted to a dielectric tripod or other stable base made of non-metallic, non-conducting

parts. The height of the base shall be 1.5 meters to approximate the height of a firefighter. The tripod or other base shall be placed at least 1 meter from the shielded chamber to minimize chamber/antenna interactions.

8.18.4.6.3 The chassis-mount connectors on the base of the metallic ground plane shall be connected to fixed attenuators having type N or SMA connectors. One RF adapter may be used between the chassis-mount connector and the attenuator. Multiple attenuators may be used to obtain the specified level of attenuation. The fixed attenuators shall be placed outside the test chamber in order to reduce the RF signal level in the test chamber.

8.18.4.6.4 The fixed attenuators shall be connected to the shielded test chamber's bulkhead connectors by a shielded 50 Ω coaxial cable having type N, SMA, or higher-frequency connectors.

8.18.4.6.5 For the case of PASS systems using multiple receive antennas, each antenna/attenuator assembly shall be connected to the shielded chamber's bulkheads as described above using identical set-ups: The cables shall be made by the same manufacturer, of the same model, length, and connector type. The attenuators shall be from the same manufacturer, have the same value, and be of the same model.

8.18.4.7 Test set-up for the user-worn RF-based PASS outside the shielded chamber

8.18.4.7.1 The RF-based PASS shall be mounted to a non-metallic, dielectric tripod or other stable base placed 3 meters from the receive antenna. The 3 m distance shall be measured from the base of the receive antenna to the base of the RF-based PASS.

8.18.4.7.2 The antenna on the user-worn RF-based PASS shall be oriented in the same direction as the receive antenna(s).

8.18.5 Procedure.

8.18.5.1 Repeatability. A minimum of three repeat measurements shall be conducted. For each repeat, the tripod or other base that supports the RF-based PASS device shall be moved and repositioned to the same location. The base station shall be powered down and restarted.

8.18.5.1.1 The base station and RF-based PASS shall establish wireless communication, by, for example, leaving the door of the chamber open or reducing the level of the variable attenuator within the chamber. The door or covering of the chamber shall then be closed and sealed.

8.18.5.1.2 The RF-based PASS shall be mounted on the transmit test base and alarm condition initiated. If the base station receives the alarm, the test chamber shall be opened, the base station alarm reset, the attenuation increased. The test procedure shall be repeated until the alarm is not received by the base station. This value of attenuation shall be noted.

8.18.5.2.3 If the level of attenuation required to cause the base station to fail to receive the alarm signal differs by more than 2 dB from one repeat test to another, the operator shall determine

why. The repeatability may be improved, for example, by reducing the level of reflectivity in the room containing the test chamber or by improving the shielding of the test chamber.

8.18.5.2 Attenuation Test. A minimum of three repeat attenuation tests shall be conducted for each RF-based PASS unit.

8.18.5.2.1 A total attenuation corresponding to the classification for which the RF-based PASS is to be certified, as specified in Table 7.15.3.2, shall be inserted between the user-worn RF-based PASS and the RF-based PASS base station. The total attenuation consists of a summation of the cable and connector losses in the test set-up (to be measured and noted by the operator), the summation of all external attenuators inserted, and the free space path loss calculated for a 3 m distance at the frequency of operation. The free-space path loss (PL) is given by:

Free space path loss:

$$PL = 10 * \log_{10}[(\lambda/4\pi d)^2] \text{ (dB)},$$

where

$$\lambda = c/f,$$

f = carrier frequency (Hz)

c = speed of light, 3×10^8 m/s

Typical values of free space path loss at 700 MHz are:

2 m: PL = 35.36 dB

3 m: PL = 38.89 dB

4 m: PL = 41.38 dB

In summary:

Total attenuation = Cable Loss + Connector Loss + Free-space Path Loss at 3 m + External Attenuators

8.18.5.2.2 The base station and RF-based PASS shall establish wireless communication, by, for example, leaving the door of the chamber open or reducing the level of the variable attenuator within the chamber. The door or covering of the chamber shall then be closed and sealed.

8.18.5.2.3 The RF-based PASS shall be mounted on the transmit test base and alarm condition initiated. The operator shall note whether the alarm was received by the RF-based PASS base station.

8.18.6 Report.

8.18.6.1 All quantities shall be reported to the nearest decibel.

8.18.6.2 The operator shall note the results of the three repeatability tests specified in 8.18.5.1.

8.18.6.3. The operator shall note the results of the three attenuation tests, including the values of (1) Cable loss + connector loss, (2) Free-space path loss at 3 m for the frequency of operation (3)

Value of external attenuators used (4) Frequency of operation (the minimum and maximum operating frequencies utilized).

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 this test shall constitute failing performance.

1982-10 Log #8 FAE-ELS
(6.1)

Final Action: Reject

Submitter: Jack Jarobe, Grace Industries Inc.

Recommendation: Add new text as follows:

All PASS, shall incorporate, as part of the system:

1. Two way distress/evacuation, individual/team/mass evacuation notification
2. Electronic personnel accountability
3. Person to person local distress notification
4. Automatic electronic PAR checks and Automatic electronic Roll Call

Substantiation: During the development of the 2007 Edition of the PASS Standard, the Technical Committee seriously considered including electronic distress and evacuation signaling as part of the minimum requirements for the Standard. However, in the absence of appropriate test methods to determine the reliability of these features they were placed in the ANNEX of the 2007 Edition.

Recently, NIST made a presentation at the NFPA ESE TC which showed that they have developed the appropriate testing criteria to determine the reach and penetration of RF Signaling. A number of manufacturers currently offer products that meet or exceed the features submitted in this proposal. Having commercial products readily available would allow for these new tests to be validated.

Each year an average of 105 fire fighters die in the line of duty. To address this continuing national occupational fatality problem, NIOSH conducts independent investigations of fire fighter line of duty deaths. These excellent reports are very comprehensive and offer specific recommendations to improve firefighter safety.

I carefully reviewed every LODD report posted for the past 10 years (period of December 22, 1999 through February 19, 2009) and discovered many of the same reoccurring problems we continue to see year after year. Fifty two Firefighters died in the line of duty during the forty incidents selected for this proposal. Had the proposed technology been in place during this period many, if not most, of these deaths could have been avoided. The four features included in this proposal are supported by recommendations made by NIOSH Investigators: The most redundant recommendations germane to this proposal are as follows:

- *Ensure that fire command always maintains close accountability for all personnel at the fire scene*
- *Consider ways to enhance the effectiveness of the personnel accountability system*
- *Ensure personnel accountability reports (PAR) are conducted in an efficient, organized manner and results are reported directly to the IC*
- *Use evacuation signals when command personnel decide that all fire fighters should be evacuated from a burning building or other hazardous area*
- *Instruct and train fire fighters on initiating emergency traffic (Mayday-Mayday) and on the importance of activating their personal alert safety system (PASS) device when they become lost, disoriented, or trapped*

The 40 incidents where these 52 Firefighters perished are included in this proposal review. I did not include the incident at the World Trade Center on September 11, 2001. However, I did speak with Fire Chief Hayden approximately six months following the incident.

He told me that they could not get an Evacuation message to the Firefighters in the second tower because the Aircraft had taken out the repeaters necessary for both "Evac and Mayday" distress signaling. The technology available today for "Distress and Evac signaling" comes with self contained repeaters dedicated solely for that purpose. They would not rely on or interfere with radio systems used by the fire or EMS operations.

Had the Command Staff had the benefit of technology which allowed for pushing one button to initiate a "Mass Evacuation", all of the Firefighters in that tower had a very good chance of surviving. This technology is readily available today through a number of manufacturers. It has proven track record for the desired performance in "Super High Rise Buildings"

The following incidents were cut and pasted from the official NIOSH Line of Duty Death investigations for the period of December 22, 1999 to February 19, 2009. You can access these reports by going to www.cdc.gov/niosh/fire.

F2009-07 Feb 19, 2009 Volunteer lieutenant and a fire fighter die while combating a mobile home fire - West Virginia

F2008-34 Oct 29, 2008 Volunteer fire fighter dies while lost in residential structure fire - Alabama

F2008-26 Jul 22, 2008 A volunteer mutual aid fire fighter dies in a floor collapse in a residential basement fire - Illinois

F2008-20 May 06, 2007 Volunteer fire fighter dies while performing exterior fire suppression at a large machine shed fire - Illinois

F2008-09 Apr 08, 2008 A career captain and a part-time fire fighter die in a residential floor collapse - Ohio

- F2008-08 Mar 05, 2008 Volunteer fire lieutenant killed while fighting a basement fire - Pennsylvania
- F2008-07 Mar 07, 2008 Two career fire fighters die and captain is burned when trapped during fire suppression operations at a millwork facility - North Carolina
- F2008-06 Feb 29, 2008 Volunteer fire fighter and trapped resident die and a volunteer lieutenant is injured following a duplex fire - Pennsylvania
- F2008-03 Feb 22, 2008 Nine fire fighters from a combination department injured in an explosion at a restaurant fire - Colorado
- F2007-35 Oct 29, 2007 Four career fire fighters injured while providing interior exposure protection at a row house fire - District of Columbia
- F2007-32 Aug 29, 2007 Two career fire fighters die while making initial attack on a restaurant fire - Massachusetts
- F2007-29 Aug 03, 2007 A volunteer mutual aid captain and fire fighter die in a remodeled residential structure fire - Texas
- F2007-28 Jul 21, 2007 A career captain and an engineer die while conducting a primary search at a residential structure fire - California
- F2007-18 Jun 18, 2007 Nine career fire fighters die in rapid fire progression at commercial furniture showroom - South Carolina
- F2007-09 Feb 09, 2007 Career probationary fire fighter dies while participating in a live-fire training evolution at an acquired structure - Maryland
- F2007-02 Nov 23, 2006 Career fire fighter injured during rapid fire progression in an abandoned structure dies six days later - Georgia
- F2006-24 Jun 25, 2006 Volunteer deputy fire chief dies after falling through floor hole in residential structure during fire attack - Indiana
- F2005-04 Jan 23, 2005 Career fire fighter dies while exiting residential basement fire - New York
- F2005-03 Jan 23, 2005 Career lieutenant and career fire fighter die and four career fire fighters are seriously injured during a three alarm apartment fire - New York
- F2005-02 Dec 20, 2004 One probationary career firefighter dies and four career firefighters are injured at a two - alarm residential structure fire - Texas
- F2004-37 Apr 08, 2004 Volunteer chief dies and two fire fighters are injured by a collapsing church facade - Tennessee
- F2004-17 Mar 13, 2004 Career battalion chief and career master fire fighter die and twenty-nine career fire fighters are injured during a five alarm church fire - Pennsylvania
- F2004-10 Feb 18, 2004 Career fire fighter dies searching for fire in a restaurant/lounge - Missouri
- F2004-04 Dec 16, 2003 Career fire fighter dies of carbon monoxide poisoning after becoming lost while searching for the seat of a fire in warehouse - New York
- F2004-02 Nov 29, 2003 Basement fire claims the life of volunteer fire fighter - Massachusetts
- F2002-12 Mar 01, 2002 Volunteer fire fighter killed and career chief injured during residential house fire - Tennessee
- F2002-07 Feb 11, 2002 One career fire fighter dies and another is injured after partial structural collapse - Texas
- F2002-06 Mar 07, 2002 First-floor collapse during residential basement fire claims the life of two fire fighters (career and volunteer) and injures a career fire fighter captain - New York
- F2001-33 Oct 13, 2001 High-rise apartment fire claims the life of one career fire fighter (captain) and injures another career fire fighter (captain) - Texas
- F2001-18 May 09, 2001 Career fire fighter dies after becoming trapped by fire in apartment building - New Jersey
- F2001-16 Mar 08, 2001 Career fire fighter dies after falling through the floor fighting a structure fire at a local residence - Ohio
- F2001-15 Mar 18, 2001 Residential fire claims the lives of two volunteer fire fighters and seriously injures an assistant chief - Missouri
- F2001-13 Mar 14, 2001 Supermarket fire claims the life of one career fire fighter and critically injures another career fire fighter - Arizona
- F2001-08 Feb 17, 2001 Two volunteer fire fighters die fighting a basement fire - Illinois
- F2000-44 Nov 25, 2000 Residential house fire claims the life of one career fire fighter - Florida
- F2000-26 Apr 20, 2000 Residential structure fire claims the life of one career fire fighter - Alabama
- F2000-23 Mar 31, 2000 Career fire fighter dies and three are injured in a residential garage fire - Utah
- F2000-16 Mar 03, 2000 Arson fire claims the life of one volunteer fire fighter and one civilian and severely injures another volunteer fire fighter - Michigan
- F2000-13 Feb 14, 2000 Restaurant fire claims the life of two career fire fighters - Texas
- F2000-04 Dec 22, 1999 Structure fire claims the lives of three career fire fighters and three children - Iowa

This is not original material; its reference/source is as follows:

Statistical information on Line of Duty Deaths was cut and pasted from the official NIOSH LODD Investigation Web Site at: www.cdc.gov/niosh/fire.

Committee Meeting Action: Reject

Committee Statement: See Committee Proposal 1982-3 (Log #CP3).

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

1982-11 Log #9 FAE-ELS
(6.1)

Final Action: Reject

Submitter: Jack Jarboe, Grace Industries Inc.

Recommendation: New text to read as follows:

All PASS, shall incorporate, as part of the system:

1. Two way distress/evacuation, individual/team/mass evacuation notification
2. Electronic personnel accountability
3. Person to person local distress notification
4. Automatic electronic PAR checks and automatic electronic Roll Call

Substantiation: NFPA Standard 1982 2012 Edition (Numbering for the PASS Standard is being changed to 1882 to conform with the Technical Committee on Electronic Safety Systems Documents)

Chapter 6 Design Requirements

6.1 General Design Requirements for PASS

Insert the following language:

All PASS, shall incorporate, as part of the system:

- (1) Two way distress/evacuation, individual/team/mass evacuation notification
- (2) Electronic personnel accountability
- (3) Person to person local distress notification
- (4) Automatic electronic PAR checks and Automatic electronic Roll Call

Substantiation:

During the development of the 2007 Edition of the PASS Standard, the Technical Committee seriously considered including electronic distress and evacuation signaling as part of the minimum requirements for the Standard. However, in the absence of appropriate test methods to determine the reliability of these features they were placed in the ANNEX of the 2007 Edition.

Recently, NIST made a presentation at the NFPA ESE TC which showed that they have developed the appropriate testing criteria to determine the reach and penetration of RF Signaling. A number of manufacturers currently offer products that meet or exceed the features submitted in this proposal. Having commercial products readily available would allow for these new tests to be validated.

Each year an average of 105 fire fighters die in the line of duty. To address this continuing national occupational fatality problem, NIOSH conducts independent investigations of fire fighter line of duty deaths. These excellent reports are very comprehensive and offer specific recommendations to improve firefighter safety.

I carefully reviewed every LODD report posted for the past 10 years (period of December 22, 1999 through February 19, 2009) and discovered many of the same reoccurring problems we continue to see year after year. Fifty two Firefighters died in the line of duty during the forty incidents selected for this proposal. Had the proposed technology been in place during this period many, if not most, of these deaths could have been avoided. The four features included in this proposal are supported by recommendations made by NIOSH Investigators: The most redundant recommendations germane to this proposal are as follows:

- Ensure that fire command always maintains close accountability for all personnel at the fire scene
- Consider ways to enhance the effectiveness of the personnel accountability system
- Ensure personnel accountability reports (PAR) are conducted in an efficient, organized manner and results are reported directly to the IC
- Use evacuation signals when command personnel decide that all fire fighters should be evacuated from a burning building or other hazardous area
- Instruct and train fire fighters on initiating emergency traffic (Mayday-Mayday) and on the importance of activating their personal alert safety system (PASS) device when they become lost, disoriented, or trapped

The 40 incidents where these 52 Firefighters perished are included in this proposal review. I did not include the incident at the World Trade Center on September 11, 2001. However, I did speak with Fire Chief Hayden approximately six months following the incident.

He told me that they could not get an Evacuation message to the Firefighters in the second tower because the Aircraft had taken out the repeaters necessary for both "Evac and Mayday" distress signaling. The technology available today for "Distress and Evac signaling" comes with self contained repeaters dedicated solely for that purpose. They would not rely on or interfere with radio systems used by the fire or EMS operations.

Had the Command Staff had the benefit of technology which allowed for pushing one button to initiate a "Mass Evacuation", all of the Firefighters in that tower had a very good chance of surviving. This technology is readily available

today through a number of manufacturers. It has proven track record for the desired performance in "Super High Rise Buildings"

The following incidents were cut and pasted from the official NIOSH Line of Duty Death investigations for the period of December 22, 1999 to February 19, 2009. You can access these reports by going to www.cdc.gov/niosh/fire

F2009-07—Feb 19, 2009—Volunteer lieutenant and a fire fighter die while combating a mobile home fire - West Virginia

F2008-34—Oct 29, 2008—Volunteer fire fighter dies while lost in residential structure fire - Alabama

F2008-26—Jul 22, 2008—A volunteer mutual aid fire fighter dies in a floor collapse in a residential basement fire - Illinois

F2008-20—May 06, 2007—Volunteer fire fighter dies while performing exterior fire suppression at a large machine shed fire - Illinois

F2008-09—Apr 08, 2008—A career captain and a part-time fire fighter die in a residential floor collapse - Ohio

F2008-08—Mar 05, 2008—Volunteer fire lieutenant killed while fighting a basement fire - Pennsylvania

F2008-07—Mar 07, 2008—Two career fire fighters die and captain is burned when trapped during fire suppression operations at a millwork facility - North Carolina

F2008-06—Feb 29, 2008—Volunteer fire fighter and trapped resident die and a volunteer lieutenant is injured following a duplex fire - Pennsylvania

F2008-03—Feb 22, 2008—Nine fire fighters from a combination department injured in an explosion at a restaurant fire - Colorado

F2007-35—Oct 29, 2007—Four career fire fighters injured while providing interior exposure protection at a row house fire - District of Columbia

F2007-32—Aug 29, 2007—Two career fire fighters die while making initial attack on a restaurant fire - Massachusetts

F2007-29—Aug 03, 2007—A volunteer mutual aid captain and fire fighter die in a remodeled residential structure fire - Texas

F2007-28—Jul 21, 2007—A career captain and an engineer die while conducting a primary search at a residential structure fire - California

F2007-18—Jun 18, 2007—Nine career fire fighters die in rapid fire progression at commercial furniture showroom - South Carolina

F2007-09—Feb 09, 2007—Career probationary fire fighter dies while participating in a live-fire training evolution at an acquired structure - Maryland

F2007-02—Nov 23, 2006—Career fire fighter injured during rapid fire progression in an abandoned structure dies six days later - Georgia

F2006-24—Jun 25, 2006—Volunteer deputy fire chief dies after falling through floor hole in residential structure during fire attack - Indiana

F2005-04—Jan 23, 2005—Career fire fighter dies while exiting residential basement fire - New York

F2005-03—Jan 23, 2005—Career lieutenant and career fire fighter die and four career fire fighters are seriously injured during a three alarm apartment fire - New York

F2005-02—Dec 20, 2004—One probationary career firefighter dies and four career firefighters are injured at a two - alarm residential structure fire - Texas

F2004-37—Apr 08, 2004—Volunteer chief dies and two fire fighters are injured by a collapsing church facade - Tennessee

F2004-17—Mar 13, 2004—Career battalion chief and career master fire fighter die and twenty-nine career fire fighters are injured during a five alarm church fire - Pennsylvania

F2004-10—Feb 18, 2004—Career fire fighter dies searching for fire in a restaurant/lounge - Missouri

F2004-04—Dec 16, 2003—Career fire fighter dies of carbon monoxide poisoning after becoming lost while searching for the seat of a fire in warehouse - New York

F2004-02—Nov 29, 2003—Basement fire claims the life of volunteer fire fighter - Massachusetts

F2002-12—Mar 01, 2002—Volunteer fire fighter killed and career chief injured during residential house fire - Tennessee

F2002-07—Feb 11, 2002—One career fire fighter dies and another is injured after partial structural collapse - Texas

F2002-06—Mar 07, 2002—First-floor collapse during residential basement fire claims the life of two fire fighters (career and volunteer) and injures a career fire fighter captain - New York

F2001-33—Oct 13, 2001—High-rise apartment fire claims the life of one career fire fighter (captain) and injures another career fire fighter (captain) - Texas

F2001-18—May 09, 2001—Career fire fighter dies after becoming trapped by fire in apartment building - New Jersey

F2001-16—Mar 08, 2001—Career fire fighter dies after falling through the floor fighting a structure fire at a local residence - Ohio

F2001-15—Mar 18, 2001—Residential fire claims the lives of two volunteer fire fighters and seriously injures an assistant chief - Missouri
F2001-13—Mar 14, 2001—Supermarket fire claims the life of one career fire fighter and critically injures another career fire fighter - Arizona
F2001-08—Feb 17, 2001—Two volunteer fire fighters die fighting a basement fire - Illinois
F2000-44—Nov 25, 2000—Residential house fire claims the life of one career fire fighter - Florida
F2000-26—Apr 20, 2000—Residential structure fire claims the life of one career fire fighter - Alabama
F2000-23—Mar 31, 2000—Career fire fighter dies and three are injured in a residential garage fire - Utah
F2000-16—Mar 03, 2000—Arson fire claims the life of one volunteer fire fighter and one civilian and severely injures another volunteer fire fighter - Michigan
F2000-13—Feb 14, 2000—Restaurant fire claims the life of two career fire fighters - Texas
F2000-04—Dec 22, 1999—Structure fire claims the lives of three career fire fighters and three children - Iowa

Respectfully submitted,
Jack Jarboe, Vice President
Grace Industries Inc.
6430 Weems Ave
Tracys Landing, ND 20779
jackjarboepsc@comcast.net
(w)443-964-8282

This is not original material; its reference/source is as follows:
Statistical information on Line of Duty Deaths was cut and pasted from the official NIOSH LODD Investigation Web Site at: www.cdc.gov/niosh/fire.
Committee Meeting Action: Reject
Committee Statement: See Committee Proposal 1982-3 (Log #CP3).
Number Eligible to Vote: 22
Ballot Results: Affirmative: 22

1982-12 Log #7 FAE-ELS **Final Action: Reject**
(6.3)

Submitter: Kevin M. Roche, Phoenix Fire Dept., AZ
Recommendation: Revise text as follows:
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 PASS shall be permitted to sound the alarm signal specified in 6.4.3 when the PASS does not sense movement for 60 seconds +5/-0 seconds.
6.3.3 The alarm signal shall be preceded by a pre-alarm signal as specified in 6.4.2 that shall sound 10 seconds, +3/-0 seconds before the sounding of the alarm signal.
Substantiation: Most fire service SCBA are purchased with integrated PASS devices. The current standard requires pre-alert activation and alarm activation within 30 seconds when the PASS does not sense movement. This causes numerous pre-alerts and alarm activations when no emergency exists. Firefighters used to hearing inadvertent activations will be less likely to respond to an alarm activation for a firefighter in distress. Extending the time increment to 60 seconds will reduce unnecessary activations and improve firefighter safety. Extension of this time increment will have minimal impact on the time needed to locate and rescue a firefighter in distress.
Committee Meeting Action: Reject
Committee Statement: The technical committee rejected the proposal after significant discussion. The TC believes that the increase in time is offset by potential additional risks to a downed firefighter.
Number Eligible to Vote: 22
Ballot Results: Affirmative: 22

1982-13 Log #CP2 FAE-ELS

Final Action: Accept

(6.4.2.1, thru 6.4.3.9.3, 7.1.1 thru 7.1.2.2, 8.14.4.2, 8.14.6.1, 8.14.6.2)

Submitter: Technical Committee on Electronic Safety Equipment,

Recommendation: Revise text to read as follows:

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 In addition to the primary pre-alarm signal, other tones shall be permitted:~~

6.4.2.3 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 prealarm signals shall be variable in a continuous pattern or shall be recurrent.

6.4.2.3.2 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.

6.4.2.3.3 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.

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

6.4.2.9 Audible Primary Pre-alarm Signal

The PASS annunciator shall be driven by a pre-alarm sequence consisting of the following 3 steps:

A Type-1 tone pair

A Type-2 tone pair

A Type-3 tone pair

6.4.2.9.1 Type-1 tone pair. A Type-1 tone pair shall consist of a sound that alternates between two tones. The first tone shall be at a frequency of 1000 ± 1 Hz and shall have a duration of 500 ± 0.5 ms. The second tone shall be at a frequency of 1260 ± 1.26 Hz and shall have a duration of 500 ± 0.5 ms. The total duration of the Type-1 tone pair sound shall be 4.000 ± 0.004 seconds.

6.4.2.9.2 Type-2 tone pair. A Type-2 tone pair shall consist of a sound that alternates between two tones. The first tone shall be at a frequency of 1260 ± 1 Hz and shall have a duration of 250 ± 0.25 ms. The second tone shall be at a frequency of 1587 ± 2 Hz and shall have a duration of 250 ± 0.25 ms. The total duration of the Type-2 tone pair sound shall be 4.000 ± 0.004 seconds.

6.4.2.9.3 Type-3 tone pair. A Type-3 tone pair shall consist of a sound that alternates between two tones. The first tone shall be at a frequency of 1587 ± 2 Hz and shall have a duration of 125 ± 0.125 ms. The second tone shall be at a frequency of 2000 ± 2.00 Hz and shall have a duration of 125 ± 0.125 ms. The total duration of the Type-1 tone pair sound shall be 4.000 ± 0.004 seconds.

~~6.4.3.6 The alarm signal shall be audible in a variable or noncontinuous tone.~~

6.4.3.7 6 The alarm signal, once activated, shall not be deactivated by the motion detector.

6.4.3.8 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.

6.4.3.9 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 26 steps:

A Type-1 chirp

A silent interval of 500.0 ± 0.05 ms

A Type-2 chirp

A silent interval of 10.0 ± 0.001 ms

A Type-2 chirp

A silent interval of 10.0 ± 0.001 ms

A Type-2 chirp

A silent interval of 10.0 ± 0.001 ms

A Type-2 chirp

A silent interval of 500.0 ± 0.05 ms

A Type-3 chirp

A silent interval of 10.0 ± 0.001 ms

A Type-3 chirp

A silent interval of 10.0 ± 0.001 ms

A Type-3 chirp

A silent interval of 10.0 ± 0.001 ms

A Type-3 chirp

A silent interval of 10.0 ± 0.001 ms

A Type-3 chirp

A silent interval of 10.0 ± 0.001 ms

A Type-3 chirp

A silent interval of 10.0 ± 0.001 ms

A Type-3 chirp

A silent interval of 10.0 ± 0.001 ms

A Type-3 chirp

A silent interval of 1500.0 ± 0.15 ms

Following Step 26, the alarm sound shall repeat beginning immediately with Step 1.

6.4.3.9.1 Type-1 Chirp. The Type-1 chirp shall begin with a frequency of 4.000 ± 0.0004 KHz and shall sweep to a frequency of 2.000 ± 0.0002 KHz using the following method. The Type-1 chirp shall be a binary (on/off) signal consisting of sequential cycles whose period changes on a cycle-to-cycle basis. The first cycle shall have an on-period and an off-period of 125 ± 0.0125 microseconds. The second cycle shall have an on-period and an off-period of 125.2 ± 0.01252 microseconds. The on-period and off-period for each succeeding cycle shall continue to be increased by 0.2 ± 0.00002 microseconds until the last cycle, which shall have an on-period and an off-period of 250 ± 0.025 microseconds.

6.4.3.9.2 Type-2 Chirp. The Type-2 chirp shall begin with a frequency of 2.000 ± 0.0002 KHz and shall sweep to a frequency of 4.000 ± 0.0004 KHz using the following method. The Type-2 chirp shall be a binary (on/off) signal consisting of sequential cycles whose period changes on a cycle-to-cycle basis. The first cycle shall have an on-period and an off-period of 250 ± 0.025 microseconds. The second cycle shall have an on-period and an off-period of 249.8 ± 0.02498 microseconds. The on-period and off-period for each succeeding cycle shall continue to be decreased by 0.2 ± 0.00002 microseconds until the last cycle, which shall have an on-period and an off-period of 125 ± 0.0125 microseconds.

6.4.3.9.3 Type-3 Chirp. The Type-3 chirp shall begin with a frequency of 2.000 ± 0.0002 KHz and shall sweep to a frequency of 4.000 ± 0.0004 KHz using the following method. The Type-3 chirp shall be a binary (on/off) signal consisting of sequential cycles whose period changes on a cycle-to-cycle basis. The first cycle shall have an on-period and an off-period of 250 ± 0.025 microseconds. The second cycle shall have an on-period and an off-period of 249.6 ± 0.02496 microseconds. The on-period and off-period for each succeeding cycle shall continue to be decreased by 0.4 ± 0.00004 microseconds until the last cycle, which shall have an on-period and an off-period of 124.8 ± 0.01248 microseconds.

7.1.1 PASS 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, and the primary pre-alarm signal shall have an initial sound pressure level of 80 dBA to 95 dBA, shall have the sound pressure level increase in at least two distinct sound pressure level increments within 6 to 10 seconds to at least 100 dBA but not exceed 110 dBA, shall have the sound pressure level remain for an additional 3 to 5 seconds at or above 100 dBA but not exceed 110 dBA, shall have the entire primary pre-alarm signal not sound for more than 13 seconds, and shall have PASS function properly as specified in 6.4.2. The sound pressure level of the Type-1 tone pair shall be between 80 dBA and 95 dBA. The sound pressure level of the Type-2 tone pair shall be between 86 dBA and 104 dBA and shall be at least 6 dB greater than the Type-1 tone pair. The sound pressure level of the Type-3 tone pair shall be between 100 dBA and 110 dBA and shall be at least 6 dB 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, and shall have at least an audible signal, and shall have the primary prealarm as specified in Section 6.4.2.9. signal consist of a minimum of two primary frequencies, shall have each primary frequency not be less than 1000 Hz nor more than 2000 Hz, and shall have these frequencies sounded either sequentially or simultaneously.

7.1.1.2.2 PASS shall be tested for signal frequency as specified in Section 8.14, Signal Frequency Test, and shall have the alarm signal consist of a minimum of three primary frequencies, at least one of which shall be 500 Hz, ±20 Hz, and at least two other frequencies shall not be less than 1000 Hz nor more than 4000 Hz, and shall have these frequencies sounded either sequentially or simultaneously: frequency content as specified in Section 8.14 and shall have the alarm signal as specified in Section 6.4.3.9.

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.

8.14.4.3 A sampling digital oscilloscope connected to a microphone shall be used to measure the frequencies of the alarm signal.

~~8.14.5.3 A primary frequency shall be at least 6 dB greater than the lowest detectable intensity between 1000 and 2000 Hz. 8.14.5.4 A new primary frequency shall have a valley of at least 3 dB between the two frequencies being measured.~~

~~8.14.5.5 The two primary pre-alarm signal frequencies and the three primary alarm signal frequencies shall be measured using the frequency analyzer.~~

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

8.14.6.2 ~~The three alarm signal primary signal frequencies shall be recorded and reported. The alarm signal shall be recorded at a minimum of 5 mega-samples per second, verified that it meets the requirements of Section 6.4.3.9, and reported.~~

Substantiation: The Technical Committee on Electronic Safety Equipment recommends that the PASS pre-alarm and alarm sounds be standardized so that in the future all PASS devices sound the same. This change will enhance recognition of both pre-alarm and alarm conditions, particularly when PASS devices from different manufacturers are on the fireground, as may occur, for example, when mutual aid departments are present. The recommended pre-alarm sound is defined in Section 6.4.2.9 and is based on sets of two alternating tones. This particular sound is unlike the recommended alarm sound. The recommended alarm sound is defined in Section 6.4.3.9 and is based on a particular class of sounds known as chirps, which sweep from one frequency to another. Chirp signals are commonly used in radar, sonar, and medical imaging systems because of their superior ability to be detected in the presence of competing noise sources, as typically occurs on the fireground.

Committee Meeting Action: Accept

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

Comment on Affirmative:

FEELY, M.: sec. 6.4.3.9 a typo exists in the tolerances for the type 3 chirp

sec. 6.4.3.9.2 the frequency mentioned in the type 2 chirp and the type 3 chirp appear to be similar. Not sure if this was the intent of the proposal.

GESTLER, C.: The proposed PASS alarm sound was tested against our existing sound and while the peak SPL value is roughly equivalent, the average SPL is significantly less due to the longer pauses in the sequence. It would be beneficial to increase the average SPL by decreasing the pauses in the sequence, making detection of the PASS alarm by humans more likely.

In addition, the timing requirements are very difficult to achieve. The 0.01% tolerance on the silent intervals between the tones is overly restrictive and the 0.1% tolerances on the frequencies and tone durations may be very difficult to meet.

1982-14 Log #6 FAE-ELS
(6.4.3, 7.1.2, and Chapter 8)

Final Action: Accept in Principle

Submitter: Bruce H. Varner, Santa Rosa Fire Department

Recommendation: Change Sections 6.4.3, 7.1.2 and Chapter 8 to provide that the "Alarm Signal" on all PASS devices meeting the requirements of the standard SHALL provide an identical sound that is clearly identifiable as the "Alarm Signal".

Substantiation: Currently different manufacturers of PASS utilize different sounds that meet the requirements of the standard. This can result in confusion on the fire ground as to the meaning of the sounds and a failure to identify a distress alarm. This is of particular importance when departments are operating in mutual aid scenarios where there may be multiple brands of PASS devices worn by firefighters from different agencies.

Committee Meeting Action: Accept in Principle

See Committee Proposal 1982-3 (Log #CP2).

Committee Statement: The technical committee accepted the proposal in principle, and is providing text to address the proposal. See Committee Proposal 1982-3 (Log #CP2).

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

1982-15 Log #1 FAE-ELS
(6.4.3.5, 7.1, and 8.2)

Final Action: Reject

Note: This Proposal appeared as Comment 1982-34 (Log #95) which was held from the F2006 ROC on Proposal 1982-2.

Submitter: John G. Casali, , Jeff A. Lancaster

Recommendation: Casali and Lancaster of Virginia Tech were asked by NFPA TC/ESE to provide a draft of a test protocol for acoustic alarms ONLY under NFPA 1800. This test protocol was presented in draft at the January 2006 meeting. It was not in final form, and is now under study by a Task Group (TG). Our concerns with NFPA 1982, 6.4.3.5 and Section 7.1, center on the sound pressure level (SPL), frequency content, and lack of a comprehensive test protocol (Section 8.2) to verify these parameters, and in addition, to verify the directionality of the alarm that is so critical to providing localization cues needed by rescuers. The alarm and its test specification for 1800 should be accommodated in the 1982 requirements.

In regard to the temperature test on acoustic alarms, we believe that if this type of test is adopted (and we clearly understand the need for it), there also should be a methodology for relating (analytically) the SPI measured in the temperature chamber to that obtained in the umbrella 1800 acoustic test protocol. This "predictive" relationship would likely be quantified via regression equations, and based on a large and diverse test sample of products.

Substantiation: The comment above was meant to convey the complex nature of the issue, and the fact that the TG assigned to the issue has not had time to adequately review and discuss the issue by the time of this standard's comment submission deadline.

Committee Meeting Action: **Reject**

Committee Statement: The technical committee rejected the proposal because there was no specific recommendation for change.

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

1982-16 Log #2 FAE-ELS
(6.13.5)

Final Action: Reject

Note: This Proposal appeared as Comment 1982-36 (Log #72) which was held from the F2006 ROC on Proposal 1982-2.

Submitter: David E. Mills,

Recommendation:

Include 1982_L2_R.doc

Substantiation: Adding the Audibility Correlation Test During Heat Stress Test) will eliminate the need to have audibility measuring equipment located inside the variable ambient oven, yet, verify that the samples produce acceptable results.

Committee Meeting Action: **Reject**

Committee Statement: The technical committee rejected the proposal as unnecessary because the measuring equipment is not located in the oven. Also, the proposed test protocol lacks sufficient data to provide meaningful results.

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

Add text to read as follows:

6.13.5 Audibility Correlation Test (During Heat Test)

6.13.5.1 Prior to conducting the Heat Test, the sound pressure output for the PASS device shall be positioned on the horizontal plane “x” distance for the acoustic measuring device. The sound measuring device shall have the capability of measuring the A-weighted sound pressure (“x” represents the distance defined by the manufacturer in order to safely conduct the audibility test). Detailed test methods shall be maintained by the manufacturer.

6.13.5.2 The Heat Test shall be conducted.

6.13.5.3 Following 5 minutes of exposure as identified in the Heat Test “paragraph TBD”, the sound pressure of the sample shall be recorded using the same method noted in 6.13.5.1.

6.13.5.4 The sound pressure correlation measurement recorded in 6.13.5.1 and 6.13.5.3 shall use linear regression calculations consisting of a correlation coefficient confidence level of at least 95 percent and a minimum sound pressure equivalence of “sound pressure dbA TBD”

6.13.5.5 6.13.5.1 through 6.13.5.3 shall be repeated 3 times on 3 separate samples.

Rational:

In this method, linear regression can be used to approximate the best fit between two or more data points (measured data during Heat Test vs. Anechoic Chamber data) and the minimum sound pressure of “TBD” dbA.

Audibility Correlation Calculation Method Using Linear Regression:

Note that the entire polynomial solution has not been displayed, only the end result formulas. Detailed polynomial information can be found in reference material such as Probabilistic Methods of Signal and System Analysis by George R. Cooper and Clare D. McGillem.

General Theory:

Beginning with the equation of a line: $y = a + bx$

where

y = the minimum sound pressure that must be achieved during the Heat Test.

x = the minimum fixed sound pressure, “TBD”

a = the intercept point for the sound pressure as measured during the Heat Test

$$b = \frac{n \sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{n \sum_{i=1}^n x_i^2 - \left(\sum_{i=1}^n x_i \right)^2}$$

$$a = \frac{n \sum_{i=1}^n y_i - b \sum_{i=1}^n x_i}{n}$$

INSERT Artwork HERE
Scatter Plot Example

The Correlation Coefficient is a determination of how closely the data correlates to a straight line. The Correlation Coefficient will range from -1 to +1. At $r = -1$, the data lands directly on the line with a negative slope. At $r = +1$, the data falls directly on the line with a positive slope. If $r = 0$, the data cannot be approximated at all by the straight line.

Correlation Coefficient (r)

$$x = a' + b'y$$

where

$$b' = \frac{n \sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{n \sum_{i=1}^n y_i^2 - \left(\sum_{i=1}^n y_i \right)^2}$$

With b' now defined, the correlation coefficient, denoted as r or R , is:

$$r = \sqrt{bb'}$$

With the correlation coefficient now determined, using the Variance Explained or Confidence Factor (r^2), the variance in Y is predicted by the X variable. This means that we can assign a % relationship to the variance to best determine if the data obtained is sufficient enough to qualify the results.

$$\text{Variance Explained} = r^2 \times 100$$

Example:

A pass device is required to produce a minimum sound pressure of 110 dbA. During testing in the Anechoic Chamber, three different samples were tested with the following results:

Sample 1 – Produced a sound pressure of 115 dbA

Sample 2 – Produced a sound pressure of 110 dbA

Sample 3 – Produced a sound pressure of 112 dbA

The sound pressure is to be recorded before and during the Heat Test. The results recorded before the Heat Test will help identify the correlating minimum value that must be obtained during the Heat Test.

The following sound pressure results were obtained prior to conducting the Heat Test, but while the samples were in the variable ambient chamber.

The following sound pressure results were obtained prior to conducting the Heat Test, but while the samples were in the variable ambient chamber.

Sample 1 – Produced a sound pressure of 87 dbA

Sample 2 – Produced a sound pressure of 82 dbA

Sample 3 – Produced a sound pressure of 84.5 dbA

$$y = a + bx$$

$$x = 110$$

$$\text{slope } (b) = 1.0714$$

$$\text{intercept } (a) = -36.03571$$

$$\text{minimum Heat sound pressure reading } (y) = 81.8 \text{ dbA}$$

$$r = 0.9643$$

$$r^2 = 0.93\% \text{ confidence}$$

Scatter plot points are illustrated in the Audibility Correlation diagram as shown below:

INSERT Artwork HERE
Audibility Correlation

1982-17 Log #3 FAE-ELS
(6.13.5)

Final Action: Reject

Note: This Proposal appeared as Comment 1982-37 (Log #112) which was held from the F2006 ROC on Proposal 1982-2.

Submitter: Jeff A. Lancaster,

Recommendation: Add new text to read:

6.13.5 Audibility Correlation Test (During Heat Test).

6.13.5.1 Prior to conducting the Heat Test, the sound pressure output for the PASS device shall be positioned on the horizontal plane "x" distance from the acoustic measuring device. The sound measuring device shall have the capability of measuring the A-weighted sound pressure ("x" represents the distance defined by the manufacturer in order to safely conduct the audibility test). Detailed test methods shall be maintained by the manufacturer.

6.13.5.2 The Heat Test shall be conducted.

6.13.5.3 Following 5 min. of exposures identified in the Heat Test "paragraph TBD", the sound pressure of the sample shall be recorded using the same method noted in 6.13.5.1.

6.13.5.4 The sound pressure correlation measurement recorded in 6.13.5.1 and 6.13.5.3 shall use linear regression calculations consisting of a correlation coefficient confidence level of at least 95 percent and a minimum sound pressure equivalence of "sound pressure dbA TBD".

6.13.5.5 6.13.5.1 through 6.13.5.3 shall be repeated 3 times on 3 separate samples.

Substantiation:

Include 1982_L3_S.doc

Committee Meeting Action: Reject

Committee Statement: See Committee Statement on Proposal 1982-16 (Log #2).

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

1982-18 Log #4 FAE-ELS
(7.1.2.2)

Final Action: Reject

Note: This Proposal appeared as Comment 1982-45 (Log #77) which was held from the F2006 ROC on Proposal 1982-2.

Submitter: Jason L. Allen, Intertek Testing Services

Recommendation: Add "at a minimum SPL of 75 dBA..." to 500 Hz requirement.

Substantiation: The committee has decided that 500 Hz is an important frequency for location of signals, and should specify a minimum SPL.

Committee Meeting Action: Reject

Committee Statement: The technical committee rejected the proposal as the TC has eliminated the 500 Hz requirement from the standard.

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

Rationale: In this method, linear regression can be used to approximate the best fit between two or more data points (measured data during Heat Test vs. Anachoic Chamber data) and the minimum sound pressure of “TBD” dbA.

Audibility Correlation Calculation Method Using Linear Regression:

Note that the entire polynomial solution process has not been displayed, only the end result formulas. Detailed polynomial information can be found in reference material such as Probabilistic Methods of Signal and System Analysis by George R. Cooper and Clare D. McGillem

General Theory:

Beginning with the equation of a line: $y = a + bx$

Where:

y = the minimum sound pressure that must be achieved during the Heat Test.

x = the minimum fixed sound pressure, “TBD”

a = the intercept point for the sound pressure as measured during the Heat Test

b = the slope of the line

Scatter Plot Example – Illustrates the best fit for the line for a given distribution of data points.

INSERT Scatter Plot Example HERE

$$b = \frac{n \sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{n \sum_{i=1}^n x_i^2 - \left(\sum_{i=1}^n x_i \right)^2}$$

$$a = \frac{n \sum_{i=1}^n y_i - b \sum_{i=1}^n x_i}{n}$$

The Correlation Coefficient is a determination of how closely the data correlates to a straight line. The Correlation Coefficient will range from -1 to +1. At $r = -1$, the data lands directly on the line with a negative slope. At $r = +1$, the data falls directly on the line with a positive slope. If $r = 0$, the data cannot be approximated at all by the straight line.

Correlation Coefficient (r)

Calculating the Coefficient b’ is as follows:

$$x = a' + b'y$$

where

$$b' = \frac{n \sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \sum_{i=1}^n y_i}{n \sum_{i=1}^n y_i^2 - \left(\sum_{i=1}^n y_i \right)^2}$$

With b’ now defined, the correlation coefficient, denoted as r or R, is:

$$r \equiv \sqrt{bb'}$$

With the correlation coefficient now determined, using the Variance Explained or Confidence Factor (r^2), the variance in Y is predicted by the X variable. This means that we can assign a % relationship to the variance to best determine if the data obtained is sufficient enough to qualify the results.

$$\text{Variance Explained} = r^2 \times 100$$

Example:

A pass device is required to produce a minimum sound pressure of 110 dbA. During testing in the Anechoic Chamber, three different samples were tested with the following results:

Sample 1 – Produced a sound pressure of 115 dbA

Sample 2 – Produced a sound pressure of 110.5 dbA

Sample 3 – Produced a sound pressure of 112 dbA

The sound pressure is to be recorded before and during the Heat Test. The results recorded before the Heat Test will help identify the correlating minimum value that must be obtained during the Heat Test.

The following sound pressure results were obtained prior to conducting the Heat Test, but while the samples were in the variable ambient chamber.

Sample 1 – Produced a sound pressure of 87 dbA

Sample 2 – Produced a sound pressure of 82 dbA

Sample 3 – Produced a sound pressure of 84.5 dbA

$$y = a + bx$$

$$x = 110$$

$$\text{slope } (b) = 1.0714$$

$$\text{intercept } (a) = -36.03571$$

$$\text{minimum Heat sound pressure reading } (y) = 81.8 \text{ dbA}$$

$$r = 0.9643$$

$$r^2 = 0.93\% \text{ confidence}$$

Scatter plot points are illustrated in the following Audibility Correlation diagram

INSERT Audibility Correlation Figure HERE

1982-19 Log #15 FAE-ELS
(7.6)

Final Action: Reject

Submitter: Craig Gestler, Mine Safety Appliances Company

Recommendation: Delete 7.6 and replace with:

7.6 Nonincendive. PASS shall be tested as being nonincendive as specified in ANSI/ISA-12.12.01, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, and shall meet the requirements for Class I, Groups C and D, and Class II, Groups E,F,G, Division 2 hazardous locations.

Substantiation: A Class I and II , Division 1 approval severely limits the amount of power available to a PASS device. This limited power results in quieter PASS alarms and shortened run times. If PASS telemetry is being considered, a Div 1 approval will limit transmitted power to under 500mW, severely limiting the range and penetration of the telemetry signal. In addition, the fire service operates in an environment that is better described by Division 2 where known explosive environments are not typical but can be expected to be encountered occasionally.

Committee Meeting Action: Reject

Committee Statement: The technical committee rejected the proposal. The TC accepted the report of the IS task group presented at the TC meeting in San Diego January 13-14, 2011 which recommended that no change be made.

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

1982-20 Log #13 FAE-ELS
(8.11.4.1.3)

Final Action: Accept in Principle

Submitter: Michael G. Feely, Boston Fire Department

Recommendation: Add text to read as follows:

A third test shall have the specimen positioned where the annunciator is oriented in a position that will contain the most water.

Substantiation: PASS devices may be found in many positions when a firefighter is down. The current test only reproduces two possible positions. There is a possibility that a PASS annunciator may fill with water and not be able to provide the necessary sound level.

Committee Meeting Action: Accept in Principle

Add new text to read as follows:

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.

Committee Statement: The technical committee accepted the proposal in principle, and provides the revised text as shown in the meeting action.

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22

1982-21 Log #5 FAE-ELS
(8.16)

Final Action: Reject

Note: This Proposal appeared as Comment 1982-102 (Log #73) which was held from the F2006 ROC on Proposal 1982-2.

Submitter: David Hodson, Draeger Ltd.

Recommendation: Revise text to read as follows;

PASS shall be tested for resistance to vibration as specified in Section

8.16 ~~Tumble=Vibration Resistance Test:~~ Environmental testing Part 2: Tests Test Eb and guidance: Bump BS EN

8.16 ~~Tumble=Vibration Test:~~ Environmental testing Part 2: Tests Test Eb and guidance: Bump BS EN 60068 2-29
1993

~~8.16.5.1 Test in accordance with appendix table 11 40g 6ms 4000 bumps in the as worn direction~~

Substantiation: This a more reliable test method and will stress the electronic components in a controlled and repeatable manner.

Committee Meeting Action: Reject

Committee Statement: The technical committee rejected the proposal because it believes this test to be unnecessary. The TC selected the tumble test that appears in the current edition of NFPA 1982.

Number Eligible to Vote: 22

Ballot Results: Affirmative: 22